SEPTEMBER

Radio-Electronics

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HUGO GERNSBACK, Editor-in-chief

ELECTRONIC IGNITION SYSTEM FOR YOUR CAR

Save gas and improve engine performance with this two-transistor, one-thyratron system. Easy to build and get working.

INDUSTRIAL SOUND SYSTEMS

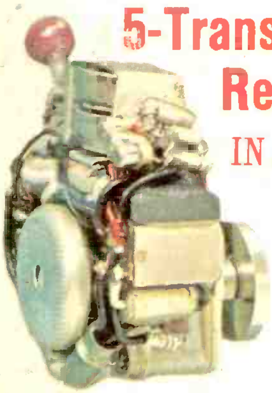
Sound installations in schools and industry have their own kinks and problems. This article tells you how to maintain and service them.

TALK ON A LIGHT BEAM

A few pieces of cardboard tubing, some lenses from a $1 surplus kit, a flashlight bulb and a photocell make a practical light phone.

HANDLING VERTICAL FOLDOVER

Wayne Lemons reveals the four causes of vertical foldover in a TV set; shows how to find and fix the trouble.



5-Transistor Receiver IN AN EARPHONE

SEE PAGE 4

You can build this little job entirely in a headphone earpiece. Receives stations to at least 25 miles with excellent quality.

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SYL 104	NPN, af-power amplifier	12 types
SYL 105	PNP, conv., mixer, osc.	30 types
SYL 106	PNP, if-amplifier	40 types
SYL 107	PNP, af-amplifier driver	60 types
SYL 108	PNP, af-amplifier output	65 types
SYL 109	PNP, af-amplifier pwr output (popular auto radio type)	54 types

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RADIO-ELECTRONICS published monthly at Mt. Morris, Ill., by Gernsback Publications Inc. Second-class postage paid at Mt. Morris, Ill. SUBSCRIPTION RATES: US and possessions, Canada: $5 for 1, $9 for 2, $12 for 3 years. Pan-American countries: $6 for 1, $11 for 2, $15 for 3 years. Other countries: $6.50 for 1, $12 for 2, $16.50 for 3 years.

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Radio-Electronics

SEPTEMBER 1961
VOL. XXXII No. 9

Formerly RADIO CRAFT — Incorporating SHORT WAVE CRAFT—TELEVISION NEWS—RADIO & TELEVISION*

editorial

radio

audio-high fidelity

electronics

test instruments

industrial electronics

television

—on the cover—

(Story on page 44)

Good things come in small packages. If you doubt it, you haven't taken a close look at the miniature 5-transistor superhet the girl on the cover is wearing over her right ear.

Color original by Irving Kaufman

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News Briefs

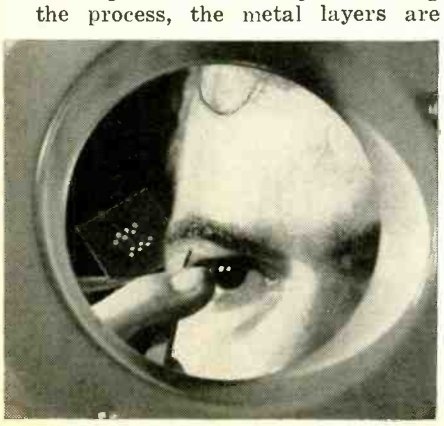
Pay TV Test Postponed

The RKO Phonevision Co. has asked the FCC to permit it to reschedule the date for starting pay television tests from Aug. 23, 1961, to July 1, 1962. The tests were to have been made in the Hartford area, from WHCT. The company reports that work is definitely going ahead, that station coding equipment will be installed by the end of 1961, and that 2,000 decoders have been ordered and that other arrangements of both a mechanical and organizational nature are being made to assure a successful test with a reasonable number of good programs "before asking the first member of the Hartford public to sign up as a subscriber."

Ultraminiature Transistors

Thin-film transistors are so small that up to 20,000 of them can fit on a postage stamp. This new device, which comes from RCA's David Sarnoff Research Center, is made by depositing thin films of semiconductor materials on an insulating base. Each finished device is only a few ten-thousandths of an inch thick. Using such transistors, it will be possible to shrink the basic circuitry of a computer to the size of a book page.

The active material used in the semiconductors is cadmium sulfide. In making thin-film transistors, an evaporation process is used to deposit successive thin layers of cadmium sulfide and metal on a glass plate. In the evaporation process, the cadmium sulfide crystals and the metal are heated in successive steps in a vacuum, turning to vapor that is collected by condensation on a glass plate. By using a special mask to cover portions of the plate during the process, the metal layers are deposited in a pattern that forms the electrical contacts needed to operate the transistor. The masking process can also be used to produce various patterns of connections among many transistors to complete a desired circuit at the same time the transistors are being made.



The completed transistor is not only very tiny, but also incorporates an important operating feature not now used in commercial transistors. In conventional transistors having comparable functions, electrons flow more or less freely through the semiconductor material between two of the contacts, and the third element provides control by reducing the flow in varying degrees. The operating principle of the experimental thin-film units is exactly the opposite. The insulating properties of the cadmium sulfide hamper the flow of electrons between the two electrodes, and the third element provides control by increasing the flow in varying degrees.

The photograph shows an enlarged laboratory test unit containing three thin-film transistors made in special elongated form on a glass base.

FCC Proposes FM Rule Changes

FM proposal recently issued by the FCC is aimed at simplifying station allocations. It sets up definite spacings for FM stations, as is now done in TV, and avoids the complex considerations used to calculate an AM transmitter's service area.

Three classes of commercial FM stations are proposed: class A, with an effective radiated power of 1 kw and 250-foot mast (the formula permits more power if the mast is lower or limits it for a higher mast); class B, 20 kw and 500-foot tower; class C, 100 kw and 2,000-foot antenna (above average terrain). Spacing of class-A stations would be 115 miles; class-B, 190 miles; class-C, 300 miles.

Two classes of educational stations are proposed: class D, 10 watts and 100 feet; class E, "same as for maximum commercial station at the same location."

Comments were asked on polarization of FM signals. The commission noted the growing number of FM auto radios, whose vertical antennas can receive a vertically polarized signal best. FM is now horizontally polarized, though circular polarization is permitted.

The question of duplication of AM and FM programs was also raised, with comments invited "as to whether complete or partial duplication should be allowed for any FM station."

Electronics Engineer Becomes Miss Universe

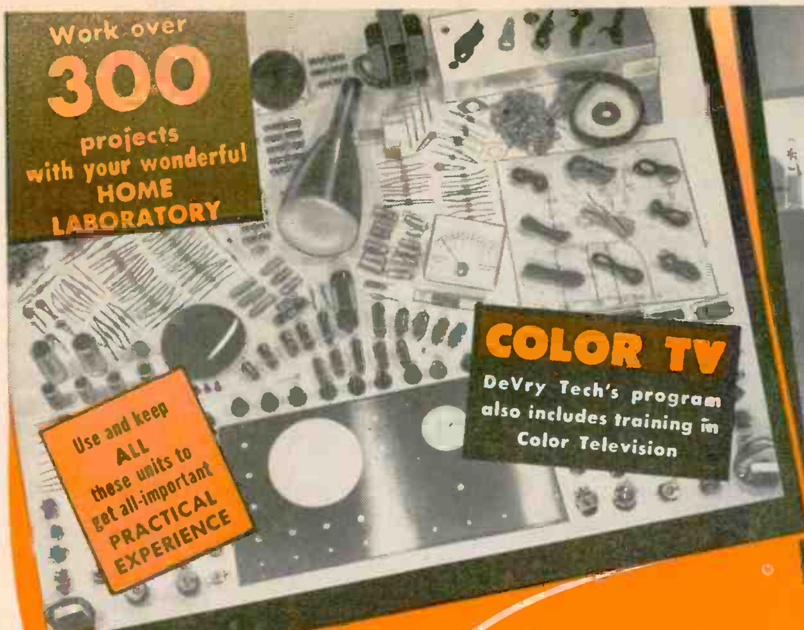
The 1961 Miss Universe is an electronics engineer who expects to return to the job as soon as her tour as Miss Universe is completed.

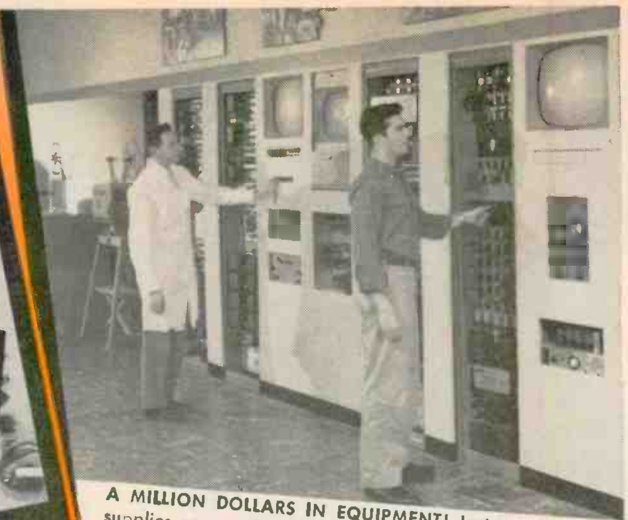
Marlene Schmidt of Stuttgart, Germany, is electronics' answer to Marilyn Monroe. She was crowned this summer at Miami, Fla., in competition with beauties from all parts of the world. A year of travel and guest appearances is one of the prizes. "But when the year is over, I will return to the job," says Miss Schmidt, who has been given a leave of absence by her employer. "Engineering is my career. I've been interested in technical subjects since I was 5." Anyone for engineering?

Kerosene Thermogenerator Powers Transistor Radio

A portable thermoelectric generator that can supply power for a transistor radio, and which runs for 24 hours on a pint of kerosene has been announced by Minnesota Mining & Manufacturing.

The kerosene lamp heats six thermocouples in the generator to produce about ½ watt of power at 0.75 volt. A built-in transistor converter steps this up to the voltage required to operate the radio (3 to 9 volts). The converter, according to 3M, will be sold at less than the price of a good transistor radio. Its chief use will be as an emergency and Civil Defense power source.





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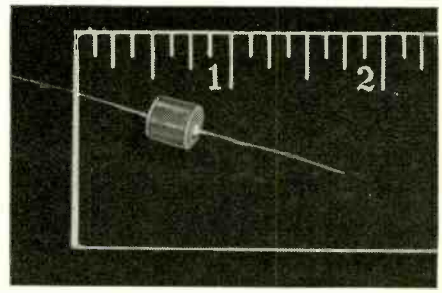
New "Solid-State" IFT

A new type of ceramic coupling unit announced by the U. S. Sonics Corp. of Cambridge, Mass., is expected to show some advantages over crystal and magnetostrictive filters, especially in price.

The new and very small device consists of two discs of a modified zir-



conate compound, approximately ¼-inch in diameter. These are in contact, and the coupling between them is acoustic. Input and output leads are to the outside centers of the two discs, and the common lead to a point on the inside circumference of both.

Two types were reported available, both at 455 kc. The transistor type is rated at 10 kilohms input, 1 kilohm output; the input impedance of the tube type is 25 kilohms and the output 200 kilohms. Insertion loss for both types is in the order of 1 db, and the bandwidth at 3 db down is 6 kc for the transistor type, 2 kc for the tube type.

Now—a Maser for Sound

The principle of stimulated emission has been successfully applied to sound waves, reports Dr. Guy Suits, head of the General Electric Research Laboratory. This is the first time, he states, that stimulated emission has been used successfully to amplify energy other than electromagnetic energy. While no immediate commercial application is visible, the maser technique may assist in the study of sound waves in many physical phenomena. It may also make possible an oscillator that can generate sound (ultrasonic) waves of higher frequency than now possible.

The equipment resembles that of the ruby light maser described in the May issue of RADIO-ELECTRONICS. As in the light maser, electrons are raised to a higher energy state than normal. Dropping back to their original state, they give out energy.

There is also interaction between the vibrations of the atoms in the crystal lattice and the energy states of the electrons, due to the electric fields of the atoms in the lattice. As the atoms vibrate, the electric fields acting on the electrons vary and this affects their energy levels. This interaction is what makes the *phonon maser* possible.

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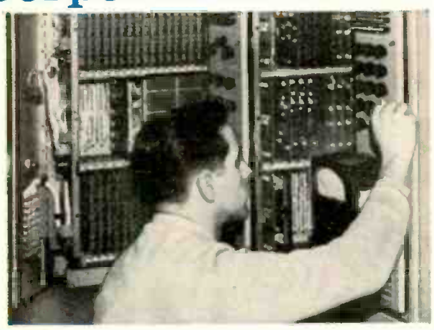

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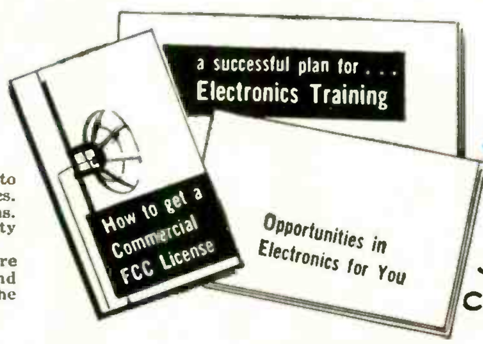

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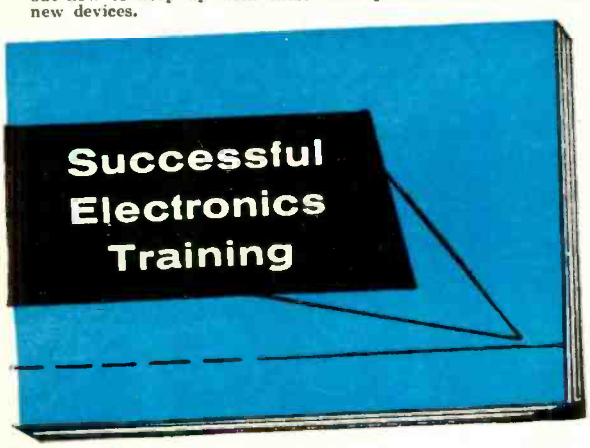

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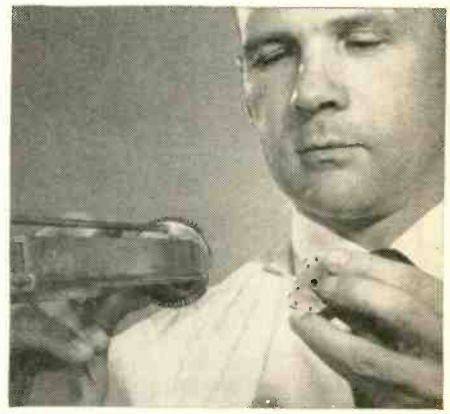
RE57B

To amplify by the phonon maser effect, as in the conventional maser, most of the electrons are raised two energy levels above the lowest by pumping with electromagnetic energy at a frequency which causes this transition (23 kilomegacycles in this case.) Then, when energy at a lower frequency is introduced, stimulated emission occurs.



Dr. Edmund Tucker of General Electric inserts ruby rod into phonon maser.

The phonon amplification is about 12% per centimeter of ruby. This is probably enough to overcome losses from crystal imperfections and deviations of the ends of the crystal from perfect flatness and parallelism. For high amplification, the waves must be reflected back and forth through the crystal many times, being amplified a little each time. The ends must be flat and parallel, or the waves reflect unevenly and interfere with each other. The ruby crystal is kept at a temperature of about 1.5° above absolute zero to minimize the effects of thermal vibrations.

Reliability the Keynote In New Transistor Plant

A semiconductor plant recently opened by Raytheon in Lewiston, Me., is "designed to produce transistors with 10 times higher reliability than presently available devices," according to Raytheon's president, Richard E. Krafve. Secret of the extremely high level of quality and reliability aimed at, company engineers explained, is a "continuous-flow" technique of quality control at all points in the process of manufacture, beginning with careful measurements and continuing with inspection of each step of the process, to the final checks on the finished transistor.

Flat Color TV Needed?

Protesting against present color TV set designs, Motorola demonstrated to its distributors an advanced design color TV receiver in a standard-size black-and-white TV cabinet. A special 23-inch 90° rectangular three-gun picture developed in the Motorola laboratory was used

(*Continued on page* 14)

(Continued from page 10)

in the set. Reducing the front-to-back distance by several inches, it adds 20-odd square inches to the viewing area.

Motorola's vice president Ed Taylor told the distributors that the new set was not an indication that Motorola was going into color. It meant that Motorola would not go into color until it could sell a set comparable to that on display. Information on the new tube is available to tube manufacturers, he said, and he "would like to see all the manufacturers in this industry put as much of their time and effort into advancing the color art in their laboratories as is being put into the marketing of receivers that are too large for the average-size American living room.

Molecular Radios Coming?

Radios in which the components will consist of thin films and dots on a piece of ceramic may be on the market "substantially before 1965," according to Westinghouse vice president Chris. J. Witting. One Westinghouse molecular block contains the equivalent of two stages of amplification—two transistors, several resistors and capacitors—on a "functional block" ¼ inch long, ⅛ inch wide and .03 inch thick. Three of these blocks stacked one on top of each other might contain the equivalent of all but the tuning circuitry and speaker of a six-transistor radio —on a "chassis" that could be dropped into the cap of a mechanical pencil.

Several companies have reported and demonstrated molecular components, and it is likely that others will be announcing their units in the near future.

"Citizens Band" for Canada

Following the US lead, Canada is to have a General Service band, roughly equivalent to the US Citizens band. Provisional specifications have been drawn up by the Canadian Department of Transport and forwarded to the Canadian Radio Technical Planning Board for comments. It is expected that either FM or AM will be permitted on the band, which will consist of 19 discrete frequencies in the 27-mc region. Radiation figures are being held within stringent limits, and there is some question as to whether kit-built equipment will be able to meet the specs. Power limit is 5 watts. No superregenerative receivers will be permitted. Starting date for the new service is next April, according to present proposals.

Flat Speakers Near

Flat but nonelectrostatic speakers appear to be just around the corner, from a number of reports. The Israeli speaker announced nearly 2

(Continued on page 20)

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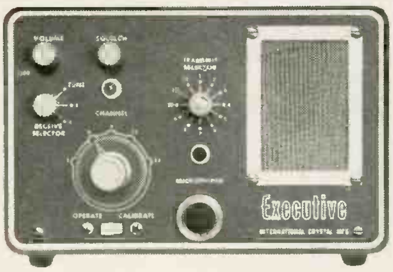

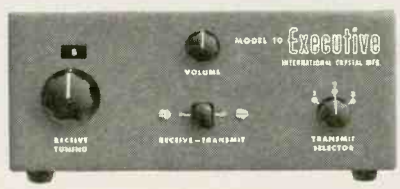

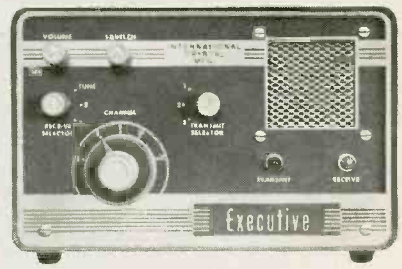

MODEL 100

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

$199.50*

MODEL 10

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

$59.50*

MODEL 50

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

$149.50*

*Suggested Price

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(*Continued from page* 14)

years ago (or one very much like it) is being manufactured in France under the name Orthophase. Emerson also demonstrated a model, for which they have obtained American rights from the Weizmann Institute in Israel. At about the same time, Bogen and Rich of Yonkers, N. Y., announced a speaker system containing a flat middle- and high-range unit that consists of a voice coil attached to a flat sheet between two sets of permanent magnets. (In the Israeli speaker, the voice coil is on ridges on a flat sheet, with magnets so placed that if the sheet excursions were large the magnets would enter troughs between the ridges.)

Calendar of Events

NATESA Convention, Aug. 17–20, Pick-Congress Hotel, Chicago.

Western Electronics Show and Convention, (WESCON) Aug. 22–25, Cow Palace, San Francisco, Calif.

Chicago High Fidelity Show, Aug. 25–26, Hotel Sherman, Chicago.

German Radio, Television and Phonographic Industries Exhibition, Aug. 25–Sept. 3, Berlin, Germany.

Danish RMA Radio & TV Show, Sept. 1–10, The Forum, Copenhagen, Denmark.

Conference of the Association for Computing Machinery and International Data Processing Exhibit, Sept. 5–8, Statler Hilton Hotel, Los Angeles, Calif.

IRE Symposium on Space Electronics and Telemetry, Sept. 6-8, Albuquerque, New Mexico.

IRE–AIEE–ASEE International Conference on Electrical Engineering Education, Sept. 6–13, Sagamore Conference Center, Syracuse University, Adirondacks, New York.

ISA Instrument Automation Conference and Exhibit, Sept. 11–15, Los Angeles Memorial Sports Arena, Los Angeles, Calif.

EIA Fall Conference, Sept. 12–14, Biltmore Hotel, New York, N.Y.

IHFM High Fidelity Show, Sept. 13–17, Trade Show Building, New York, N.Y.

AIEE-IRE Engineering Management Conference, Sept. 14–15, Roosevelt Hotel, New York, N.Y.

IRE Symposium on Engineering Writing and Speech, Sept. 14–15, Bellevue-Stratford Hotel, Philadelphia, Pa.

National Exhibition of Radio and TV, set for Sept. 14-25, Parc Des Expositions, Paris, France.

Instrument Society of America–AIEE–IRE Industrial Electronics Symposium, Sept. 20–21, Bradford Hotel, Boston, Mass.

IRE National Communications Symposium, Oct. 2–4, Utica, N.Y.

IRE Canadian Electronics Conference, Oct. 2–4, Automotive Bldg., Exhibition Park, Toronto, Canada.

IRE Annual Broadcast Symposium, Oct. 6–7, Willard Hotel, Washington, D.C.

IRE–AIEE National Electronics Conference, Oct. 9–11, International Amphitheatre, Chicago, Ill.

Audio Engineering Society Fall Convention and Technical Exhibit, Oct. 10–12, Hotel New Yorker, New York.

Stereo FM for Canada?

The Canadian Radio Technical Planning Board, representing the Canadian radio industry, has submitted proposals to the Department of Transport, Ottawa, for FM multiplex stereo broadcasting. (Radio in Canada comes under the jurisdiction of the Department of Transport.) The department is stated to be studying the matter, and it is expected that stereo broadcasting will be permitted. END

Correspondence

× = TRANS

Dear Editor:

Xmitter = Transmitter
Xformer = Transformer
So why doesn't
Xistor = Transistor?

NATE SILVERMAN

Los Angeles 26, Calif.

[Perhaps one day when transistors have been around as long as transmitters and transformers Xistor will be an applicable abbreviation. At present the abbreviation does not Xist, as far as we know. But then again, Xistor might turn out to be an actual device by that time and couldn't be used as an abbreviation for transistor.—*Editor*]

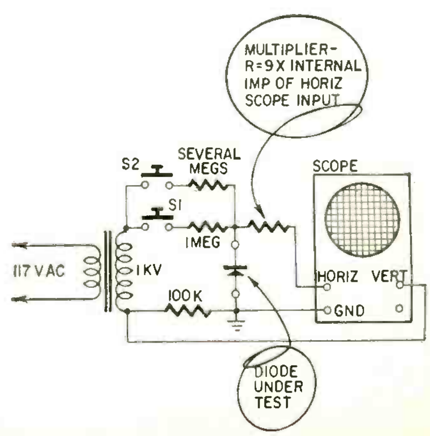
ALTERNATE TEST CIRCUIT FOR ZENER DIODES

Dear Editor:

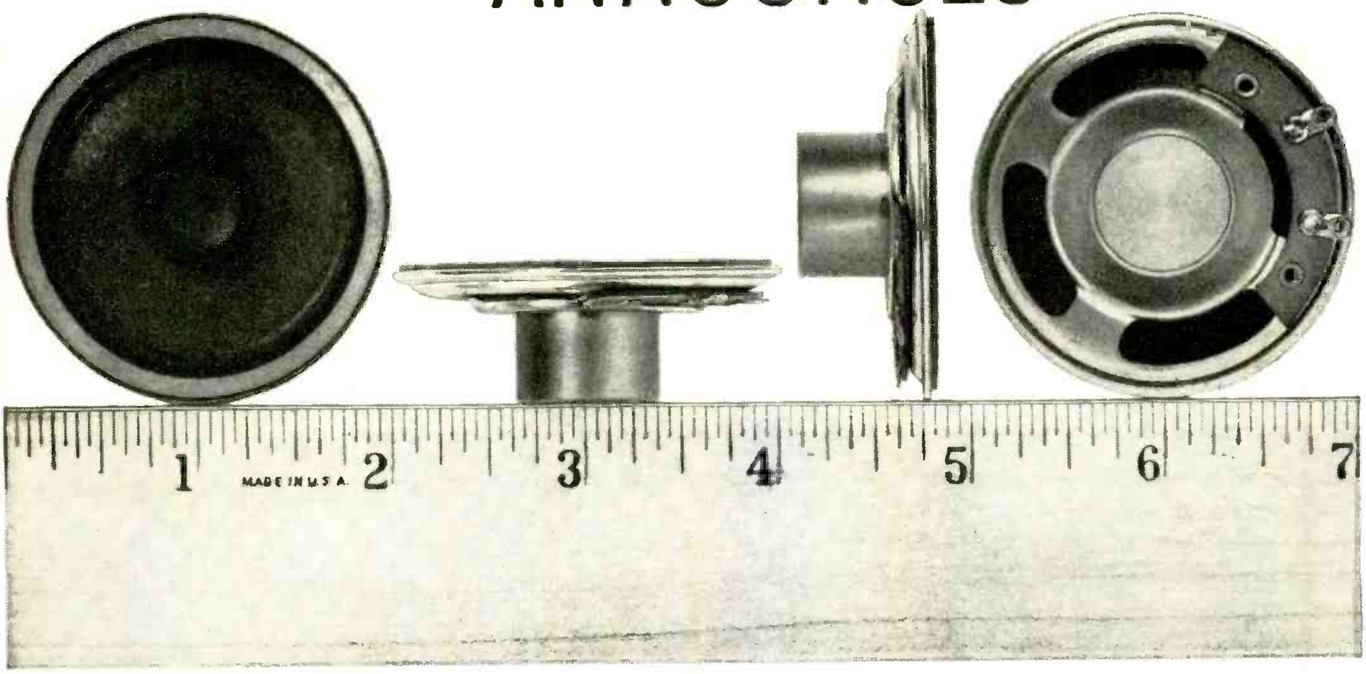
Mr. Donald L. Stoner's circuit for checking the Zener voltage of diodes in the January issue is very good with one exception. The 1-megohm resistor will form a voltage-dividing circuit with the internal resistance of the oscilloscope's horizontal input. This can range from 100,000 ohms to several megohms and can introduce an appreciable error when using the ac voltmeter. It may also seriously attenuate the voltage, making it impossible to Zener the diode.

The best approach is to calibrate the horizontal amplifier to read 10 volts per centimeter and then add a multiplier resistor which is nine times the input impedance of the amplifier (see diagram). This will reduce the voltage in the scope to a safe value and each centimeter will represent 100 volts. It will also reduce the voltage attenuation to a minimum.

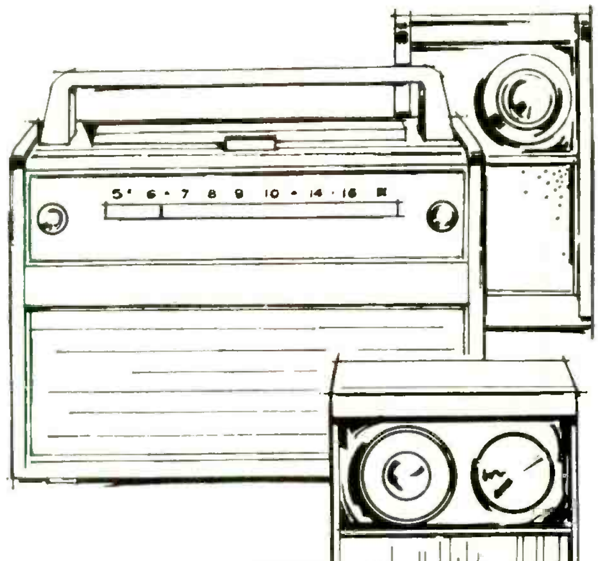
The Variac and voltmeter are not necessary with this setup. I used a 1,000-volt transformer with a push-button to apply the voltage. In testing



UTAH ANNOUNCES



...the first complete line of all-American-made replacement speakers for transistor radios!



Hardly surprising that Utah becomes the first domestic source for transistor radio replacement speakers. A pioneer in developing electronic and acoustical products, Utah uses only 100% American labor and 100% American parts in building these miniature speakers. Seven basic speaker models fit both imported and domestic sets. Performance equals or betters that of original equipment speakers. Compare these features and you'll see why it pays to buy and replace with all-American-made speakers from Utah!

• extra shallow baskets for clearance in crowded cases • special terminal strips keep basket depth wafer-thin • deeper models (SP25A, SP27A) for larger domestic sets will handle more power • all steel surfaces cadmium plated • voice coil impedance 12 ohms (correct value for most sets)

Model No.	SP2T	SP22T	SP25A	SP25T	SP27T	SP27A	SP3T
Size and Description	2" round	2¼" round	2½" square	2½" round	2¾" round	2¾" round	3" round
Total diameter	2"	2¼"	2½" sq.	2 19/32"	2 25/32"	2¾"	3"
Basket Depth	7/32"	¼"	½"	⅜"	11/32"	13/32"	11/32"
Total Depth	11/16"	¾"	1 5/16"	27/32"	13/16"	1 3/16"	13/16"

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Huntington, Indiana

more than 100 diodes, two broke down under test. These were probably weak to begin with. A second current-limiting resistor of appropriate value could be added for delicate diodes and could be controlled by a second pushbutton if desired.

R. G. ANDERSON
Field Service Supervisor
Friden, Inc.
Philadelphia, Pa.

90-DAY WARRANTY OK?

Dear Editor:

From what I have read in your magazine about this 90-day parts and labor business, I have come to one conclusion: that the service technicians should go to a school which will teach them how to think.

When a factory recommends a particular service shop, it is giving the shop a free plug. After the 90 days the shop charges its normal fee and has the customers who were referred to it by the company. It is obvious that a customer would much rather do business with a shop that is authorized by the factory, because he feels that they are specialists in repairing his piece of equipment.

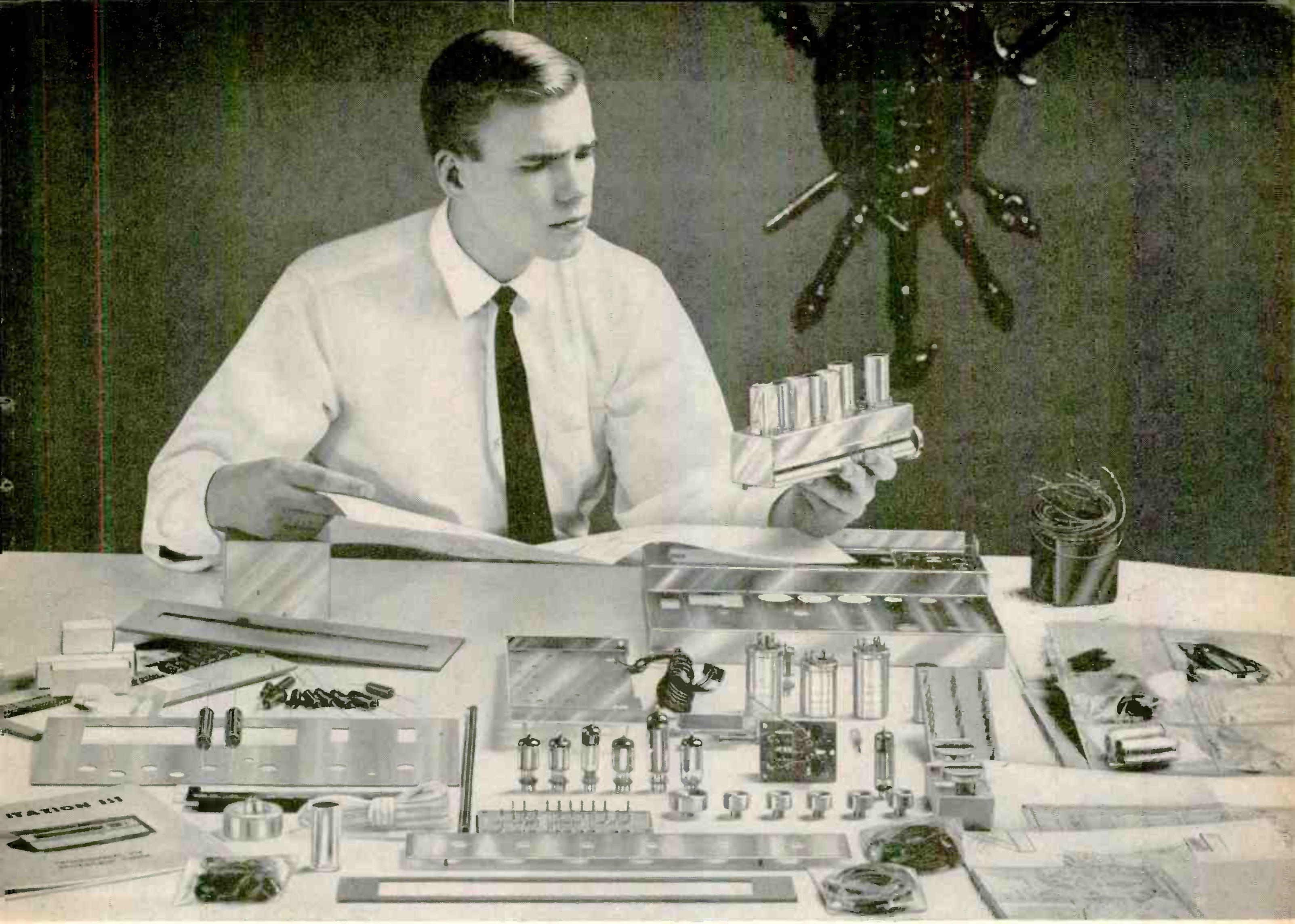
As for the fee, this is a matter that should be left up to the firm and the shop and not be abused in a magazine.

I would like to conclude by stating that any loss on the shop's part is its fault. I have found that, when a customer brings his set in on a warranty, the service shop kicks the set around, throws parts together without the least bit of concern as to whether they installed the part correctly, misadjusts or does not adjust the adjustments, and then wonders why the customer does not come back when the warranty is over. They then complain that factory authorization does not bring them permanent customers.

I know of one man who brought his record changer in to be serviced with the complaint that the changer made a great deal of noise on the 78 speed. When he got it back, he found the noise was gone, but in its place the tone arm did not track properly and, when he shut the changer off, the entire changer started to vibrate violently. (I found later when checking his set, that there was a misadjustment in the idler-wheel lever which caused it to disengage and then re-engage the motor pulley. So he returned the changer to the shop for repair and, when he got his set back again, he found that the vibration was still present and the changing mechanism was no longer activated by the pickup arm when it reached the end of the record. It is rather obvious that he never returned to that shop and they lost a customer.

HERBERT A. KATZ
Brooklyn, N. Y.

[You have passed very rapidly over the heart of this problem—what the technician should receive for doing a warranty repair. Obviously, his fee should be exactly the same as for the same job performed for a regular customer. If he gets less, he is losing money. As far as kicking a set around goes, this is not done by any reputable techni-



Can You Afford 15 Hours to Build The World's Best FM/Multiplex Tuner?

Fifteen hours. That's all it takes to build the world's best FM/Multiplex tuner.

Citation has the "specs" to back the claim but numbers alone can't tell the story. On its real measure, *the way it sounds*, Citation III is unsurpassed. And with good reason.

After years of intensive listening tests, Stew Hegeman, director of engineering of the Citation Kit Division, discovered that the performance of any instrument in the audible range is strongly influenced by its response in the non-audible range. Consistent with this basic design philosophy — the Citation III has a *frequency response three octaves above and below the normal range of hearing*. The result: unmeasurable distortion and the incomparable "Citation Sound."

The qualities that make Citation III the world's best FM tuner also make it the world's best FM/Multiplex tuner. The multiplex section has been engineered to provide wideband response, exceptional sensitivity and absolute oscillator stability. It mounts right on the chassis and the front panel accommodates the adapter controls.

What makes Citation III even *more* remarkable is that it can be built in 15 hours without reliance upon external equipment.

To meet the special requirements of Citation III, a new FM cartridge was developed which embodies every critical tuner element in one compact unit. It is completely assembled at the factory, totally shielded and perfectly aligned. With the cartridge as a standard and the two D'Arsonval tuning meters, the problem of IF alignment and oscillator adjustment are eliminated.

Citation III is the *only* kit to employ military-type construction. Rigid terminal boards are provided for mounting components. Once mounted, components are suspended tightly between turret lugs. Lead length is sharply defined. Overall stability of the instrument is thus assured. Other special aids include packaging of small hardware in separate plastic envelopes and mounting of resistors and condensers on special component cards.

For complete information on all Citation kits, including reprints of independent laboratory test reports, write Dept. RE-9, Citation Kit Division, Harman-Kardon, Inc., Plainview, N. Y.

The Citation III FM tuner—kit, $149.95; wired, $229.95. The Citation III MA multiplex adapter—factory wired only, $89.95. The Citation III X integrated multiplex tuner—factory wired, $319.90. All prices slightly higher in the West.

The Citation III

Build the Very Best **CITATION KITS** *by* **harman kardon** cian, warranty or no warranty! If you enlarge your investigation to include more than just the one case you describe, you will find you have described the exception and not the rule.—*Editor*]

ELECTRONIC IGNITION IS FOR ME

Dear Editor:

I built an all-transistor voltage regulator for my car after the February 1960 issue. It is installed in my 1961 Buick Special equipped with a Delco electrical system employing a 12-volt negative ground.

The regulator works exceedingly well. However, it has been in use too short a time to evaluate its durability and freedom from bugs.

I changed the value used for resistors R1, R2 and R3 shown in Fig. 3-a of the original article to improve the bias arrangement of V1. I use 6,800 ohms for R1; a 250-ohm wirewound pot for R2 and a 270-ohm resistor for R3.

I keep the current limiter in the stock regulator and suggest that anyone using this circuit do the same. This can be done by merely placing a piece of insulating material between the points of the stock regulator and running a lead from the current limiter to the transistorized voltage regulator much in the manner shown in Fig. 3-a. To avoid errors consult a diagram of the stock voltage regulator before making any changes. WILLIAM B. FRASER
San Francisco, Calif.

[Don't miss the electronic ignition system described in this issue. If you liked the regulator, you'll love this setup.—*Editor*]

USE A SHOCK SINK

Dear Editor:

On page 28 of the July issue, it was stated that transistors are not as sensitive to heat as has often been harped about. But don't throw away the long-nosed pliers because they're still useful as shock absorbers.

It is true that I have yet to ruin a transistor by soldering it into a circuit without using a heat sink, but it is also true that I destroyed an unknown number of transistors before I discovered that cutting the leads off with diagonal pliers may transmit a powerful shock into the device, thus separating the delicate connections inside. I found the failure rate to be as high as 5% in one test where I checked the transistors before and after clipping.

There are several precautions which will minimize this type of damage:

1. Use long-nose pliers at clipping time to absorb any shock.
2. Cut only one lead at a time to minimize total shock.
3. Cut with the back of the cutter jaw to reduce shock.
4. Sharpen your dikes for this purpose, removing the bevel edge on face.
5. A nice wire cutter is on the market. It looks like a miniature pair of tinsnips. Unlike diagonal cutters, the shock from the clipper (if any) appears at right angles to the lead being cut.

RICHARD L. SHAUM
Albuquerque, N. M.
END

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Central grad GLEN LEIRER, shown here, earned an attractive income from part-time Radio-TV Servicing. Now he's employed as a Computer Technician for RCA Service Co., Camden, N. J.

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"I averaged between $60 and $70 a month servicing radios and TV's part-time while taking your home study course. Plan to open my own shop soon." Student THEODOR SCHMIDT, Peshastin, Wash.

Central grads HOWARD EDMONDS & FLOYD CONKRIGHT are joint owners of EDCO FACTORY TV SERVICE CO., K. C., Mo., and RANCH MART TV & STEREO, Leawood, Kansas, have three service trucks, seven full-time employees.

Grad FRANK LEENKNECHT works in missile field for Convair Astronautics, San Diego, Calif., and as Transmitter Engineer for Station KDEO as a sideline.

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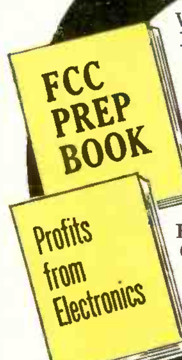

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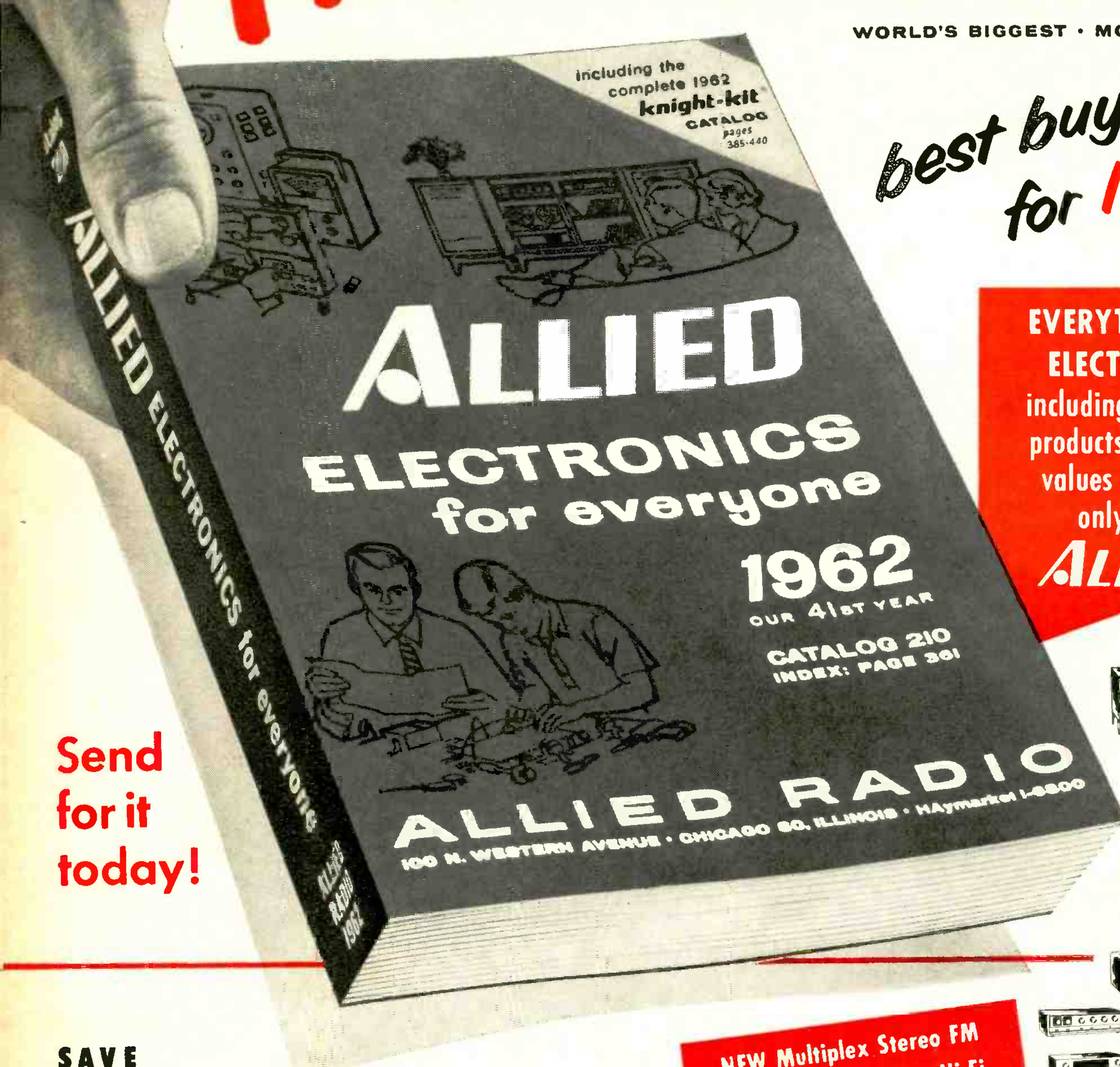

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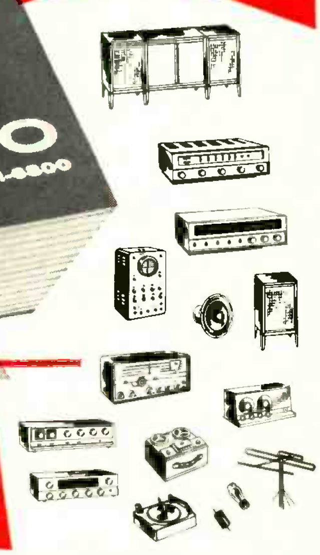

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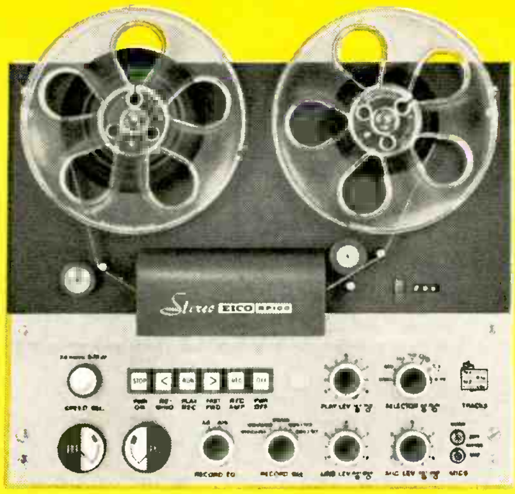

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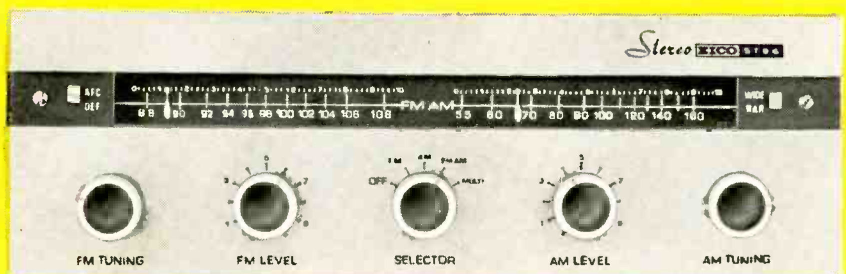

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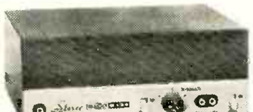

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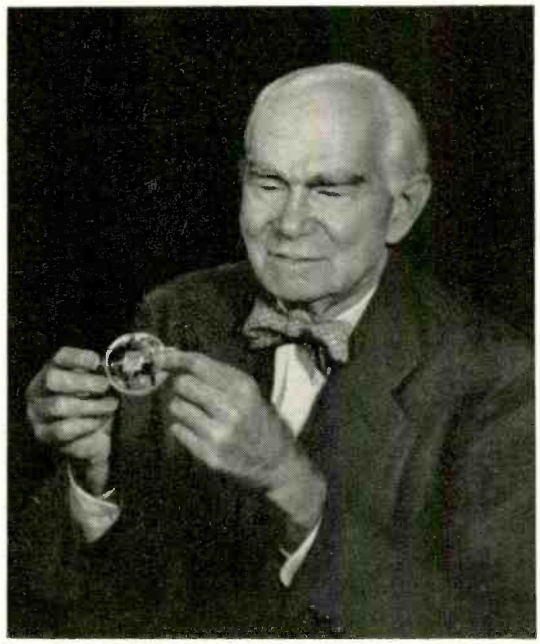
Lee de Forest
FATHER OF RADIO
1873-1961



LEE DE FOREST, ILLUSTRIOUS inventor of the Audion tube, died on June 30 from a heart attack, at his home in Hollywood, Calif. He was almost totally incapacitated since 1959 by an illness that kept him bedridden and that was to last almost 2 years. His legion of friends will be comforted that he died without suffering and in peace. His last signed letter to the present writer—one of hundreds—was dated June 6, 1959.

So passes a great historic era which ushered in not only radio but electronics as well. It was Dr. de Forest's vacuum tube—the Audion—that lifted the whispering wireless–crystal-detector age into the radio–loudspeaker age, where it has remained ever since. No one doubts that the electronic age began in 1906 with his stupendous invention, which in turn gave us amplification, regeneration and oscillation, making possible the radiotelephone, broadcasting, radar, television and the host of other incredible electronic wonders already here, with new ones still in the future.

Because his Audion—the first practical detector-amplifier—was one of the most brilliant and far-reaching inventions ever made, it fell to de Forest's unenviable lot to be constantly immersed in a long, fierce and costly series of patent litigations. So much was involved, not only in the US but in other countries as well, that everybody wanted to get into the act and share in the fabulous profits. The vacuum-tube gold rush was on.

First of the contenders was Dr. J. A. Fleming of England with his two-element valve, which could neither amplify or regenerate. He had not even invented it, but had lifted it—without credit—*in toto* from the real inventor. Edison had observed in 1883 the famed "Edison effect" which made it possible to send an electric current between a cold conductor and a hot filament in a vacuum. (To the credit of English scientists, Fleming a few years back was officially disowned as the inventor of the three-element de Forest vacuum tube, despite the long patent battle.)

Then there were patent suits in behalf of German and French contenders, plus a long list of American litigants, among whom were Maj. Edwin H. Armstrong, inventor of the superheterodyne circuit as well as superregeneration and the FM system now in increasing use and Dr. Irving Langmuir for the General Electric Co.

The expensive, decades-long patent suits finally ended in 1934 in the US Supreme Court in a full victory for de Forest, who by that time had gone through at least four fortunes running into millions of dollars. In 1936, he went into personal bankruptcy, with considerable liabilities and assets of only $390.

As is true of many inventors, de Forest had the misfortune of being associated with too many unscrupulous business managers and associates who looked out for themselves but not for him. Nor was he over much interested in business or money. His great urge in life was inventing.

A prolific originator and inventor, he had well over 300 patents. Aside from his Audion and numerous vacuum-tube circuit patents, here are a few of the more outstanding ones: a tubeless (dynamic) amplifier, a gaseous microphone, a diffraction microphone, a subterranean signaling system, a cautery high-frequency surgery device (he was operated on with one several years before his death), a telegraphone. De Forest was intensely interested in loudspeakers—he invented many different types of various principles; a thermionic pickup; talking-picture devices; a thermophone, a diaphragmless speaker. A television sign operated by remote control and various television patents, including stereoscopic vision, large picture size and others, were also among his achievements.

While de Forest, during his long and eventful life, had been honored with some eleven outstanding medals and decorations, including the recently awarded Cross of the Legion of Honor from the French Government, he was much disappointed that he never had been awarded the Nobel Prize. In private talks with this writer, the great inventor could not understand why Marconi should have been awarded the coveted prize while he, de Forest, with a much greater contribution in the arts, should not have been so honored.

Accordingly, in March 1955, RADIO-ELECTRONICS and the undersigned started a widespread campaign, petitioning the Nobel Fund, through the Swedish Academy of Science, in de Forest's behalf. Yet after the usual deliberation of the Fund, the result was negative. We were given to understand that the Nobel Prize in Science (physics) nowadays is given only for pure science, rarely for an invention. Unofficially we learned that there was not a sufficient number of votes for de Forest; certain individuals did not wish to vote because of their industrial affiliations in their respective countries. It became known, nevertheless, that the final voting was stormy. De Forest was heartbroken and stated so in a communication to us.

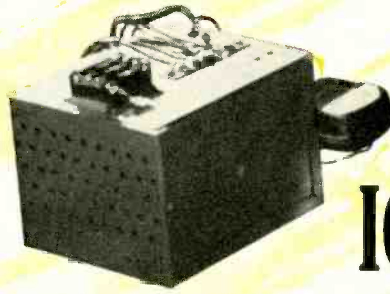
The celebrated scientist-inventor, who saw his Audion blossom into a world-wide, multibillion dollar business, died in very modest circumstances after a long protracted illness that consumed all his life savings.

As the undersigned stated in the January 1947, de Forest Anniversary Issue of this magazine, in a paraphrase of Winston Churchill:

"Verily, never in the history of the world has so much been owed by so many to one man—Lee de Forest."

—Hugo Gernsback

By CMDR. THURMAN E. SMITHEY



ELECTRONIC IGNITION FOR YOUR CAR

Build this transistorized electronic ignition system; it needs no critical adjustments

THIS CIRCUIT FEATURES A TRANSISTOR power supply with silicon rectifiers, a light to indicate system warmup, a tachometer, a quick-start auxiliary device, and an emergency switch which instantly restores conventional operation in the unlikely event of failure in the electronic system.

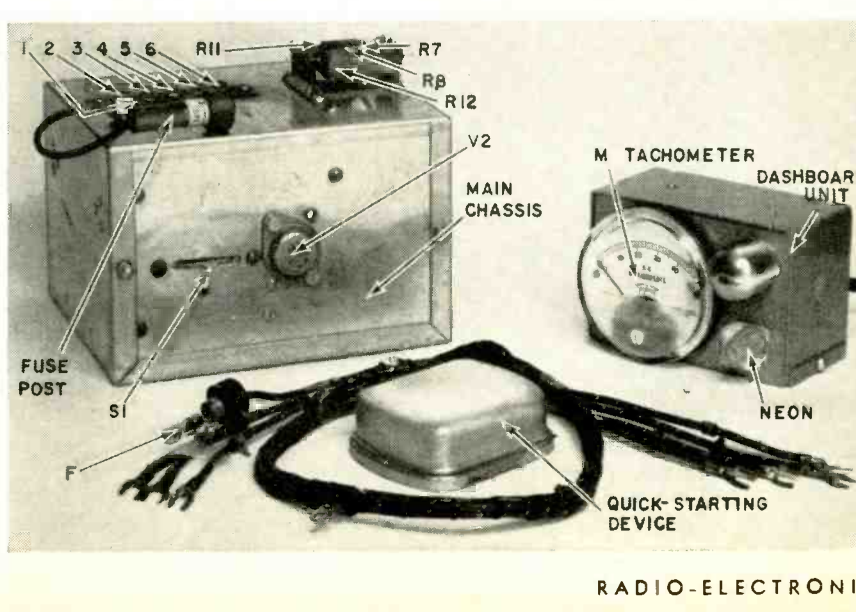
The idea of an electronic ignition system is rather old.[1, 2, 3] But an electronic ignition system which you can build and expect to work reliably *without any adjustments* on any automobile with a 12-volt electrical system may well be considered new.

In a conventional ignition system, the spark impulse is produced by interrupting the current in the primary of the ignition coil. (The "coil" is actually a two-winding transformer.) The collapsing magnetic field produces a high voltage in the coil secondary, which causes current to jump the gap in the spark plug. In the electronic ignition system, the spark impulse is produced by discharging a charged capacitor through the coil primary.

One advantage of this system is that operation is significantly faster, so the amount of charge placed on the capacitor is essentially the same regardless of engine rpm. This means that the energy in each spark is the same, regardless of rpm, and that ignition timing need not be noticeably retarded at high rpm due to large ignition-system time constants, as in conventional systems.

Fig. 1 is a simplified diagram of the electronic ignition system. Assume C2 is charged and that the distributor points are closed. The voltage at point A is zero. V's grid is biased negatively so that the tube does not conduct. At the instant a spark is required, the points open. Point A rises abruptly to 180 volts, in square-wave fashion. This abrupt rise of voltage at point A is coupled to point B through C1 as a positive voltage spike, since C1 and the combination of R2 and R3 form a differentiator circuit. The spike amplitude is large compared to the bias voltage, so V conducts. C2 then discharges through the coil primary and C3 in series with V as the switch. This discharge produces a spark across the spark gap at the desired instant. The transient induced in the coil primary is damped by RECT 2 and most of its energy recaptured to replace the charge removed from C3 during the pulse.

V, in its function as a switch, opens as soon as C2 is discharged. CH is important here. At the beginning of the



The three basic units of the ignition system.

pulse, the current through CH was zero. After C2 discharged through V, the current through CH could not start flowing rapidly enough to maintain ionization of V. Therefore, V extinquishes and becomes the open switch it was just before the pulse started. Current builds up through CH which, with C2, forms a resonant charging circuit. The effect of this circuit is that C2 is charged to about 700 volts from a total supply of 360 volts, and the system is ready for the next pulse. RECT 1 prevents the excess voltage on C2 from flowing back into the power supply. R5 carries the dc component of the current through C3.

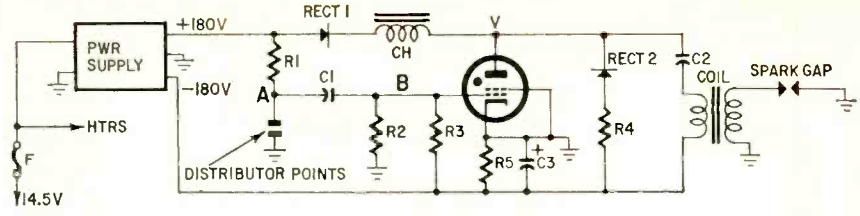


Fig. 1—Basic circuit of the electronic system.

Circuit details

Let's examine Fig. 2, the detailed schematic of the practical ignition system.

Note first that a thermal delay relay has been added to the circuit of Fig. 1. It prevents plate voltage being applied to V3 before the cathode has warmed up. Applying plate voltage sooner would injure the 2D21 and occasionally cause the thyratron to conduct continuously upon first warming up, preventing the proper conditions for pulse operation from ever being established. The nominal delay is 20 seconds.

Early in the work on this system this few seconds' waiting for system warmup, coupled with not knowing just when warmup was complete, prompted the installation of a neon indicating light and the network C3, R4, R5. The light flashes when the ignition system is turned on and stops flashing when the relay closes, indicating that the system is warmed up.

Before the system was reduced to its present form, I was somewhat reluctant to commit myself to the open road with mobility dependent on an unknown quantity. Switch S1 was installed as a safeguard. C7 is the original distributor capacitor. Remove it from the distributor and mount it inside the case of the electronic system. When S1 is thrown to the "emergency" position, the conventional ignition system is completely re-established with the exceptions that a fuse and S1 are in the circuit. In addition, C4 shunts the distributor during emergency operation, but C4 is small compared to C7 in parallel with it.

This switch also proved handy when leaving the car in the hands of a parking lot or service station attendant. A lot of explanation regarding the warm-up time can be avoided by merely throwing the switch. It also adds to the reliability of the overall system. As good as the electronic system is from a reliability standpoint, it still is undeniably more complex. Therefore, a simple backup system as provided by S1 is good to have. S1 is not designed to switch heavy currents, so always turn the ignition system off before changing the switch position in either direction.

A meter is connected in the circuit to read the average charging current through CH. This current is proportional to rpm so we have a convenient tachometer.

In practice the tachometer is linear, provided input voltage is constant, to only about 200 pps (pulses per second) (3,000 rpm on an 8-cylinder engine). The nonlinearity at higher pulsing rates is due primarily to drops in the power supply voltages.

Construction

The photographs show parts layout. Spacing and size of individual components are very critical in such a small cabinet (6 x 5 x 4 inches). If there is room, it would be wiser to use a larger case to simplify construction. R7, R8, R11 and R12 are mounted outside the cabinet for better heat dissipation. After this is done, the main

PARTS LIST (Fig. 2)
R1—82 ohms, 2 watts
R2, R3—33 ohms, 1 watt
R4—2.2 megohms
R5—1 megohm
R6—100,000 ohms, 2 watts
R7, R8—12,000 ohms, 2 watts
R9—270,000 ohms
R10—100,000 ohms
R11—100 ohms, 2 watts
R12—15 ohms, 5 watts
All resistors ½ watt 10% unless noted
C1, C2—10 µf, 450 volts, electrolytics
C3—0.5 µf, 200 volts, paper
C4, C5—.001 µf, 400 volts, paper
C6—1 µf, 1,000 volts, oil filled
C7—removed from distributor
CH—choke, modified Stancor C2326 (see text)
F—9 amps, 32 volts
M—0-50 ma, milliameter (Triplett 221-PL)
RECT 1, RECT 2, RECT 3, RECT 4, RECT 5, RECT 6—silicon rectifiers, 150 ma, 130 volts (Sarkes Tarzian M-150 or equivalent)
RECT 7, RECT 8—silicon rectifiers, 500 ma, 130 volts (Sarkes Tarzian M-500 or equivalent)
RY—thermal delay relay, 20-second delay (Amperite 6N020T)
S1—4-pole double-throw lever switch (Centralab 1458 or equivalent)
T—toroidal power oscillator transformer (Triad TY-69S)
TS—terminal strip, 6 screw terminals
V1, V2—2N554 (Motorola)
V3—2D21W
Tube socket, Vector turret, for V3
Pilot-light assembly (Drake 105 Postlite modified as per text)
Case to suit
Tube holddown for 2D21, Mini-Spring 21-A or equiv.
Tube holddown for Amperite relay, Mini-Spring 68-A or equiv.
Miscellaneous hardware

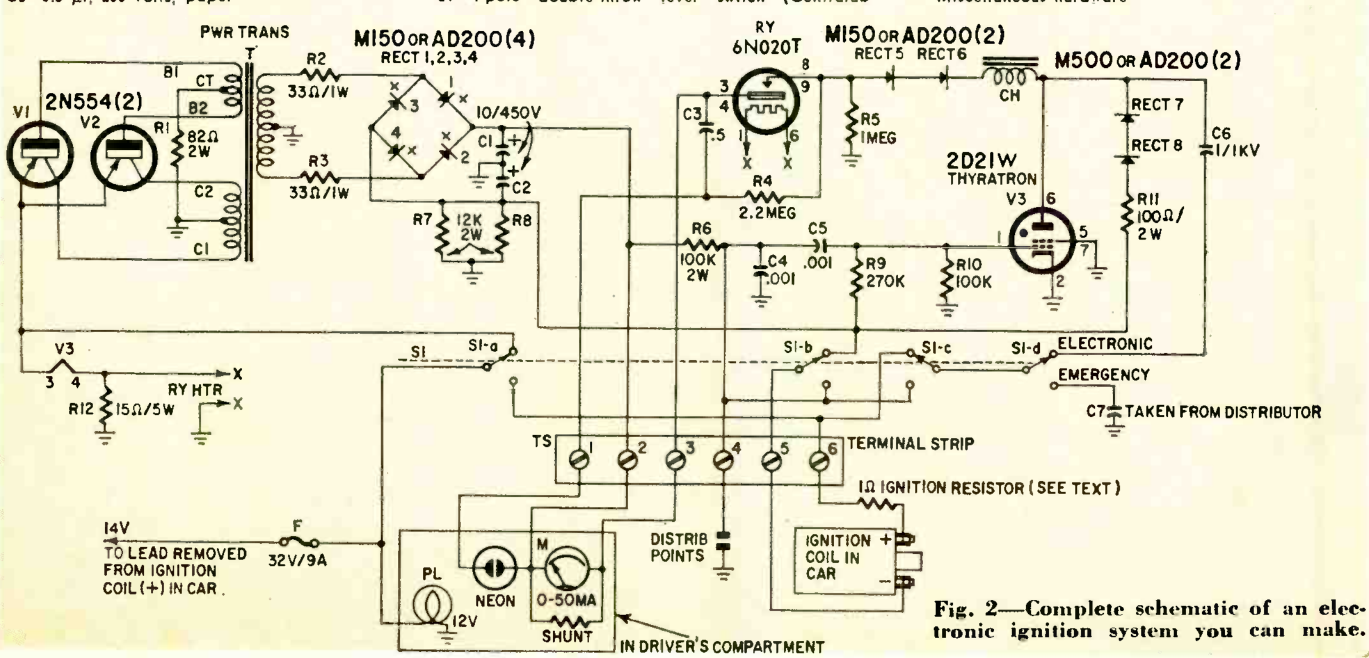
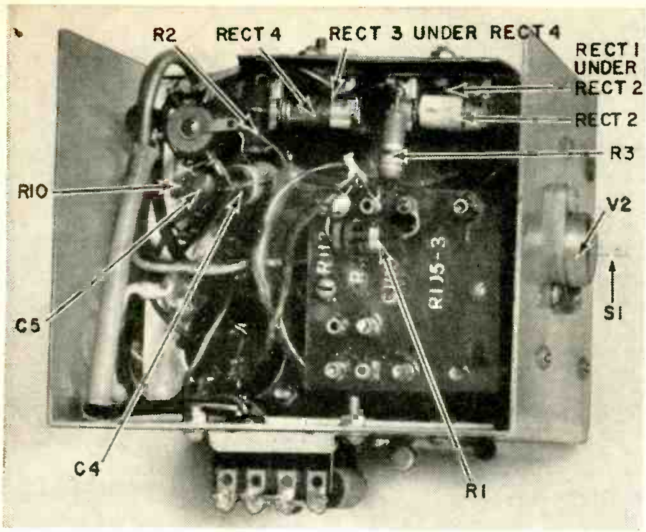
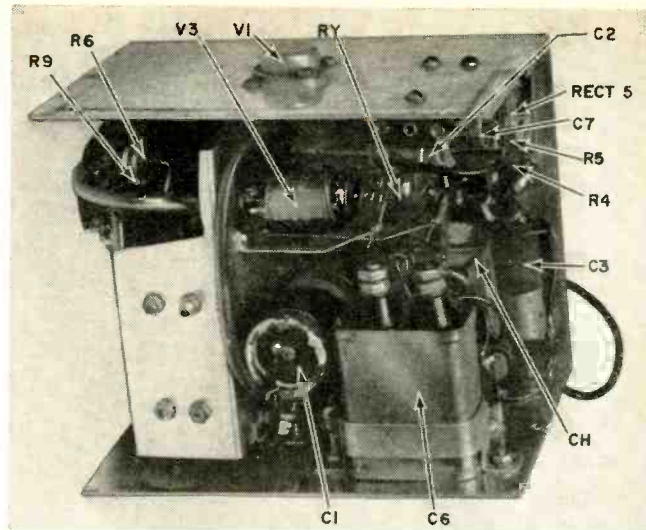


Fig. 2—Complete schematic of an electronic ignition system you can make.



Parts layout inside the main chassis.



Another view of the main chassis interior.

heat producers inside the cabinet are the heaters of the thermal delay relay and V3.

No leads require shielding. The usual good construction practices should, of course, be followed and the highest-grade components used. Remember, the unit will be subjected to extremes of heat, moisture and vibration in use. The failure of any component, connection or solder joint can put it out of commission. Build the unit ruggedly and clamp or tie down anything that can vibrate, such as long leads and heavy components. Use cambric spaghetti over hookup wire, and bundle small leads together inside pieces of large insulating tubing for protection.

Two components are modified before use. The indicator lamp is a Drake 105 Postlite which incorporates a base resistance. Use a soldering pencil to melt a hole in the base so you can get at the resistor, then short it with a jumper. An NE-2 neon lamp is a satisfactory electrical substitute, but presents mounting problems.

Choke CH must have about seven layers of its winding removed. Dc resistance of the units measured 42 ohms before wire removal and 27 ohms afterward. The choke must be carefully taped and reassembled for good reliability.

Both the transistors and the transformer in the power supply operate beyond their normal ratings at the higher rpm's. However, nothing has failed in many thousands of miles of high- and low-speed driving, so the overload cannot be serious. Power transistors other than the 2N554 have been tried in the circuit and have failed to oscillate, although by modifying the oscillator circuit it could certainly be made to work.

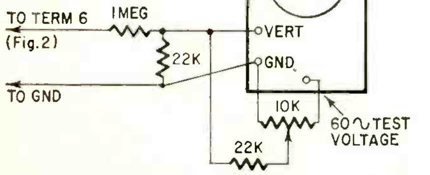


Fig. 3—Oscilloscope hookup for tachometer calibration.

Transformer T is a commercial unit, but some constructors may wish to wind their own[4].

Testing the completed unit

Initial tests can be conducted using any source of well filtered dc capable of delivering up to 5 amperes somewhere between 12 and 15 volts. A fully charged 12-volt automobile battery is adequate and a metered battery eliminator with fully controllable voltage is ideal. Remove V3 from its socket and apply input power. Check for positive and negative voltages of 150 to 180 at C1 and C2, respectively, and about 50 volts negative at pin 1 of V3. The neon indicator light, if connected, should blink continuously. When these checks are satisfactory, you are ready for the first operational test.

A quick check may be made on the car you're going to use with the unit. Connect the coil low-tension terminals to terminals 5 and 6 on the ignition system. Connect either a tachometer meter between 2 and 3, or short these terminals with a jumper. Remove one spark plug. Remove the coil high-tension lead from the center of the distributor cap and connect to the removed plug. Place the plug where its case is grounded and its electrodes are visible. With power applied, ground and unground terminal 4, using a short length of wire. At each ungrounding, a spark should be seen at the plug electrodes.

When the unit has been checked out, it is ready for tachometer calibration if one is used. Since the tachometer calibration is very sensitive to input voltage variation, it is best to calibrate the meter with the system installed on the automobile on which it is to be used.

You will probably find a 1-ohm resistor somewhere in your conventional ignition system. If convenient, leave this resistor in the coil circuit as shown in Fig. 2, or between terminal 4 and and distributor points. For electronic operation its effect is insignificant, but it is needed when conventional operation is restored with S1. The points burn very quickly if this resistor is not in the circuit. If physically inconvenient to incorporate it as shown, remove this little resistor from the circuit entirely but reinsert it if any extended conventional operation becomes necessary.

CAUTION: Make sure no other leads or radio noise-suppression capacitors are connected to the coil. Some automobiles incorporate a system for shorting out the resistor during starter cranking, and connections for this may be made at the coil. Such leads must be removed or starting will be impossible on electronic operation.

The input power lead should be connected to the lead from the ignition switch. Connect the other leads as indicated in Fig. 2. Observe the polarity markings on the coil and connect as shown. Remove the capacitor from inside the distributor and mount it inside the electronic system case. Connect the tachometer and start the engine.

Adjust an oscilloscope's horizontal sweep frequency to approximately 60 cycles. Connect the vertical amplifier to terminal 6 on the ignition unit through the network of Fig. 3. Adjust the 10,000-ohm potentiometer so the 60-cycle amplitude is about ¼ inch when the terminal 6 waveform is about 2 inches high. The pattern will now be steady only when the prf (pulse repe-

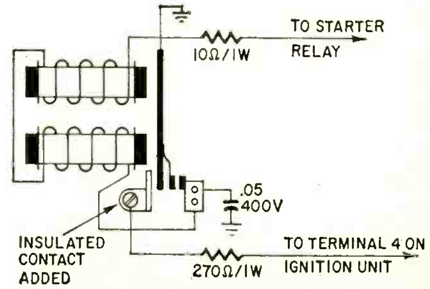
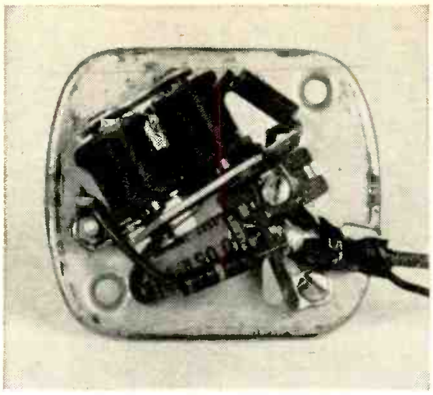


Fig. 4—Modified doorbell buzer insures a quick start.



Inside view of the little quick starter.

tition frequency) is exactly a multiple of 60 cycles. This will provide conveniently spaced rpm calibration check points, as follows:

No. Waveforms	*Prf*	*6-Cyl Rpm*	*8-Cyl Rpm*
1	60	1,200	900
2	120	2,400	1,800
3	180	3,600	2,700
4	240	4,800	3,600
5	300	6,000	4,500

I chose a 0–50-ma meter for the tachometer because the scale was readily adaptable for reading 0–5,000 rpm and the requirements on the necessary external shunt were not very severe. A satisfactory shunt was made from a length of the wire removed from CH. With the oscilloscope setup of Fig. 3, adjust the shunt till the meter reads correctly for 3,600 rpm on a 6-cylinder engine or 2,700 rpm on an 8-cylinder engine since these numbers represent calibration points near the top of the linear range of the tachometer in each case. The wire length will turn out to be about 30 feet for the 6-cylinder engine and about 22 feet for the 8-cylinder. When the exact length is determined, coil the wire and tape it to the back of the meter.

Quick-starting aid

You may have some trouble starting the engine when using the electronic system. I don't know the exact reason for this, but it's rather easy to cure. What is needed is a series of sparks in the firing cylinder during each compression stroke instead of only one as is normally provided. The system can provide the addition sparks, if it gets proper firing signals. The signals are supplied by a doorbell buzzer modified as shown in Fig. 4. I used a Rodale 6- to 8-volt ac doorbell buzzer. Somewhat different values from the 10-ohm series resistor and .05-μf capacitor may be required if another type of buzzer is used. The auto electrical system voltage is usually between 9 and 12 during starter cranking, so tests on the buzzer should be carried out in this range of voltages. A good value of series resistance is that which will just permit starting the buzzer at 9 volts. The best capacitor size is the one that gives minimum sparking at the points.

After these components have been determined and installed, add the additional contact and the 270-ohm resistor. Make the new contact from a small angle of any convenient metal stock which will not deform under the beating of the buzzer armature. This contact must be insulated from the buzzer case. Spacing between the new contact and the armature is not critical. The buzzer will do its job as long as some contact, even a high-resistance one, is made and then broken on each stroke of the armature.

The 270-ohm resistor isolates the buzzer from the distributor points when operating on the conventional system. If you leave it out, the added contact would be burned during starter cranking if S1 of Fig. 2 were positioned for emergency operation on the conventional system.

When the buzzer is completed, connect it as indicated in Fig. 4. It operates only when the starter relay is energized. Since the added contact is in parallel with the distributor points, the buzzer can have no effect when the distributor points are closed, even though it operates continuously. When the distributor points are open, however, the buzzer provides the electronic system with a series of firing signals in addition to the one provided by the distributor points. One of them is certain to fire the mixture on each compression, and quick starting is assured.

One difficulty may be encountered in using the buzzer. Some distributor caps are small, and plug wire contacts are closely spaced inside the cap. In one instance, the distributor rotor moved far enough during the time the points were open that one of the later sparks in each series was firing the plug ahead of the one intended. This left no unburned mixture in that cylinder to fire at its proper time, so the engine merely bucked the starter and would not start. The remedy was to round off the leading corner of the conducting part of the distributor rotor with a file. This confined the sparks to the desired plugs, and the trouble disappeared.

There is no reason for considering the buzzer a separate or auxiliary unit. If space permits, it should be mounted inside the main system box, adding one more terminal for the lead from the starter relay. In my case, the buzzer was developed after the box was already full. A 12-volt auto radio vibrator might make an admirable substitute for the buzzer, but has not been investigated.

Performance

Why, then, an electronic ignition system? Remember how well your car ran just after you had it tuned up last time? It will run like that all the time (as far as the ignition system is concerned) with an electronic system. Points can't burn—they just polish themselves. Spark-plug electrodes are not eroded as much because the spark duration is shorter. They should last much longer before requiring replacement.

Then there is the matter of speed. If you need ignition in a high-speed engine, a requirement that would normally dictate dual points or a magneto such as in racing cars or hydroplanes, this system is for you. Put in a heavier power supply and shave down on the charging inductance a bit, and you can run any 8-cylinder engine so fast it will fly apart before you exceed the capabilities of the electronic ignition system. This presupposes a set of points that can open and close properly at high speeds.

I have used the unit described in this article in a 1956 Ford V-8 and a 1960 Valiant. The Ford was driven about 5,000 miles with the electronic system. The Valiant has just been driven on a cross-country trip of nearly 4,000 miles using the electronic system. The 2D21 thyratron has been the only component to fail in either installation. It seems to require replacement about every 4,000 to 5,000 miles. END

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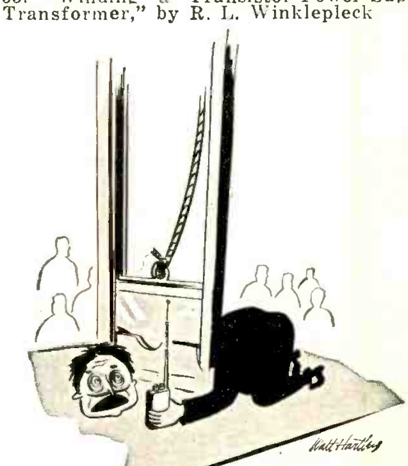
[2] *Ibid.* September, 1955, page 182, "Added Notes on 'Electronic Ignition System' "

[3] *Ibid.* June, 1956, page 106, "More Notes on Electronic Ignition System," by Charles Erwin Cohn

[4] RADIO-ELECTRONICS, October, 1960, page 55, "Winding a Transistor-Power-Supply Transformer," by R. L. Winklepleck

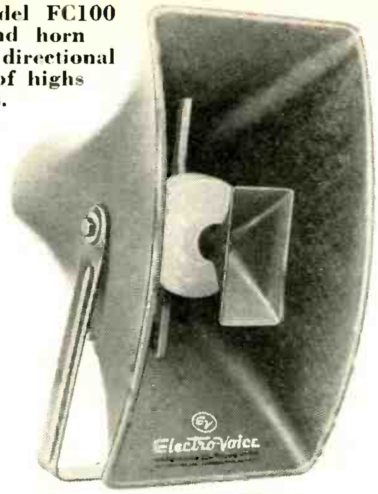


Help!"

SOUND SYSTEMS IN SCHOOLS AND INDUSTRY

What they are and how they work

By YVON O. JOHNSON*



The model FC100 compound horn permits directional control of highs and lows.

The AC100 is an 80° coverage speaker.

Jensen VR-11 gives 360° coverage in horizontal plane.

Shallow depth speaker makes in-wall mounting possible.

Many schools and industrial plants have complete sound systems. You as a service technician may suddenly find yourself called upon to repair one. This article will show you what such systems consist of, how they work, and how they can be serviced.

Schools have sound systems in auditoriums, gyms, stadiums, offices and classrooms. These may be simple amplifiers with one microphone and one or two speakers, or may be elaborate consoles like the Bogen Series III, which has 33 inputs! Consoles include mixers, preamplifiers, power amplifiers, AM–FM tuners, record players, provision for tape playback, remote-line input, tone oscillators and switch panels for program distribution or communication to one or more than a hundred rooms.

Schools and plants present profitable opportunities to the technician who goes after and gets that business. These markets also give the technician an opportunity to work on well designed and well built equipment. Space is usually not at a premium. Tubes and parts are readily accessible.

Let's look at the difference between commercial and home systems.

Electronics or electricity?

You are standing on the border between electronics and electricity. One step this way and you might have to be a state-licensed contractor; a step in the other direction, you need not be.

Your state may have a category of "specialized contractor" which permits you to install the 25- and 70-volt audio lines (more about these later) generally used in schools and industrial applications. Local codes may require running the 70-volt system through conduit. State codes may require grounding any electrical apparatus containing a motor through three-way connectors. A city code may go even further and state that all sound systems in schools must be grounded, motors or no motors.

Servicing and maintaining existing equipment does not require a licensed contractor unless there is a licensing law in your locality. It is a moot point, however, whether modifications—such as installing an additional speaker line—would be considered maintenance or installation!

The logical procedure for an electronics technician or firm that wants to specialize in this field would be to start at the maintenance end. This would give time to check into installation licensing while getting familiar with the equipment.

Constant-voltage systems

You'll get your first surprise—if you have worked previously only on home hi-fi equipment—when you discover that the output connections on the power amplifier have, in addition to the familiar 4-, 8- and 16-ohm taps (and possibly a 500-ohm tap), two other taps labeled 25 volts and 70 volts.

These two constant-voltage outputs are the ones generally used in school and relatively low-powered industrial applications. The 70-volt (70.7 volts to be exact) is usually used in installations that do not provide for intercommunication. Or the 25-volt system may be used—especially with intercommunication without callback or with high-level callback. (However, 25 volts is common in schools because the Los Angeles school system pioneered it.) Local electrical codes may have a bearing on which system is used: the 70-volt line may have to be installed in conduit, making it more expensive.

Some industrial sound installations use 100- or 140-volt systems, but most equipment you will come across will be 25- or 70-volt output. Intercoms usually have 45–50-ohm outputs.

What is "constant"?

The first point to clear up is that a constant-voltage system of, say, 25 volts does not necessarily always have 25 volts of audio across the 25-volt terminals. It should appear when the amplifier is supplying its *rated power* into its *rated load impedance*. In other words, the voltage across the output terminals would vary with volume level, frequency and load.

*Audio-visual building coordinator, Herbert Hoover JHS, San Francisco, Calif.

The output voltage is a *mathematical constant*, even though it isn't constant under operating conditions. Calculations for speaker matching assume that the amplifier is always delivering its full output voltage. Therefore, in solving for impedance or power, E in the formula is either a constant 25 or 70 volts.

Commercial installations use constant-voltage lines with matching transformers rather than direct connection to speakers (using the 4-, 8- or 16-ohm taps) or the constant-impedance system employing 250- or 500-ohm taps.

Direct connection to speakers is not practical for long runs because the power loss in the lines is excessive. It is somewhat more difficult to calculate the power distribution to the speakers in the constant-impedance system, but its main drawback arises when more speakers and a more powerful amplifier are added to an existing system.

Constant-voltage lines are sometimes balanced to minimize crosstalk with other outputs. This is done by connecting the amplifier ground to the voltage center tap (12.5 volts for a 25-volt line; 35 volts for a 70-volt line) instead of the "common" terminal.

Let's see how easy it is to match speakers to an amplifier when we use a constant-voltage system.

Power equals power

The designer first determines the total amount of audio power required. If he decides, as in Fig. 1, that he needs 15 watts delivered to one speaker, 10 watts to another, and 5 watts to the third and last, he needs an amplifier with a nominal power of 30 watts. (It would have a higher maximum power, but he is interested in the rated power for normal operation.) So the total power consumed in the system should be equal to or slightly less than the normal power output of the amplifier—never more.

The designer is not concerned with the fact that two 4-ohm speakers in series equal 8 ohms, or that two 1,000-ohm line-matching transformers in parallel equal 500 ohms. He needs to know only the amount of power he wants for a given speaker and the voice-coil impedance of that speaker.

Likewise, you need know only those two items to match a speaker properly to a constant-voltage line—assuming, of course, you know the rated voltage of that line.

Simply select a line-matching transformer designed for the voltage of that line and amplifier. If you have a transformer with a tapped primary (Fig. 2-a), choose the required power level terminals. Connect the speaker to the secondary terminals that match its voice coil. A check of catalogs will show the range of power that can be selected by these line-matching transformers.

Jensen lists 70-volt transformers covering, in the total line of transformers, ⅛ to 30 watts. Each transformer covers a part of that range. Electro-Voice also has a series of tapped primary transformers.

The line-matching transformers of the Bogen series shown in Fig. 2-b are slightly different. The power level is selected by the connections to the tapped secondary. The primary is not tapped.

As stated previously, it's not as convenient, but you *could* use a constant-impedance transformer. Calculate the primary impedance by dividing the desired speaker power level into the square of the voltage. Also consider power rating, frequency response, mounting and weatherproofing. This goes for the speaker, too.

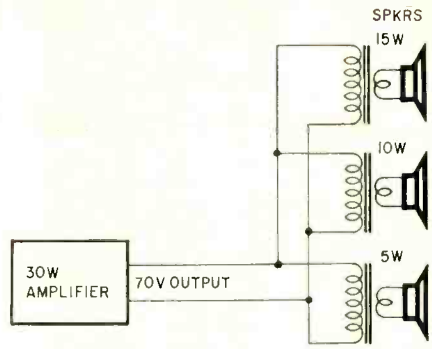


Fig. 1—Total power used to drive speakers equals amplifier power.

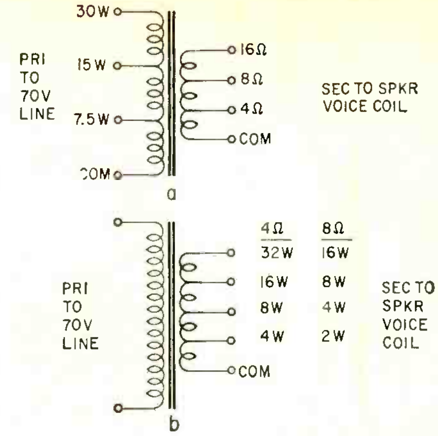


Fig. 2—Constant-voltage line-matching transformer: a — primary tapped for power; b—secondary tapped for power.

Proving it works

If the constant-voltage line-matching procedure seems too simple or contrary to all you know about impedance matching, let's take a look at Ohm's law formulas and prove that there is a perfect match between the amplifier and the speakers of our 30-watt 70-volt system. Its amplifier ouput impedance is:

$$(1)\quad Z = \frac{E^2}{P} = \frac{70.7^2}{30} = \frac{5{,}000}{30} = 167\ \Omega$$

So our 30-watt amplifier has a 167-ohm output impedance across the 70-volt terminals. (A 50-watt amplifier would be 100 ohms at 70 volts, and so on.)

According to basic amplifier theory, we should present a load of the same impedance to the amplifier for maximum undistorted power output. Let's see if our three speakers driven at 15, 10 and 5 watts, respectively, do present a total of 167 ohms to the amplifier:

$$(2)\quad Z = \frac{E^2}{P} = \frac{70.7^2}{15} = \frac{5{,}000}{15} = 333\ \Omega$$

$$(3)\quad Z = \frac{5{,}000}{10} = 500\ \Omega$$

$$(4)\quad Z = \frac{5{,}000}{5} = 1{,}000\ \Omega$$

So far we find that the 15-watt speaker and its transformer present a load of 333 ohms; the 10-watt speaker and transformer, 500 ohms; the 5-watt speaker and transformer, 1,000 ohms. Since the transformer primaries are in parallel, let's combine them according to the usual formula:

$$(5)\quad \frac{1}{Z_t} = \frac{1}{Z_1} + \frac{1}{Z_2} + \frac{1}{Z_3} = \frac{1}{333} + \frac{1}{500} + \frac{1}{1{,}000} = \frac{6}{1{,}000}$$

$$Z_t = 167\ \Omega$$

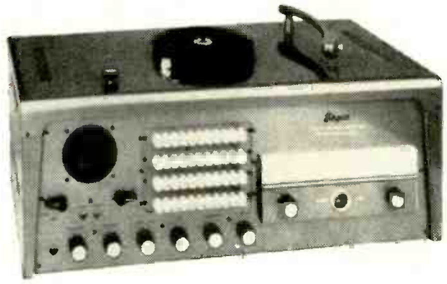
So we find that matching by power


Electro-Voice model TH waterproof transformer housing.


Jensen constant-voltage line-matching transformer.

Bogen Series III is a complete multi-channel sound-system console.

One-channel system with 30-watt amplifier for intercom or program is the TM 40 by Bogen.



in a constant-voltage system results in a proper impedance match when we use the full rated power output of the amplifier.

But in many systems, speakers are selected at the switch panel and only when they are all "on" is the amplifier working into the precise match of our example. Without all speakers on, we get a mismatch that results in a power loss. But we do not need the full rated power output since we are not using all the speakers.

Since the load impedance increases as we delete speakers and their transformers, the mismatch is in an upward direction which decreases the plate current of the output tubes. Switching on all speakers in a properly designed system merely results in a perfect match. The amplifier will never work into a downward mismatch which would cause excessive plate current unless more speakers were added or taps incorrectly selected.

If additional speakers are added, it is necessary only to replace the old amplifier with a new one capable of supplying the new total power to all speakers. Taps on the old line-matching transformers would not have to be changed. This is one of the major advantages of the constant-voltage system. Both amplifiers supply the same voltage (say, 70 volts) but the power increases and the output impedance decreases when the new amplifier is substituted.

Amplifier servicing

If the amplifier is new to you, read control labels, infer tube function by type and location, try various inputs to isolate the fault. You might even find a schematic inside the bottom plate.

Many troubles are mechanical or caused by abuse. I've seen an amplifier with a burnt-out output transformer because someone plugged leads from the output terminals into the 117-volt ac line! You'll find broken controls because someone insisted that there must be a switch on the control. You'll find broken keys in key-operated switches.

Large, jeweled, high-intensity indicator lights are often used to indicate that the power is on. Sometimes the indicator light is a neon glow lamp for longevity. Unfortunately, some pieces of equipment have the light behind a door on the equipment. In backstage installations, you may find the indicator light mounted on a nearby wall as part of the 117-volt ac circuit to the amplifier.

Don't assume the output line is connected to the proper tap—it may not be! Unfortunately, output terminal strips are often too accessible to the wrong persons. You may have to do detective work to determine how the system was originally set. For example, inspect line-matching transformers to find the line voltage rating.

Microphones

Amplifiers usually come from the factory with high-impedance microphone inputs. High-impedance microphones work fine with a 25-foot or shorter cable. You are familiar with these crystal, ceramic and, sometimes, dynamic units from ham work and Citizens-band, tape-recording and small portable PA systems.

In runs of more than 25 feet, you'll find low-impedance microphones of 30 to 50 ohms and (sometimes called "medium" impedance) 150 to 250 ohms. The amplifier's input must be changed to match the particular low impedance used. To do so, insert the manufacturer's plug-in transformer designed to match that mike. On some amplifiers you'll have to clip wires on the input transformer socket too.

High-impedance mike cables commonly are a single conductor within the shield while low-impedance mike cables are two conductors within the shield.

Some dynamic microphones such as the Astatic 77 and the Shure 55S have a built-in switch to give you a choice of 35 or 50 ohms, 150 or 250 ohms or high impedance. The Electro-Voice 636 can be either 150 ohms or high impedance, depending on which connector contacts you select. (Make up two cables: one for low-impedance input of the amplifier; another for the high-impedance input of a tape recorder.)

Not only do service opportunities abound in broken mike cables and damaged connectors, but there are sales opportunities for specialized microphones and accessories.

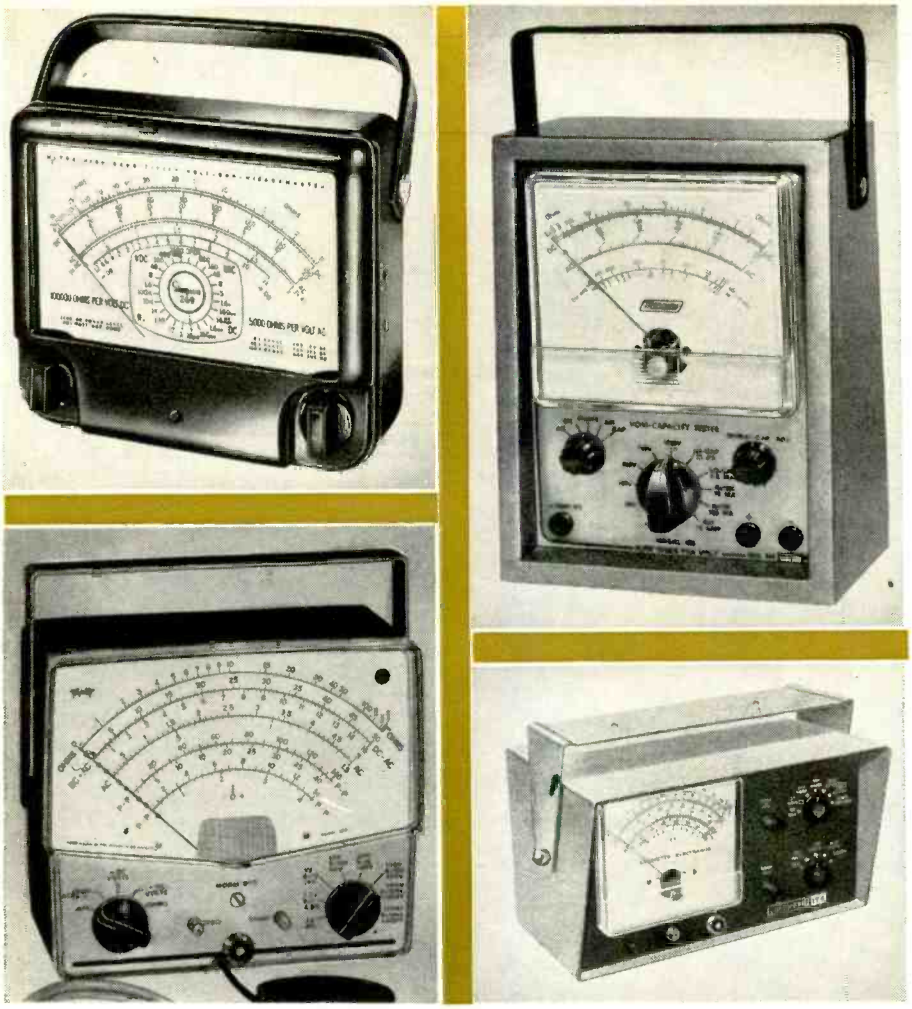
Mechanical know-how

If you contemplate working in this field, you must have, in addition to electronic experience and knowledge, quite a bit of mechanical aptitude. The mechanical portions of the equipment often break down before the electronic.

You also need a knowledge of wire and connectors beyond that required in TV servicing. Many otherwise good technicians are inept when it comes to handling shielded cables and connectors.

This interesting field can lead to profitable and pleasant work if you have the technical and business know-how. Schools and industry are willing to pay for competent and fast servicing—time is often of the essence. END

3,000 WATTS OF AUDIO give a big voice to baseball scoreboard at Comiskey Park, home of Chicago White Sox. Separate 100-watt amplifier feeds each of 30 speakers (24 are shown here). The complete system was built by Dukane Corp., St. Charles, Ill.



FULL VALUE FROM YOUR MULTIMETER

Servicing can be quicker and safer if you use your meter right.

By BARRON KEMP

EVEN though we seldom think about it, the multimeter is the most valuable tool in the shop. A basic and most useful instrument, it is used for troubleshooting, making ac, dc and resistance measurements, voltage and continuity checks.

First: Use your multimeter correctly! Errors can be expensive. Carelessness in making resistance measurements probably accounts for the greatest number of damaged multimeters. When we forget to set the voltage selector switch to the highest range before measuring unknown voltages in a circuit or forget to switch from resistance or current when measuring voltage, the meter suffers. In the minority but still adding to the injuries of our uncomplaining servant, are mishandling, jarring and dropping.

Measuring resistance

One of the most important uses of your multimeter is troubleshooting by measuring resistance. With ordinary care, there is not much chance of damaging the meter on these measurements. But be sure always to discharge all high values of capacitance before making resistance or continuity measurements! If you don't, voltage remaining in the capacitor may throw the needle of the meter against the stop pin, either ruining the meter or bending the needle. And don't measure resistances with the power on—you may find yourself measuring high voltage instead!

It is often difficult to check the resistance of individual parts and circuits because they are shunted by other parts in a circuit. Disconnect one terminal of the part or circuit from the rest to get accurate readings. *Keep your hot little fingers off the test prods!* They can louse up high-resistance readings because your body resistance is in parallel with the circuit being measured.

When you're through measuring resistance, set the selector switch to OFF or to the highest voltage range. This protects the meter against possible damage if you later use it for measuring voltage without first checking the setting. If you're going on vacation and won't be using the multimeter for some time, remove the battery.

Measuring current

When making current measurements, the circuit must be opened to insert the meter. Connect the meter with special care. It can easily be ruined if you set it to a low-current scale and connect it into a high-current circuit. The important thing to remember is that the meter must be in series with the circuit, and the current range you use must be high enough to pass the current. Also, you must watch meter polarity. When the meter is in the positive leg of the supply, as when measuring plate or screen current, the positive terminal goes to the source and the negative terminal to the load. Measure grid current with the negative terminal toward the grid and the positive terminal toward the bias source or ground.

Measuring voltages

Before measuring voltages check the circuit to see whether it's ac or dc; then set the meter accordingly. If the switch is set for dc and you connect the meter ac, it may be damaged. On dc, watch polarity too. When the voltage is positive with respect to the chassis, connect the negative test lead (black) to the chassis or other reference point first, then the positive lead (red) to the point being measured. If you're measuring a negative voltage, reverse the red and black leads, or throw the voltage reversing switch found on some multimeters.

A 60-cycle ac line voltage will cause the needle to quiver on dc meter settings. This can be destructive because the violent motion of the needle can shake the meter movement out of balance.

Unless your multimeter is designed to read peak voltages, only sine-wave voltages will give accurate indications on the ac scales. The ac scales of most meters used with multimeters are calibrated to read 0.707 times the peak value of the sine-wave voltage (the rms voltage). The meter indication multiplied by 1.414 will give you the peak voltage.

Rf voltages

Sometimes you'll find it necessary to measure rf voltages with a vtvm and rf probe. When measuring rf, a few precautions will prevent false readings. First, leave the tip of the probe as it is; do not extend it with a piece of wire for convenience. Such an extension causes erroneous readings at higher frequencies because the extension picks up stray radiated rf energy. Also, it's good practice not to grasp the probe too firmly or too close to the tip, or body capacitance may introduce additional errors. Another cause for erroneous readings when using a probe is a faulty ground connection or ground leads that are too long. One sign of a poor probe ground is the inability to repeat a voltage reading when the ground connection is shifted to another point.

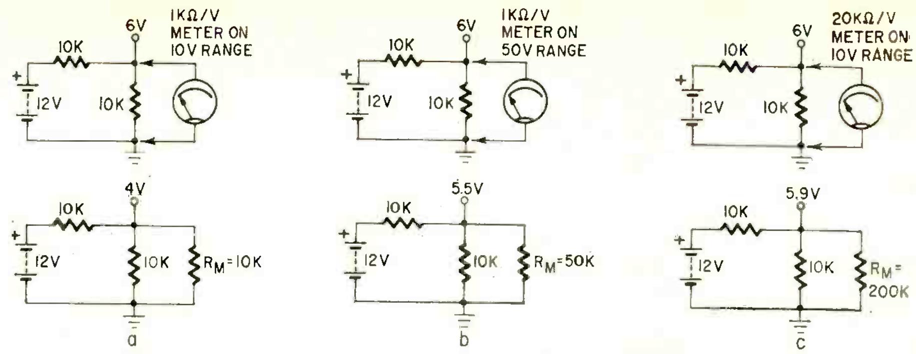


Fig. 1—Loading effect of voltmeter on circuit being tested: a—how low-sensitivity meter loads circuit. b—Circuit loading can be reduced by using a high voltage range c—Loading is minimized by using high-sensitivity voltmeter or vtvm.

Circuit loading

When a voltmeter is connected between two points in a circuit, the resistance of the meter is added to the circuit resistance and can change the circuit voltages. The meter "loads" the circuit. The amount of loading depends upon the meter's internal resistance. Since such loading results in a voltage reading lower than the actual circuit voltage, you should be aware of this and learn to allow for it.

Loading is a problem in both ac and dc circuits. In either case, the meter resistance or impedance should be many times the resistance between the meter and the point being measured. When the circuit has little or no series resistance, as in a power supply or battery, the meter drain is so small compared to the available current that loading is no problem. The loading effect of voltmeters is illustrated in Fig. 1.

To minimize circuit loading effects use a high-resistance voltmeter. For negligible loading when making voltage readings, the resistance of the meter should be at least 20 times that of the circuit being measured. Use the highest practical range which will allow an accurate reading. The higher the range used, the higher the total meter resistance and the lower the circuit loading. Use a vtvm if you have one. Measure the voltage on two or more ranges. If you don't get the same reading on all ranges, the meter is loading the circuit.

Extending meter range

Sometimes you'll have to measure a voltage that is beyond the range of your meter. Some meters have a high-voltage probe especially designed to extend their range, but maybe you don't have one of these contraptions. Don't be discouraged; there is a way to measure the voltage. Just add an extra multiplier resistor in series with the meter lead to increase the range of the meter (Fig. 2). You must know the meter sensitivity if using a nonelectronic meter, or the input resistance if using your vtvm.

It's convenient to increase the meter range by a factor of 10. Since the meter will now indicate 10,000 volts full scale, all readings must be multiplied by 10 to find the value of the measured voltage. For instance, if you're going to check a 7,500-volt circuit and have a 5,000-ohms-per-volt meter with a top range of 1,000 volts, first determine the total resistance required for measuring 10,000 volts full scale. Do this by multiplying the sensitivity of the meter by the desired full-scale voltage: that is, 5,000 ohms per volt multiplied by 10,000 volts, or 50 megohms. However, since the 1,000-volt range already has a 5-megohm multiplier resistor, only 45 megohms additional resistance is required in series with the meter lead for the meter to indicate 10,000 volts at full-scale deflection.

If your vtvm has a 20-megohm input resistance and a maximum voltage range of 1,000, add sufficient resistance to form a 10-to-1 voltage multiplier. In this case, the added resistance must be 9 times as great as the meter resistance, or 180 megohms. Since you probably don't have this value resistor around the shop, use a number of smaller ones in series to get the 180-megohm total resistance.

Isolating the meter

The capacitive effect of the test leads used to measure dc voltages cause a similar type of loading when rf is present. This type of circuit loading is noticeable mostly when the test leads are connected across a tuned circuit because the capacitance between the test leads can be large enough to detune the circuit. For example, when you try to measure grid bias in the local oscillator of a superhet, the loading can cause the oscillator frequency to change

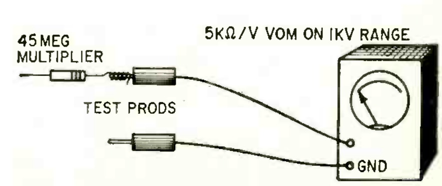


Fig. 2—Extending vom range by using multiplier resistor in series with internal resistance of the meter.

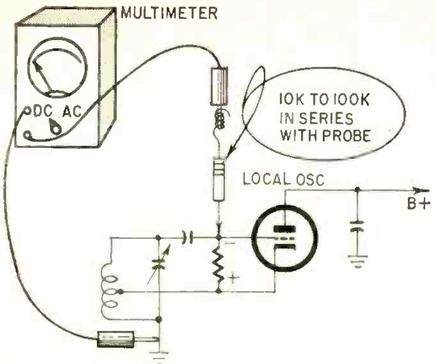


Fig. 3—Measure oscillator bias by using an isolating resistor to minimize circuit loading.

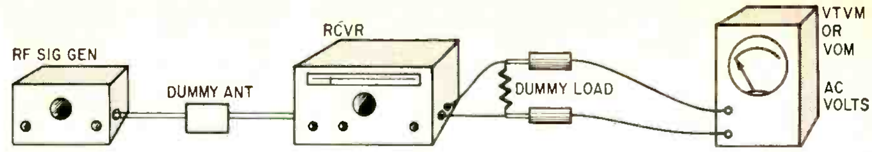


Fig. 4—Checking receiver sensitivity by measuring output power.

while the test leads are connected across the circuit.

To minimize this type of loading, isolate the circuit from the multimeter as much as possible by inserting a large resistor in series with your vtvm probe. This effectively separates the capacitance of the test leads from the circuit. Although the measured dc voltage is decreased slightly, this is unimportant.

An indication that low-powered rf circuits are working can be obtained with a low-sensitivity multimeter. Measure the grid bias, using a high value of resistance (10,000 to 100,000 ohms). The resistor can be clipped temporarily to the test point or may be wrapped around the test prod (Fig. 3). Although the voltage indicated on the meter will be influenced by the voltage-divider action of the isolation resistor and meter resistance, you know that an oscillator is working if there is bias voltage at the grid. Another indication of oscillation is that the needle of the meter will show a quick kick as the test prod is attached to the grid, then returned to zero.

Power level and db

The output of an audio amplifier must sometimes be measured to determine whether the equipment is operating properly. This requires an output meter. This kind of ac voltmeter usually has a selection of standard resistance loads which can be connected to the equipment being tested, and is calibrated in decibels.

An ac voltmeter and a resistive load can be used if you have no output meter. The normal loudspeaker load is not suitable for accurate power measurement since it does not have the same impedance at all frequencies. More uniform results can be obtained by using a resistive load. It must have the same value as the impedance of the amplifier output and have a power rating *at least* as great as that of the amplifier.

Since the meter can indicate only the ac voltage across the resistive load, you'll have to compute the power. Fig. 4 shows the setup for checking the sensitivity of a receiver. The receiver output should be a certain value when a standard modulated rf signal is applied to the antenna terminals. If the load resistance is 600 ohms and the minimum power output required is 100 mw, the voltmeter should indicate 7.75 volts or more. The exact value can be found from the standard power formulas, $E = \sqrt{PR}$, $P = E^2/R$. Since P is in watts, the answer will be in terms of watts—100 mw would be expressed as 0.1 watt.

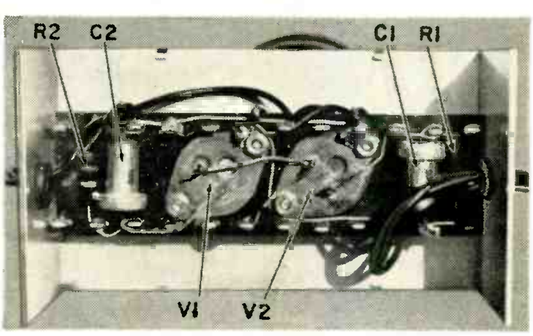
Ac voltmeters intended for use with audio frequencies usually have a db scale in addition to voltage scales. This makes it convenient to make power measurements when the power level is in db. The voltmeter uses a linear scale for ac voltage measurements and a nonlinear one for dc measurement.

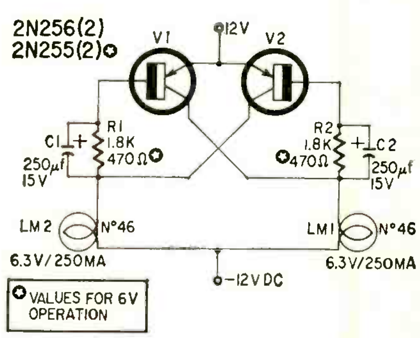
The scale of my meter (a Simpson 270) is calibrated to read directly in db when the meter switch is set to the 2.5-volt ac range and the meter is connected across a 600-ohm load resistance. The standard reference (0 db) measurement is 1 mw across a 600-ohm load. This corresponds to 0.775 volt. A correction factor must be added to or subtracted from the reading to obtain the true db level of 600 ohms. This correction factor is marked on the meter panel opposite the setting of the selector switch at each range and the figures are added algebraically. Different meters use different correction scales.

If the db meter is calibrated for 1 mw across 600 ohms and is used to make measurements across a load that is not 600 ohms, the db readings must be corrected to give the true value. A correction factor to add or substract from the meter indication is calculated from the formula: db correction to be added $= 10_{\log}600/Z$, where Z is the impedance of the circuit being tested.

To increase the usefulness of your multimeter further, adapters are available which permit using the multimeter for measurements not incorporated into its basic design (see "Test Adapters," July 1960, page 40). With these adapters, the multimeter can be used as a battery tester, transistor beta tester, ac ammeter and audio wattmeter. END

Electronic Flasher





Here's a nifty little two-lamp flasher that's an easy one-evening project. It uses two transistors in a multivibrator circuit. If you want to amuse the kids, build three of these circuits into one box, each with a different flash rate (adjusted by changing the value of the series resistors). Paint the lamps different colors, put a few toggle switches on top of the box and turn it over to the little ones. It's sure to keep them busy. It will also draw attention to store displays.

The lamps are connected in the collector circuit of the multivibrator transistors so when V1 conducts LM1 lights and when V2 conducts LM2 lights. A 12-volt battery powers the circuit. If you would rather use 6 volts as the power source, use 2N255 transistors and 470-ohm resistors. The photo shows the parts arrangement of one flasher. The lamps are connected externally. They could be mounted on the box.

If the lamps do not alternate properly, the transistors may be badly mismatched. Check by connecting a milliammeter in each leg to see if the currents balance. If not, adjust the resistors until they do.—*E. H. Marriner*

COVER STORY

SUPERHET IN A HEADPHONE

Tiny 5-transistor set covers the broadcast band — and it's not hard to make

The radio is worn like a headphone.

BY PHILIP DE LA ROZA*

The availability of subminiature components makes very compact radios possible. The five-transistor superhet described here fits into an headphone case. The set performs well. Even indoors, strong local stations come in clearly. Battery life is about 25 hours with a 4-ma drain. If a 2-foot length of wire is connected to the antenna lead going to the tuning capacitor, many weaker stations can also be received.

Although this type of three-dimensional construction takes a bit of patience, it is not too difficult to solder components in place with a little practice. I used a pencil iron rated 23 watts, with a ⅛-inch tip. A pair of tweezers, small diagonal cutters and a small pattern file are the only other tools needed to assemble the radio. A pair

*Technical Consultant, Allied Radio Corp.

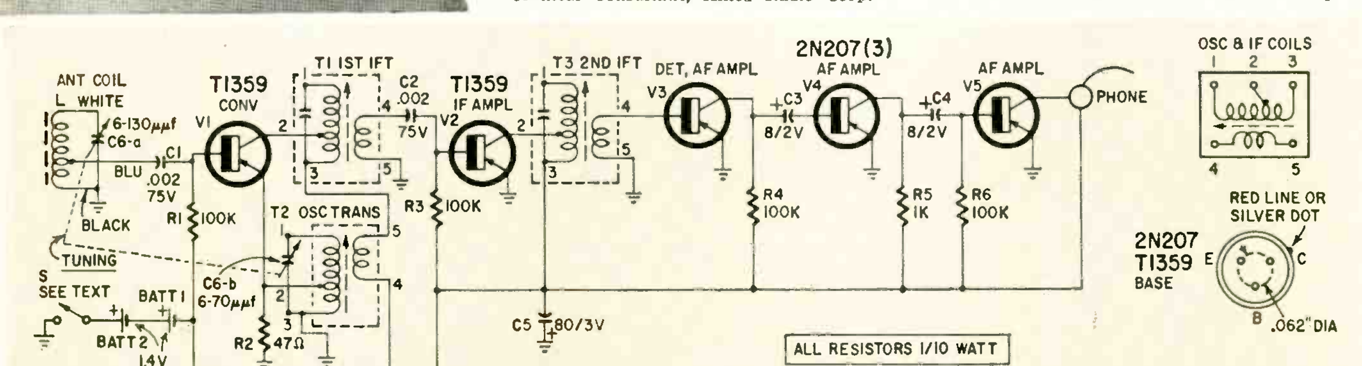


Fig. 1—Circuit of the little superhet.

R1, R3, R4, R6—100,000 ohms, 1/10 watt, 10%
R2—47, ohms, 1/10 watt, 10%
R5—1,000 ohms, 1/10 watt, 10%
C1, C2—.002 μf, 75 volts, ceramic subminiature (Allied 78 L 716 or equivalent)
C3, C4—8 μf, 2 volts, subminiature electrolytic (Allied 19 L 830 or equivalent)
C5—80 μf, 3 volts, subminiature electrolytic (Allied or 18 L 959 or equivalent)
*C6—tuning capacitor; osc, 6–70 μμf; ant, 6–130 μμf
BATT 1, BATT 2—1.4 volts, mercury cell (Mallory RM-675 or equivalent)
*L—antenna coil, ferrite core, cut down to 1⅝ inches
S—see text
*T1—if transformer:
*T2—oscillator transformer:
*T3—if transformer:
V1, V2—T1359 (Philco)
V3, V4, V5—2N207
Earpiece, 2,000 ohms, miniature (Allied 59 J 119 or equivalent)
Phono hookup cable, 10 feet (Allied 49 T 614 or equivalent)
Epoxy cement
Headphone, single earpiece, 1⅝-inch inside diameter, ¾ inch deep (Allied 59 J 112 or equivalent)
Miscellaneous hardware
These components are all part of a coil kit sold by Allied Radio under the stock number 60 H 074

of cuticle nippers are handy, because of their narrow tip, for cutting fine wire in tight corners.

The circuit, using only six capacitors and six resistors, was designed to eliminate as many components as possible to reduce the size and amount of wiring involved. The schematic follows conventional transistor circuitry with few variations. Resistor R2 reduces feedback in the oscillator circuit for better stability. (With a real "hot" transistor for V1 you may have to reduce R2's resistance for optimum stability. R2 is 15 ohms in one version of this circuit.) Capacitor C1 affects stability too. V3's bas circuit rectifies the if output, and the amplified audio signal appears at the collector. Load resistor R4 was made larger than usual to reduce the audio gain slightly as there is no volume control. Tiny 1/10-watt resistors, very small ceramic capacitors rated at only 75 volts and subminiature tantalum capacitors originally designed for hearing aids make this compact circuitry feasible.

How to build it

Cement all large components together with an epoxy cement. Use thin phono pickup cable for wiring and insulate transistor leads with insulation pulled from ordinary hookup wire.

The best method of soldering, I found, was to hold the leads together, melt a little solder and flux on the iron and quickly apply it to the work. Hold the iron in place for only a second and snip or file off any excess solder left on the leads.

Choose an earphone case deep enough to accommodate the combined thickness of the tuning capacitor and small earphone. You'll have to file the flange on the front of the phone flush and possibly trim off part of the plastic housing. Cut away part of the back to expose the terminals and solder short leads to them.

Drill a hole in the case for the tuning capacitor shaft and position the if transformers, antenna and tuning capacitor as shown. Trim the antenna's ferrite core to fit the inside diameter of the case. It is best to cement the capacitor and antenna together first, and add the coils later. Center the antenna coil midway on the core. Let the epoxy cement harden for about half an hour under a light bulb. More heat will shorten the drying time but may overheat the parts. Do not cement the earphone in place until after alignment is finished. It may be necessary to cut away a little of the inside of the case to get a loose fit.

The battery bracket and switch plate are made from sheet brass. The heaviest gauge of automobile shim brass would be suitable. Solder a No. 2 or No. 3 nut to the plate over the hole and solder the plate to the battery bracket. Notice that a small piece of flexible plastic insulates the two mercury cells and also makes battery removal easier. When fastening the plastic strip to the bracket, cut a small hole in the plastic so the cement bonds

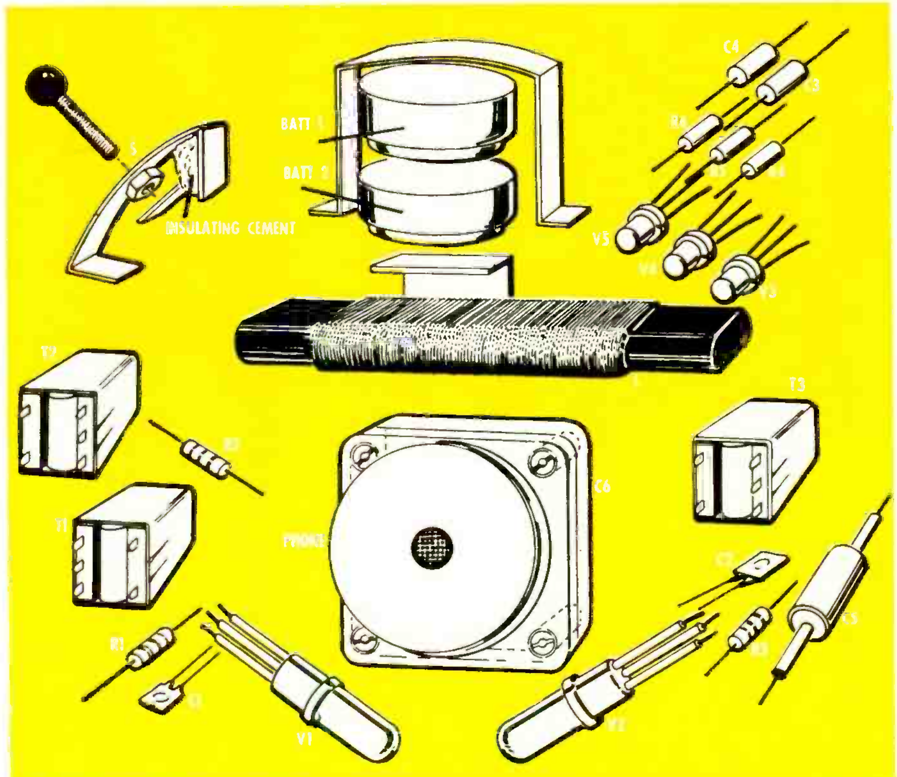
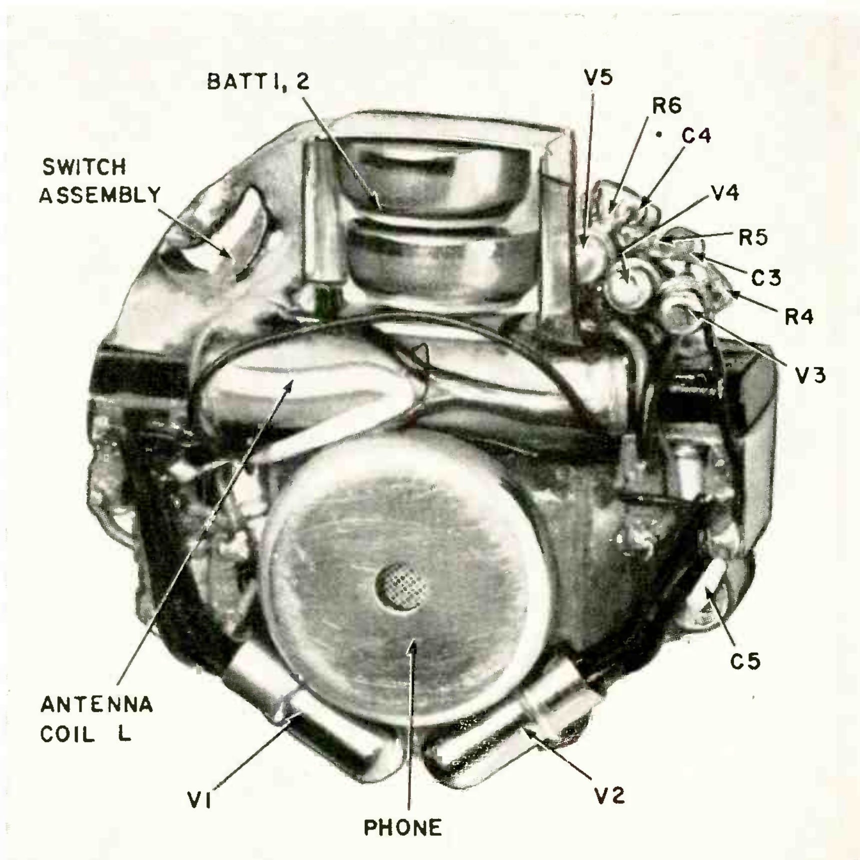


Fig. 2—Parts location detail with reference to interior photos.



Earpiece side of the radio, showing parts layout.

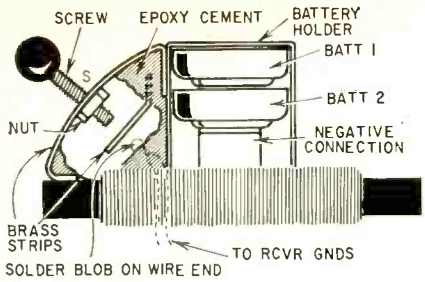


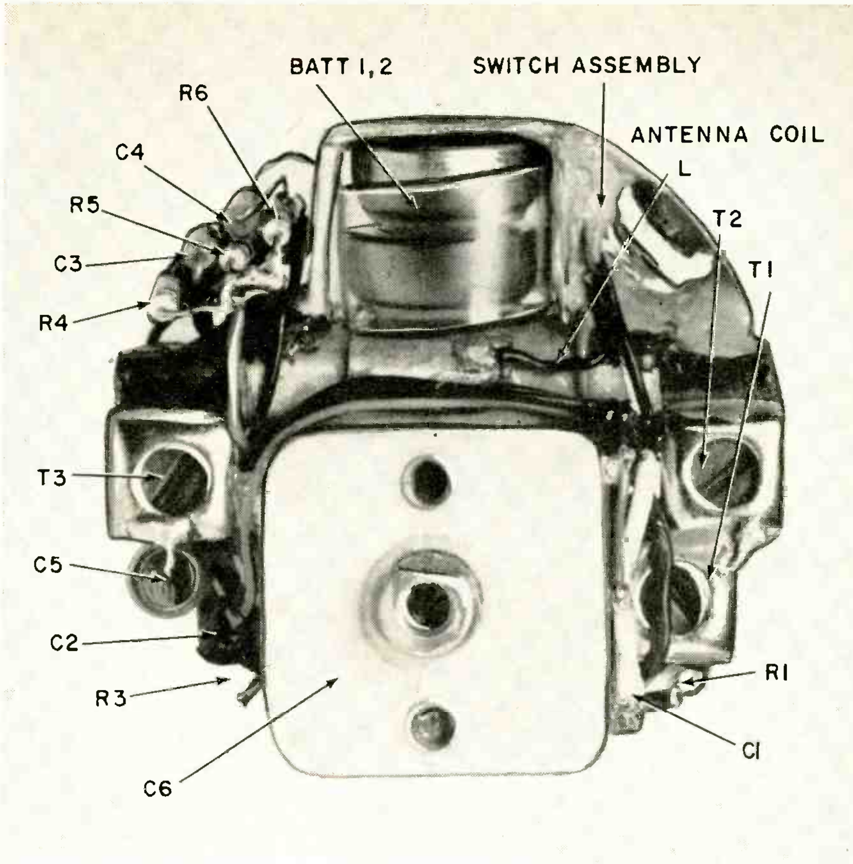
Fig. 3—Details of switch assembly construction

with the metal. After the bracket has been fastened in place, cement the negative terminal to the side of the antenna. The outer cases of these cells are positive, so the bracket becomes the positive terminal when the cells are inserted.

To complete the switch, form a small bead of solder on the end of a piece of light hookup wire and partially imbed it in glue underneath the screw which forms the other contact of the switch. A blob of cement on the head of the screw serves as the knob. Drill a hole in the side of the case large enough for the screw.

The three-stage audio amplifier is assembled separately and then wired into the radio. Don't use too much solder, and position all leads to avoid shorts. Spot cement the amplifier in place after making certain it will fit into the case, and finish wiring.

The radio was designed to be completely self-contained so it would be very rugged and could be removed from its case easily.



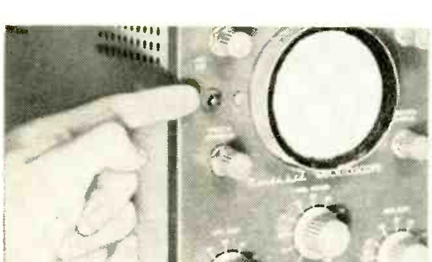
The tuning capacitor is on this side of the tiny set.

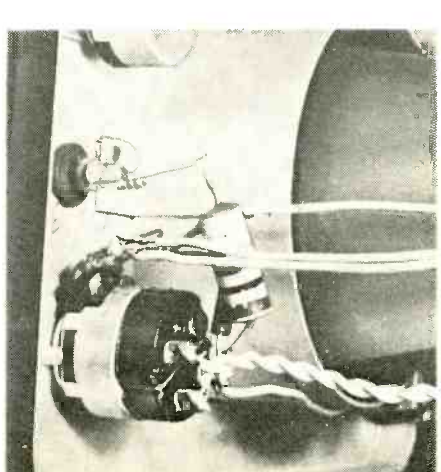
Alignment

To align the set, tune in the strongest local station. Use a wire strung around the room if extra pickup is needed. Adjust the if transformers for the maximum volume. Now tune in a station near the low end of the band and adjust the oscillator slug. Set the tuning capacitor at several positions, near the low end of the band, and readjust the oscillator to determine which setting of the capacitor gives maximum volume on the same station. Repeak the if's and tune in a statio naround 1400 kc. Adjust the trimmers on the tuning capacitor, recheck the low end and the alignment is complete.

I was worried that the compact construction would cause feedback problems, but no serious effect resulted. I did notice a slight tendency to howl on strong stations, but a slight adjustment of the if's cured it. END

Add a scope pilot light





Two views of the pilot-light installation

Some of the less expensive oscilloscopes don't have a pilot light. What is doubtlessly an economy measure for the manufacturer can be a nuisance for the scope owner. When the intensity control is turned down to dim or eliminate the trace, it's easy to forget the scope is on and leave it running for hours.

A simple and convenient pilot-lamp installation can be made at the point indicated in the photo. Drill a hole in the scope's front panel close to the intensity control and mount a miniature neon pilot-lamp assembly. An alternative method is to press-fit an NE-2 through a rubber grommet mounted on the panel. After mounting the bulb or pilot assembly, run one of its leads to a convenient ground point. Connect the other lead to a 4.7-megohm ½-watt resistor. The free resistor lead goes to either of the two outside terminals of the intensity control, and the job is finished.—*J. Scheckley*

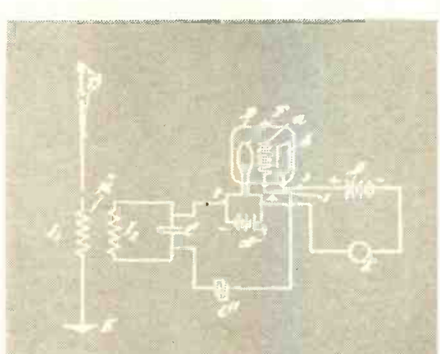
By **FRED SHUNAMAN**
MANAGING EDITOR

What did de Forest really Invent?

A PROFOUND MISCONCEPTION ABOUT THE nature of de Forest's fundamental invention has prevented many from appreciating the full importance of his contribution to communications and electronic science. Indeed, if he had simply "interposed a grid between the cathode and anode of a two-element vacuum tube" as some seem to think, he would have no claim to the title "Father of Radio" which he has borne without challenge for several decades.

Yet, in spite of their superficial resemblances, the de Forest Audion and the Fleming valve do not belong in the same family of detection devices. De Forest started out with the *Responder*, an electrolytic detector. A steady current from a local battery flowed through it. Arrival of a radio signal reduced the conductivity of the solution and interrupted the current. Thus it was, like the Branley coherer, a *relay*, in which very small amounts of radio-frequency power controlled much larger quantities of power supplied by a local source. The Responder was the subject of de Forest's first patent.

De Forest did not "add a grid to the diode": he developed an entirely new electronic device



This early patent drawing may be the first of the grid Audion and its circuit.

While working with the Responder, de Forest was led by an accident into the study of flame or hot gases as a means of detecting wireless signals. The Audion was the last of a long series of heat-operated devices. All of them used a local or B-battery (de Forest's term—abbreviated from "booster battery"). The leads from this battery terminated in two electrodes, placed in different parts of a flame (in the earlier models). The battery current was to be controlled by the wireless signal, picked up by an antenna attached to one of the electrodes of the device, which in its simplest form is shown in Fig. 1. Another electrode was grounded, to complete the antenna circuit. The telephones were in the battery circuit.

Several of these devices, using a Bunsen burner as the chief element in the detector, and with different types of elements variously positioned, were patented by de Forest.

But the inventor realized that his flame detector, though improving with each new model, was fundamentally unsuited for practical work, especially on

De Forest and Sarnoff before the plaque erected at the site of the invention of the vacuum tube.

Dr. de Forest inspects the newly invented transistor while Dr. Shockley, who directed the team responsible for its invention, holds one of the early Audions.

shipboard. A breath of air or slight list of the craft could change the relative positions of flame and electrodes, making the detector intermittently useless. "So," he said, "I thought of other means of heating the gases." After trying and abandoning a small arc, he had a number of small lamps—with the essential elements built in—constructed (Fig. 2).

It would be naive to suppose that Fleming's valve might not have given him a suggestion. On the other hand, he might have got his inspiration from an ordinary electric light bulb. In any case, the elements sealed into those earlier tubes—and most especially the circuitry surrounding them—were definitely those of the de Forest gaseous detectors. (Even the final grid Audion is reminiscent of a much earlier device which used a number of rings in a Bunsen burner flame.)

De Forest argued that the arrangement of Fig. 2 was imperfect "because it permitted part of the high-frequency energy to pass to earth through the telephone and B-battery circuit, instead of concentrating it upon the ions between the plate and filament." He therefore tried attaching the antenna to a piece of tinfoil wrapped around the glass of the lamp. The next step was to insert it in the tube, at first as an additional plate or "wing" on the opposite side of the filament from the plate.

The new model was "a further distinct improvement" on previous detectors, and work was intensified to find the best shape and position for the new element. The Audion was practically invented. Already a system was in existence that isolated the signal and local circuit, and finding the ideal placement of the control element was a matter of a few experiments. De Forest was convinced that it would have the greatest effect on the conductive stream (of ions, as he envisioned them) if placed between cathode and "wing" or plate. The plate was perforated as a first experiment, then de Forest handed tube maker McCandless a piece of wire, bent in zigzag fashion into the shape of a grid about ⅝ inch square. Instructions were to put this grid between the wing and filament, and "as close to the filament as possible."

The new tube, delivered with a batch of others of different forms, had a life of barely 3 minutes. Yet that was long enough to prove a device of an entirely new order of sensitivity was born. Thus the Audion, which differed from all previous detectors of electric waves in that it could *amplify*, was born.

In contrast, the Fleming valve was a simple rectifier. It is related to the crystal diode or the imperfect-contact type of detector rather than to the family of the coherer. Putting a third electrode in it—while retaining its method of operation—would simply make it "a rectifier with one too many electrodes." It could never have advanced electronics beyond the crystal-diode stage.

In recent years even the British—who tended to defend Fleming during his lifetime—have pretty well recognized de Forest as the inventor of a new device. De Forest's own attitude, which the British considered sporting, was partly responsible for the swing in his favor. Fleming consistently attacked de Forest as a charlatan and cheat, while he took a far more tolerant attitude toward his British colleague. According to one British author, de Forest went so far as to remark that "Fleming went to his death convinced that he was the inventor of the vacuum tube."

Now that both great pioneers of radio are dead, and personalities no longer enter into the problem, it is clear that

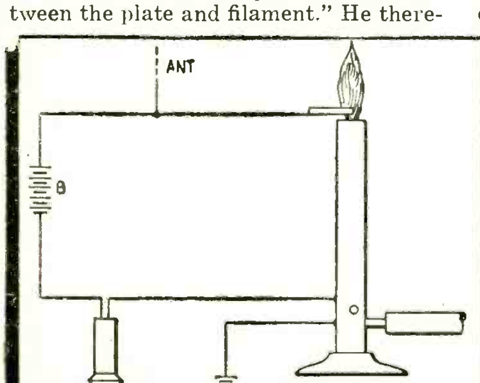


Fig. 1—The earliest model of the flame or heat-operated detector.

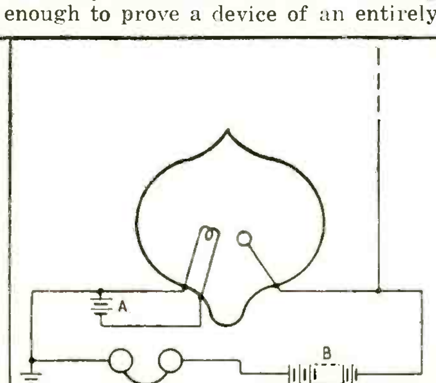


Fig. 2—Elements of the flame detector of Fig. 1 sealed in a glass envelope.

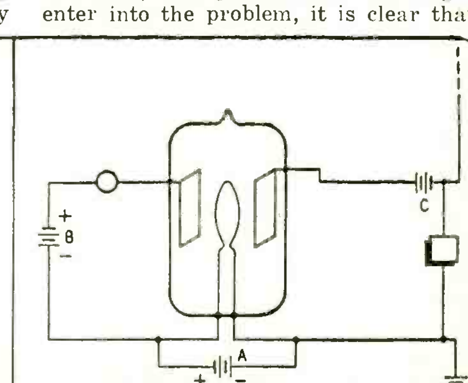


Fig. 3—A near-Audion. Signal circuit connects to a separate electrode.

what de Forest invented was not just another and more efficient "oscillation detector" but a revolutionary new device, a thermionic relay in which a very small electric charge can be made to control the flow of much larger charges, in short a device that can amplify. It is this ability to amplify all types of electric signals, from direct current to the kilomegacycles, without changing their form, that made the Audion and its descendants creators of the Electronic Age. De Forest's confidence in the relay principle and the "booster battery", which could supply large amounts of power, was justified and helped him to invent the device on which depends not only modern radio, but television, radar, countless control devices, including those that make modern aviation possible, our great new computers and data-processing devices and a host of other equipment and apparatus. The term "Father of Radio" dates from a day when the potentialities of his invention could not be realized or imagined. Today he may more correctly be hailed as the Father of the Electronic Age. END

Dr. de Forest's picture appearing on page 33 was taken from an oil painting by Geo. L. Camarero in 1952. It now hangs in the home of H. Gernsback.

In 1946, editor Hugo Gernsback asked permission to have de Forest's hands photographed. De Forest, in a letter to Gernsback, objected to this because he thought "it was not dignified." We convinced him that the picture was necessary for a historical record. The photograph above is printed here for the first time; it shows the hands that fashioned the Audion, which ushered in the electronic age.

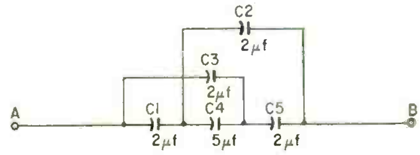
WHAT'S YOUR EQ?

Here we go again. Sharpen up your pencils, put on that thinking cap and settle down to some interesting puzzles.

If you've got one of your own that will stump our readers, especially if it's on an engineering level, send it to us. We pay $10 and up for each one accepted. Write to EQ editor, RADIO-ELECTRONICS, 154 W. 14 St., New York 11, N. Y. Answers to July puzzles are on page 89. Answers to this month's puzzles appear next month.

Series-Parallel Capacitors

Five paper capacitors are connected as shown. The capacitances are given in microfarads. Now, what is the capacitance between points A and B?—*T. A. Varhelyi*



Over the River

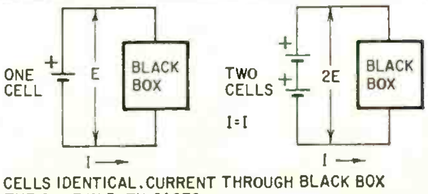
Here is a puzzle that should increase aspirin sales:

You have a cable containing 100 wires running under a river. None of the wires are color-coded. The problem is to identify (using numbered labels or cable markers) the corresponding wires on both sides of the river. Only one round trip across the river is permitted and the only piece of equipment that may be used is a continuity checker (not an ohmmeter).—*Ronald J. Draus*

Black Box No. 3

In the figure, note that at the left, one cell identical to the two cells at the right is used to power the black box. Further, note that the current drain of the black box in both cases is the same.

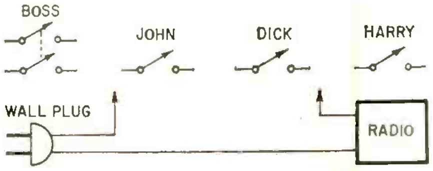
Question: What's in the black box?—*George R. Wisner*



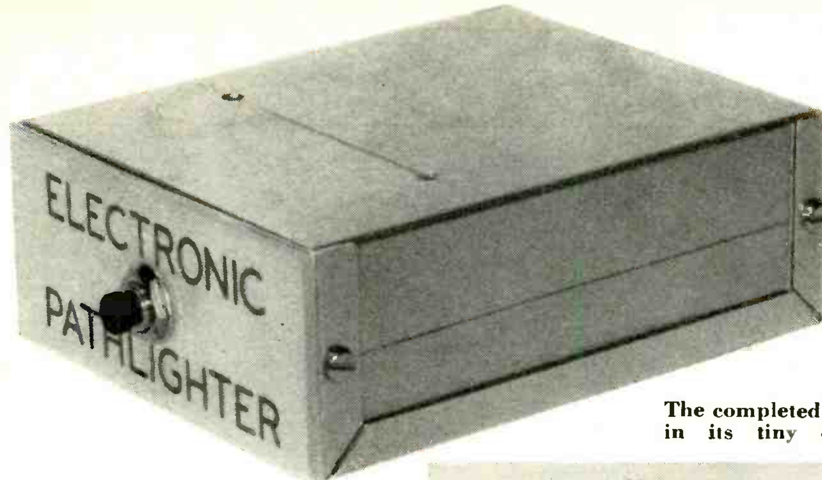
CELLS IDENTICAL. CURRENT THROUGH BLACK BOX THE SAME IN BOTH CASES

Automated Voting

To solve the usual office problem of whether to have music or not, one boss installed a double-pole switch on his own desk and single-pole switches on the desks of each of his three men, John, Dick and Harry, as shown in the figure. When anyone wants music, he votes for it by closing the switch at his desk. Closing the boss' switch counts as *two* votes, while closing any of the other three switches counts as one vote. When there are three or more votes for music, the radio comes on.



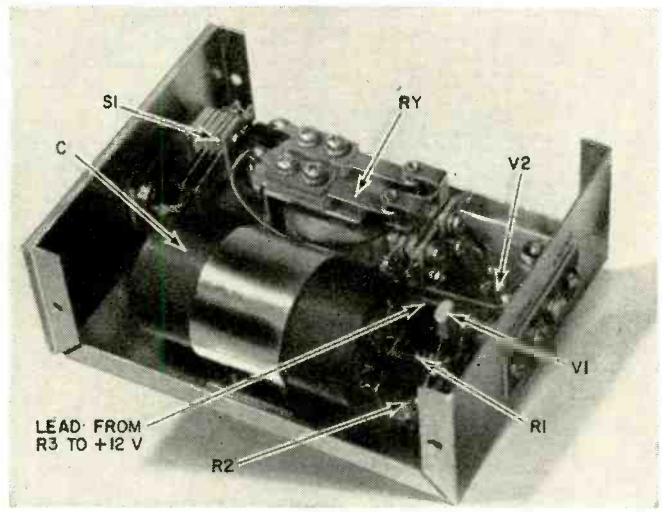
Wire up the circuit. No additional parts are needed, and the switches need not be altered. Before deciding you have done the job right, check to make sure the radio will come on for any combination of three or more votes, and never for any combination of less than three votes.—*Darrell L. Geiger*



The completed unit in its tiny case.

ELECTRONIC PATHLIGHTER *is easy to build*

TWO-TRANSISTOR UNIT TURNS OUT YOUR CAR'S HEADLIGHTS AFTER YOU'VE MADE IT SAFELY TO YOUR FRONT DOOR



Two main components (size-wise) inside Pathlighter are the relay and electrolytic capacitor.

By R. L. WINKLEPLECK

DO YOU remember just last week when you came home late from a meeting, pulled up in the driveway, doused the car lights and made a dash for the house in darkness blacker than black, completely unaware of the tricycle lying in your path? And the week before when you nearly hung yourself on the clothesline which hadn't been taken down after the wash had dried. Next week could be worse—but it won't be if you build the Pathlighter.

This simple little transistor-operated gadget, which can be mounted unobtrusively under the edge of the automobile dash, permits you to leave the auto lights on to light your path while you saunter casually into the house. A couple of minutes later, after you've you've made it safely into your home, the car's lights automatically go out and all is secure.

The Pathlighter can be easily assembled and installed in one evening. The only moving parts are the pushbutton and the relay. The unit should outlast several cars and is so easily installed that it can be quickly transferred whenever you switch to a new car. Once you've enjoyed its convenience, it will be as indispensable as the turn indicator or the windshield washer. It'll be just as dependable, too.

The two bulky components are the relay, which must have heavy-duty contacts to handle the amperage of the headlights, and the capacitor, which must store enough electrical energy to keep the relay closed for the desired interval. Together with the switch, transistors and resistors, they can be housed without crowding in a small aluminum box mounted conveniently beneath the dash.

A glance at the schematic shows that the circuit couldn't be simpler. When the pushbutton is depressed, C is charged with the battery voltage. This charge is then dissipated slowly through current-limiting resistor R1 and V1's base–emitter circuit. As long as the current flows, V1 is biased to conduction. This in turn biases power transistor V2 to conduction with a current flow great enough to close the power relay and turn on the lights. When the flow of current from C1 decreases, the conduction of the transistors decreases and the relay opens, turning off the car lights. S1-b and the upper contacts of the relay connect the unit to the car battery while it is being used and disconnect it when the lights go out. Otherwise, there would be a constant transistor leakage current which, while insignificant in view of the big battery from which it is being drawn, is best eliminated.

The unit illustrated is built into a 3 x 4 x 5-inch case which was cut down to 1¾ inches high. It is designed for an automobile with a 12-volt system and negative ground. Thus, power transistor V2, (its case is the collector) is mounted directly on the aluminum case which is attached to the grounded dash of the auto. Resistor R2 biases V1's emitter to prevent possible thermal runaway. Resistor R3 limits the flow of current in V2's emitter–collector circuit to a safe value. The circuit is essentially a two-stage, complementary-symmetry transistor amplifier. The delay, with the components shown, is approximately 1½ minutes.

Construction hints

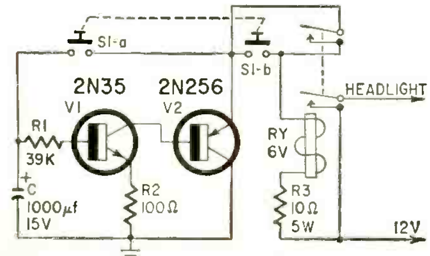
There is nothing complicated or time-consuming about the wiring. Just be careful, as always, not to overheat the transistors while soldering. Be sure not to confuse the transistor leads, and watch the polarity of the electrolytic capacitor. The box is the negative battery connection when it's mounted to the metal auto dash. The positive battery and headlight connections can be made to a two-terminal composition strip on the end of the box opposite the pushbutton. Transistor V1 is mounted on a tie strip as illustrated. This transistor, its two resistors and the short lead to V2's base, can all be soldered to the strip before installing it in the box. The capacitor can be securely fastened in place with a piece of scrap aluminum.

Installation is even quicker and easier than the wiring. Mount the box somewhere around the dash as dictated by convenience and appearance. The light lead goes to the light-switch terminal that connects to the headlights. This terminal can be quickly located with a voltmeter or even by close observation. The positive battery lead may be connected at a number of points, but there is also a positive terminal on the light switch, so this is probably the most convenient location.

All kinds of modifications of the physical layout are possible to fit specific mounting requirements or to suit the builder's preferences. If the unit is installed in a car with a positive ground, V2 must be mounted on a thin sheet of insulating material. Composition shoulder washers should be used with the mounting screws to isolate the transistor collector. Also all connections shown grounded in the schematic must be brought to one of the terminals on the insulated strip on the back of the box which becomes the negative connection. Positive connections are then made to the box. If the unit is to be used with a 6-volt electrical system, R3 may be eliminated and R1 reduced to 20,000 ohms. The delay with a 6-volt input will be slightly shorter. To increase the delay with either a 6- or 12-volt supply, use a larger-value electrolytic capacitor. Conversely, the delay can be shortened by using a smaller one. (Electrolytic capacitors are customarily made to wide tolerances and this factor, plus wide variations in their leakage characteristics, makes it difficult to predict the amount of delay accurately.) Thus, the builder may prefer to use a 2,000-μf unit. If the delay is too long, the capacitor can be shunted with a resistor whose value will shorten the delay period to the desired amount. A potentiometer could be connected across the capacitor to provide an adjustable delay.

This project should be enjoyable to build and you'll be working with the assurance that your path through the dark of night will always be lighted. END

R1—39,000 ohms, 1/2 watt
R2—100 ohms, 1/2 watt
R3—10 ohms, 5 watts
C—1,000 μf, 15 volts, electrolytic
RY—6 volts dc, dpdt (Advance PC/2C/6VD or equivalent)
S1—dpst pushbutton
V1—2N35
V2—2N256
Case, 3 x 4 x 5 (see text)
Miscellaneous hardware



Circuit of simple instrument.

SHORT-WAVE FORECAST

Aug. 15–Sept. 15

By STANLEY LEINWOLL†

THE GENEVA RADIO REGULATIONS OF 1959 REQUIRE THE WORLD'S HIGH-FREQUENCY broadcasters to make four major schedule changes annually. These occur in March, May, September and November, and are intended to take seasonal changes in radio propagation conditions into account.

The schedule change for the fall 1961 season will take place on Sept. 3 and remain in effect until early November, when the winter schedule will go into effect. Daytime frequencies will be higher than during the summer months, and the lower frequencies will be used more during the evening and nighttime hours.

The tables show the optimum broadcast band, in megacycles, for propagation of programs between the locations shown during the time periods indicated.

To use the tables, the listener selects the one most suitable for his location, reads down the left side to the region he wishes to hear, then follows the line to the right until he is under the appropriate time. (Time is given at the top of each table in 2-hour intervals from midnight to 10 pm, *in your local standard time.*) The figure thus obtained is the short-wave band (in megacycles) nearest to the optimum working frequency.

For example, a listener in Chicago would use the Central USA table. He would be most likely to hear broadcasts from Western Europe in the 15-mc band at noon and the 11-mc band at 8 pm, Central Standard Time.

The tables are designed to serve primarily as a general guide, since day-to-day variations in receiving conditions can be large.

At certain hours, propagation over some of the paths given in the tables may be extremely difficult, or impossible. These are shown with an asterisk (*).

†Radio Frequency and Propagation Manager, RADIO FREE EUROPE

EASTERN US to:	Mid	2	4	6	8	10	Noon	2	4	6	8	10
West Europe	9	7	9	11	15	17	17	17	15	15	11	9
East Europe	9*	7*	9*	11	15	15	15	15	15	11	11	9*
Northern Latin America	15	11	11	11	15	15	15	15	15	15	15	15
Southern Latin America	15	11	9	9	15	15	15	15	15	15	15	15
Near East	9	7*	9*	11	15	17	17	17	15	15	9	9
North Africa	9	7	9	9	15	17	17	17	17	15	11	11
South & Central Africa	11	9	9*	15	15	17	17	21	15	11	11	7
Far East	11	9	9*	9*	11	11	11*	11*	15	17	17	15
Australia & New Zealand	11	11	11	9	11	11*	11*	15	15	17	17	17

CENTRAL US to:	Mid	2	4	6	8	10	Noon	2	4	6	8	10
West Europe	9*	7*	9	11	15	15	15	17	15	11	11	9*
East Europe	9	9	9	11	15	15	15	15*	11*	11*	11	11
Northern Latin America	11	9	9	15	15	15	15	15	15	15	15	11
Southern Latin America	11	9	9	15	15	15	15	15	15	15	15	15
Near East	9*	9*	11*	11	17	17	17	17	15*	11*	11	11
North Africa	9	7	9*	11	15	15	15	17	15	15	11	9
South & Central Africa	11	11*	11	15	15	15	15	15	15	11	11	11
Far East	11	9	9*	9*	11	11*	11*	15	15	17	17	17
Australia & New Zealand	11	11	9	9	11	11*	11	15	15	17	17	17

WESTERN US to:	Mid	2	4	6	8	10	Noon	2	4	6	8	10
West Europe	9	9*	9*	11	15	15	15	17	15*	11*	11	11
East Europe	9	9*	9*	11	15	15	15	11*	11*	11*	11	11
Northern Latin America	9	9	9	11	15	15	15	15	15	15	15	11
Southern Latin America	11	9	9	15	15	15	15	15	15	15	15	15
North Africa	9	7*	9*	11	17	15	15	15	15	11	11	11
South & Central Africa	9	7*	9*	15	15	17	17	15	11	11	11	9
Far East	15	11	9	9	11	15	15	15	15	15	17	17
South Asia	9	9	9*	9	11	15	15	15*	15	17	17	17
Australia & New Zealand	15	15	11	9	9	11	15	15	17	21	17	17

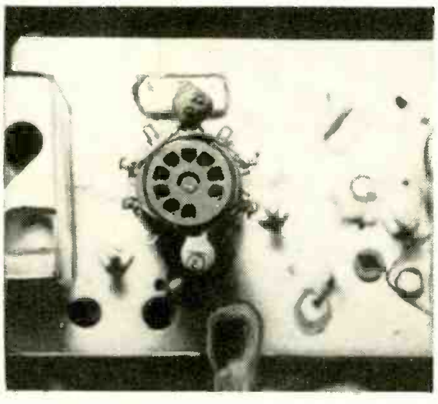
Antenna Coil or RF Amplifier?

By C. H. CITRON

The test-adapter "stage-jumping" method described here determines whether a snowy TV picture is being caused by a defective antenna coil or a defective rf stage. And you don't have to disconnect any coil leads.

Suppose the symptom is a weak, snowy picture. Pull the rf tube and plug in the proper socket adapter. If the picture improves (or at best is no worse), the trouble is in the rf stage. However, if the picture becomes even weaker and more snowy or goes out entirely, then the trouble is between the antenna and the rf grid—probably the antenna coil itself.

Seven-pin socket adapter plugged into TV tuner. Note single capacitor connected from grid to plate pins.



Nine-pin adapter calls for two capacitors across socket.

Two socket adapters, one seven- and one nine-pin, are all you need. The seven-pin unit is for pentode, tetrode and triode rf stages, the nine-pin for cascode types. Two capacitors are used with the nine-pin socket so it will act as a stage jumper regardless of which triode is used for the input stage. The capacitors are connected between pins 1 and 7 and between pins 2 and 6. Only one capacitor is used with the seven-pin adapter, between pins 1 and 5.

Capacitor value is not too critical; anything between 5 and 50 $\mu\mu f$ seems to work well.

One last point: on series-string sets, connect the proper heater pins with a length of hookup wire. END

GUIDE TO LOW-POWER CB TRANSCEIVERS

Pick the unit that suits you best

By ROBERT F. SCOTT
TECHNICAL EDITOR

Hand-held Citizens-band transceivers are selling like ice in the Sahara desert. These units have innumerable uses in industry, business, agriculture, sporting activities and for personal use. All but two can be used license-free under Part 15 of the Rules and need not be licensed unless they are used in a net with licensed CB stations.

Selecting the low-power transceiver best suited for your needs can pose a number of problems. Even though many manufacturers are making these units, dealers and distributors rarely carry more than two or three models. Also, the technical information available on the units the dealer has is hardly adequate for an intelligent comparison. All have power inputs of about 100 milliwatts (except the 1-watt Ray Jefferson Spokesman 700), built-in telescopic antennas and crystal-controlled receivers and are powered by inexpensive dry cells or rechargeable nickel-cadmium batteries.

From this point on, the transceivers divide into two classes. One group consists of relatively inexpensive units designed mainly for personal use and light business and industrial applications. The second group is generally more expensive and is aimed at industrial and specialized applications. These sets include many extras—lapel microphones, dual-conversion superhet receivers with automatic noise limiters and adjustable squelch, rechargeable batteries, jacks for mobile and other antennas not longer than 60 inches, and ground straps for optimum performance.

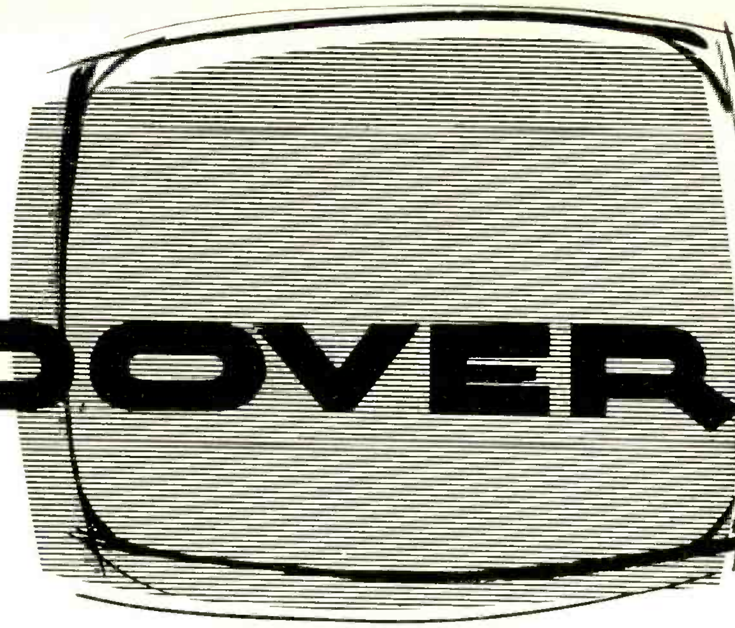
The chart lists pertinent characteristics and features. It will help you evaluate the many units available and select the equipment that is best suited to your needs. END

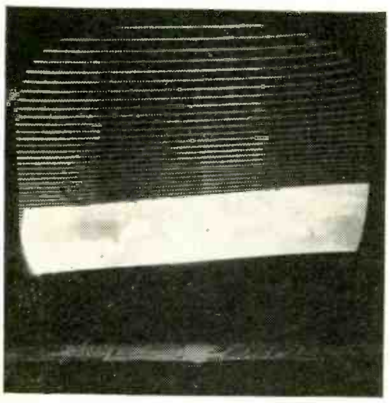
PERSONAL TYPE TRANSCEIVERS FOR CB AND LICENSE-FREE OPERATION

			RECEIVER					TRANSMITTER										
Manufacturer	Model No.	Certificate FCC Rules Part 15-19	Type	Xtal control	Ext. tuning	ANL	Squelch	Type	Pwr. input to final (mw)	Tran-sis-tors	Diodes	Channel supplied	Batt. Volts	Batt. type No. (NEDA)	Dimensions (H x W x D)	Ant. (in.)	Weight (oz.)	Accessories and features
Allied Radio 100 N. Western Ave. Chicago 80, Ill.	Lincoln L-271D	15	Superhet	Yes	No	No	No	MOPA	90	9	1	7	9	15	6⅝ x 2½ x 1½	57	24 without batt	1, 3, 8
Cadre Industries Endicott, N. Y	Cadre 100	Both	Superhet	Yes	No	No	No	Mod. Osc.	100	7	1	Your choice	12	Mercury TR-169	6-9/32 x 2-23/32 x 1-9/16	42	16 with batt	
Dorsal Electronics, Inc. 1412 Broadway New York, N. Y.	Walk 'n Talk RT-101	19 Note C	Superhet	Yes	No[17]	No	No	MOPA	100	9	1	9	9	15	6½ x 3 x 1½	56	18 with batt	1, 3, 5, 8, 17, 18, 19
Electronic Instrument Corp. 3300 Northern Blvd. Long Island City 1, N. Y.	740	Both	Superhet	Yes	No	No	No	MOPA	100	9	1	16	9.6	Ni Cad	7⅛ x 2⅝ x 1⅝	41	19 with batt	1, 7, 10
Electro-Voice Buchanan, Mich.	RME 4304	Both	Superhet	Yes	No	No	No	Mod. Osc.	90	7	1	3, 6, 11, 16	12	1810M	7½ x 3¼ x 2	35	21 with batt	1, 7
Globe Div. GC Electronics Rockford Ill.	Pocket-phone	Both	Superhet	Yes	No	No	No	MOPA	100	9	1	7, 11, 15	9	N. Cad	6¼ x 2⅜ x 1⅝	less than 60	13 with batt	3, 7, 8, 16
	Silent phone	15	Dual Superhet	Yes	No	Yes	No	MOPA	100	11	0	7, 11, 15	9	Ni Cad		18	32 with batt	22
Heath Company Benton Harbor, Mich.	GW-30, DM-278	Both	Superregen	No	No	No	No	Mod. Osc.	100	4	0	Note A	9	1602	6½ x 3½ x 2½	40	40 with batt	2
	GW-31	Both	Superregen	No	No	No	No	Mod. Osc.	100	4	0	Note A	9	1602	5⅞ x 3 x 1½	36	20 with batt	
International Communications, 1929 Wilshire Blvd. Santa Monica, Calif.	Herald Mark 1	Both	Superhet	Yes	No	No	No	MOPA	95	9	1	10	12	15	6 x 3-1/16 x 1½	52	19 with batt	3
Ray Jefferson, Inc. 4312 Main St. Philadelphia 27, Pa.	Spokesman 700	19 Note C	Superhet	Yes	No	Yes	No	Mod. Osc.	1 watt	8	2	6	13.5	14	3 x 4 x 12	50	36 with batt	2, 4, 5, 6
E. F. Johnson Co. Waseca, Minn.	Personal Messenger	Both	Superhet	Yes	No	Yes	Yes	MOPA	100	11	4	5, 7, 11, 18, 22	12	Ni Cad	8 x 3½ x 1¾	35	24 with batt	1, 4, 6, 7
Kaar Engineering Corp. 2995 Middlefield Rd. Englewood, Calif.	Han-D-Phone TR 330	Both	Superhet	Yes	No	Yes	Yes	Mod. Osc.	100	9	3	10, 13, 20	12	15, 15-A Ni Cad	10 x 2⅞ x 2½	41	24 without batt	1, 7, 8, 9
Keltner Electronics 1045 W. Hampden Englewood, Colo.	HT-1	Both	Superregen	No	No	No	No	Mod. Osc.	90	7	0	7	9	216	4 x 2 x 1⅝	47	11 with batt	
Lafayette Radio Electronics 165-08 Liberty Ave. Jamaica 33, N. Y.	HE-29	Both	Superhet	Yes	No	No	No	MOPA	100	9	1	10	12	15	6⅜ x 3¼ x 1⅝	46	16	1, 8, 10
Morrow Radio Mfg. Co. 2794 Market Street Salem, Ore.	VP-100	Both	Superhet	Yes	No	No	Yes	MOPA	100	12	1	Your choice	9	1604	6 x 3 x 1⅛	27	18 without batt	1, 6, 10, 11
Osborne Electronic Sales 13105 S. Crenshaw Blvd. Hawthorne, Calif.	Duo-Com 100	15	Dual Superhet	Yes	No	No	No	MOPA	100	10	3	10	12	910	1⅝ x 4 x 7¾	60	20 with batt	1, 3, 6, 11, 12, 13, 14
	Duo-Com 100S	15	Dual Superhet	Yes	No	No	Yes	MOPA	100	11	4	10	12	910	1⅝ x 4 x 7¾	60	20 with batt	1, 3, 6, 11, 12, 13, 14
Radio Corp. of America Special Products Dept. Telecommunication Center, Meadow Lands, Pa.	Personal-Com	Both	Superhet	Yes	No	No	No	Mod. Osc.	100	7	1	7	11	1810M	7¾ x 3½ x 2¼	35	24 with batt	2, 8, 10
	Personal-Com 300	Both	Superhet	Yes	No	No	No	Mod. Osc.	100[23]	9	2	7	11	RCA VS320	7⅝ x 2⅞ x 1⅞	40	16 with batt	8, 10, 23, 24, 25
Radio Shack Corp. 730 Commonwealth Ave. Boston 17, Mass.	Realisti-phone	Both	Superhet	Yes	No	No	No	MOPA	100	9	1	11	9	216	6 x 2¾ x 1½	36	12 with batt	1, 8, 10, 16
Raytheon Co. 411 Providence Turnpike Westwood, Mass.	Rayette Super	Both	Superhet	Yes	No	Yes	Yes	MOPA	100	10	1	11	9	Ni Cad	5¼ x 2¾ x 1-3/16	46	15 with batt	1, 7, 8, 9
	Rayette Regal	Both	Superregen	No	No	No	Yes	MOPA	100	5	0	11	9	Ni Cad	5¼ x 2¾ x 1-3/16	46	14 with batt	1, 7, 8, 9
Ross Laboratories, Inc. 124 Lakeside Ave. Seattle 2, Wash.	Pocket Talkie	Both	Superregen	No	No	No	No	MOPA	50	5	0	9	9	1604	5⅛ x 2¼ x 1½	42	9 with batt	1
	Pocket Phone	Both	Superhet	Yes	No	Yes	Yes	MOPA	100	12	2	9	6	15	6½ x 3⅛ x 1½	42	23 with batt	1, 15
Seiscor Communications Section Box 1590, Tulsa, Okla.	Telepath PM-A	15	Superhet	Yes	No	No	No	MOPA	100	9	1	11, 18	9	1600	5¾ x 3 x 1⅜	42	12 with batt	1, 8, 10
Sonar Radio Corp. 3050 W. 21st St. Brooklyn 24, N. Y.	Sonarcom CBP	Both	Superhet	Yes	Yes	No	No	Mod. Osc.	100	8	1	11	12	1403	3 x 3½ x 8¼	53	40 with batt	3
Webcor, Inc. 5610 W. Bloomingdale Ave. Chicago 39, Ill.	Micro 350	Both	Superhet	Yes	No	Yes	No	MOPA	100	9	2	14	9	1604	5⅜ x 3⅜ x 1⅜	44	13 without batt	2, 16
Wightman Electronics, Inc. 9 West St. Easton, Md.	WE Phone	Both See note B	Superhet	Yes	No	Yes	No	MOPA	100[20]	10	1	22	12	14	9¾ x 3½ x 2¾	48	40 with batt	2, 9, 21

1—Phone jack
2—Shoulder strap
3—Leather case and strap
4—12-volt auto battery adapter
5—117-volt ac adapter
6—Jack for external antenna
7—Battery charger
8—Earpiece
9—Hand strap
10—Leather case
11—Lapel micorphone
12—Headset
13—External mobile and fixed antenna (less than 60 in.)
14—Ceramic filter if
15—Jack for external microphone
16—When used with radio paging system the whip need not be extended. Extend to full length for longer range reception or to transmit.
17—Includes AM broadcast receiver with 6-transistor circuitry
18—Leather antenna case
19—Leather earpiece case
20—500-mw input under Part 10 (See Note B)
21—Earphone, flexible antenna and throat mike available on 30-50-mc version.
22—Transceiver built into headgear for use in high-noise areas such as airports, factories and at sporting events. Fits under size 6½ to 8½ hard hat.
23—May be factory-modified with plug-in module to increase transmitter power input to 350 mw. 350-mw unit has MOPA transmitter, 12 transistors and weighs 17½ oz with NiCad battery.
24—Center-loaded 19½-inch antenna available.
25—Battery chargers available for 1 and 2 NiCad batteries.
A—As ordered or random
B—Also licensed under Part 10 (Public Safety Radio Services) for use by police, fire and emergency communications in the 30-50-mc band.
C—Approved for licensed CB operation only.

VERTICAL FOLDOVER PROBLEMS





In this severe case of foldover wedge of picture near bottom of screen is upside down.

Yes, vertical foldover has 4 major causes. Do you know what they are and how they can be located?

By WAYNE LEMONS

VERTICAL foldover is caused by a defect in the vertical output stage almost every time! This simple but all-important fact seems to elude us, unhappily right when we need it most—when we have a vertical foldover problem. Oscillator defects causing foldover are scarce as hen's teeth. What, then, are the causes and cures for foldover?

Foldover is always caused by one or more of four conditions: improper bias, low plate voltage, inadequate bypassing or mismatch. This is true regardless of the circuit.

First, look at a conventional (if such a thing exists) output stage as used in many models of Admiral receivers 5 or 6 years ago. The output stage uses a 6S4 triode. Plate voltage comes from the boost circuit through a 1,200-ohm resistor, bypassed by a 20-μf decoupling capacitor in series with 100-μf cathode bypass. The 6S4 bias is adjusted by a 3,000-ohm vertical linearity control in the cathode circuit.

In this circuit (Fig. 1) improper bias can be caused by a defective tube, leaky coupling capacitor (C1) or defective cathode resistors (R2 and R3). Low plate voltage is due to a weak low-voltage rectifier or damper tube, changed-value decoupling resistor (R1) or leaky decoupling capacitor (C2). Inadequate bypassing is the result of an open decoupling capacitor (C2) or an open cathode bypass capacitor (C3). Mismatch is caused either by a defective transformer or yoke. (Generally you should be suspicious of these only if either has been replaced.)

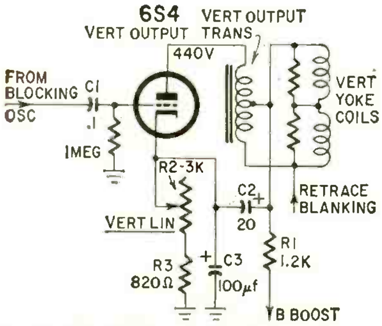


Fig. 1—Typical triode vertical output stage.

Fig. 2 is a pentode vertical output stage. Only 120 volts is used on the plate of the 12W6 in this Arvin circuit. A negative feedback circuit (R4, R5, C4 and C5) from the plate to the grid tends to improve overall linearity. Trouble spots are identical to the circuit of Fig. 1 except for the feedback network. Here, C5 may short and burn R5, reducing the plate voltage and causing foldover.

In Fig. 3, we have an unusual output circuit. This direct-coupled circuit was used some years ago in all Super V Crosleys and in many Motorola and Hallicrafters sets. The height control not only controls the plate voltage of the oscillator but affects the bias of the output stage as well. The linearity control varies the amount of degeneration in the output stage by increasing or decreasing the amount of cathode bypassing. For this reason the controls have inverted functions; that is, the height control has more effect on the top of the picture, while the linearity control has more effect on the bottom.

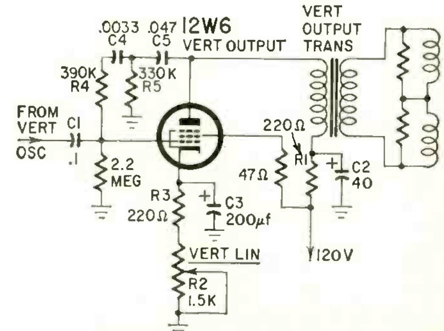


Fig. 2—Low-voltage pentode vertical output stage.

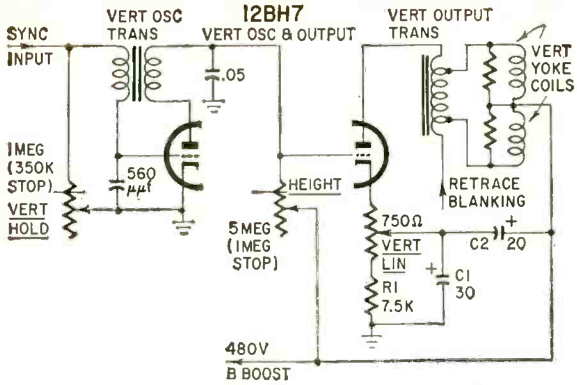
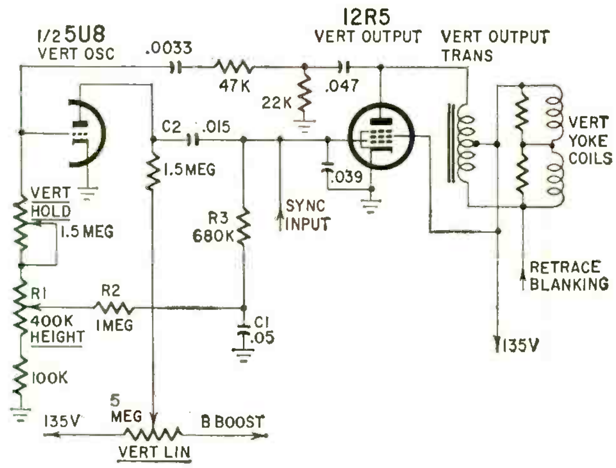


Fig. 3 — Direct-coupled vertical oscillator output circuit.

Fig. 4—Oscillator output multivibrator. Height and linearity controls may seem to be labeled incorrectly, but this is the way the set manufacturer (G-E) does it.



The most common defect in this circuit (in addition to electrolytic capacitors C1 and C2) is the 7,500-ohm resistor (R1, sometimes 8,200 ohms). When this resistor changes value or opens, a variety of symptoms may occur, depending upon the condition of the 12BH7 and just how much the resistor changes value. The most common symptoms are inadequate height and severe foldover. In every case, of course, the vertical deflection is seriously affected or even nonexistent.

Fig. 4 is a G-E circuit. It is the output feedback or oscillator-output multivibrator circuit used almost universally in today's TV sets, in a multitude of forms. It is the hardest type of vertical circuit to troubleshoot; so many of its functions interact. But like all the others, foldover is almost always caused by a defect in the output stage. This circuit, like many of its type, obtains a negative voltage from the grid of the input stage for biasing the output stage. The voltage is tapped off R1 and fed through R2 and R3 to the grid of the 12R5. C1 is a decoupling capacitor to prevent pulse voltages in the two parts of the circuit from interacting. One of the common causes for foldover is leakage in C1. Often the leakage is much more severe after the set has been on for a while. This produces what might be called creeping foldover, and it's difficult to troubleshoot. It's best to replace both C1 and C2 when you encounter this condition; this nearly always cures the trouble.

Summary

Remember, even though circuits differ, foldover is nearly always caused by a defect in the output stage. Remember, too, the four primary causes of vertical foldover in any circuit:

- **Improper bias.**
- **Low plate voltage.**
- **Inadequate bypassing.**
- **Mismatch.**

Biasing and voltage defects can be detected with any good meter, preferably a vtvm. Inadequate bypassing can be detected by shunting a suspected capacitor with a good one or by measuring the peak-to-peak voltage across it with a scope. Mismatch is best determined by replacing the suspected part temporarily with the correct output transformer or yoke. Or you might use one of the new "universal" vertical output transformers, selecting the proper tap to match the yoke used.

Whatever the problem causing foldover at the bottom of the picture, you'll find it lurking somewhere in the output stage! END

Watchdog Television

lets tenants in new apartment houses see who's downstairs before letting them through the main door. Closed-circuit TV camera and monitor are mounted at entrances, and each apartment has its own receiver. The system is made by Bell Television Inc. and has been installed in a new apartment house in Brooklyn, N.Y.

TALK ON A LIGHT BEAM

Put light to work and forge a visible communications link

By R. E. PITTET JR.

Here is a delightful little gadget for talking via light waves. Uncomplicated, it needs few parts and can be easily assembled. As a source of fun and amusement it will be hard to beat.

The transmitter combines a light source, a modulating membrane with a reflector mounted on it and a simple optical focusing system. The receiver uses a phototube and lens to receive the light beam and detect the modulation envelope, plus an audio amplifier to boost the signal to listening level (Fig. 1).

To build the transmitter, first collect three pieces of cardboard tubing each about 12 inches long. The two larger pieces should be about 1½ and 1¼ inches, respectively, in diameter so that the smaller one will telescope snugly into the larger one. The third piece of tubing should be about ⅝ inch in diameter so it can accommodate a flashlight bulb. The diameters of the two larger tubes are not too important although the largest should be big enough to talk into comfortably.

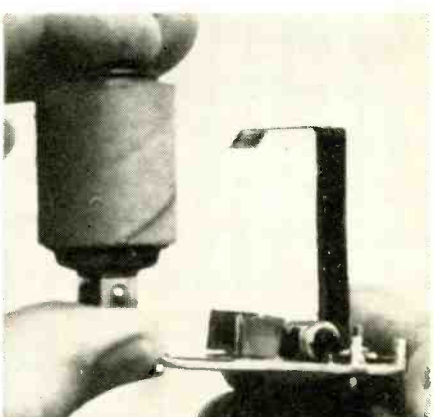
The Edmund Scientific Co., Barrington, N. J., sells a set of telescoping cardboard tubes that is just right for this project with lots left over for future optical experiments. The stock number is 80,043 and the price $4.50. I used these tubes to build my unit.

Next, get a small piece (2 x 2 inches) of Saran Wrap or other very thin, transparent wrapping plastic and a small piece (½ x ½ inch) of aluminum foil. Some fast-drying cement, a few odd pieces of cardboard, hand tools, scissors, ruler and some flat black paint complete almost everything needed except the lenses. They can be taken out of a child's toy binocular or from Edmund Scientific Co.'s beginner's lens kit, stock No. 2 ($1). There are 10 different lenses in the kit. One is 30 mm in diameter and has a 153-mm focal length. (This is equivalent to about 1-3/16 inches in diameter and a 6-inch focal length.) The focal length is important and helps determine the length of the two tubes. I used the 30-mm × 153-mm lens. Note in Fig. 2 how dimension line A plus dimension line B equals a little more than the 6-inch focal length, thereby determining the length of tube II.

Cut the tubes to size with a hacksaw. Follow the dimensions in Fig. 3 and paint the insides with flat black paint. The drilled hole is larger in tube I so the light beam can be manually centered on the aluminum reflector mounted in the center of the plastic membrane after the unit is assembled. Cement the small piece of aluminum foil to the center of the plastic membrane with the shiny side up. Then cement the membrane over the angled cut on tube II so the aluminum is centered and its shiny side faces down. Solder two wires to a flashlight bulb and mount it in tube III, but don't cement it in place yet. Shape tube III with a razor blade to make it fit snugly over the hole in tube I and cement into place. After that cement the lens to the front end of tube II.

Next, assemble the unit and line it up optically by connecting the bulb to a battery, sighting through the front end and adjusting tube II into tube I until the light from the bulb appears the brightest on the aluminum-foil reflector. Then cement tube II in place. Next, point the light beam at a light-colored wall in a dark room. The range should be about 10 feet. Slide the bulb in and out of tube III until the projected light beam is sharply focused on the wall, then cement the bulb in place. A series of vent holes are recommended in tube I over the membrane which is inside and mounted on tube II. These holes will allow your breath to escape as you talk and also allow the sound waves to travel down the tube, strike the membrane and dissipate themselves.

If possible, get a small ¼ x ¼-inch square of very thin glass to use in



Close-up look at receiver. Phototube unit is at left.

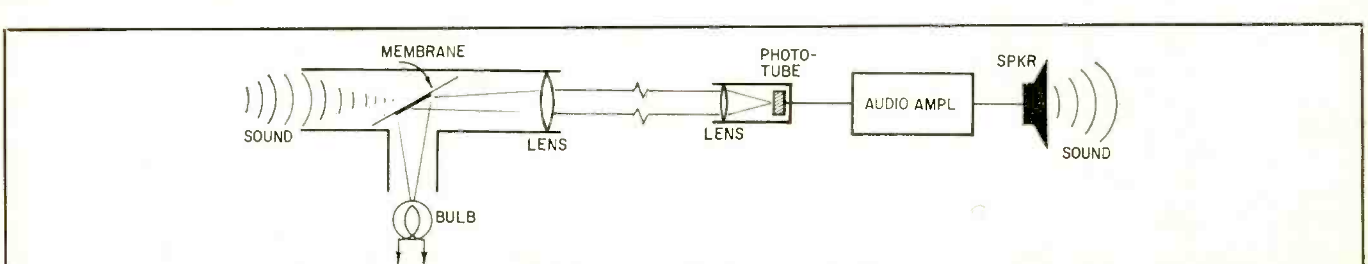


Fig. 1—Light communications arrangement.

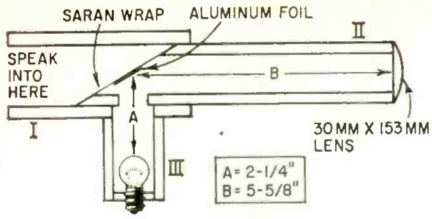


Fig. 2—Transmitter setup.

place of aluminum foil for your reflector. It will improve the operation of the device tremendously. A cover glass for microscope slides is ideal because of its light weight. Coat the back with aluminum paint.

As a final touch, paint the outside of the transmitter a flat black.

Receiver construction

The receiver is reasonably simple and only requires a phototube, one resistor, one capacitor, a battery, some miscellaneous mounting hardware and cardboard tubing. The electronic circuit was built according to Fig. 4 and fed into the crystal-mike input of a tape recorder, using it as a public-address set. The "phono input" on a radio or TV set should do just as well.

As shown in Fig. 5, fit the 921 phototube into a cardboard tube that has a small window cut into it. Over this window attach another tube containing a focusing lens. Mount this on a piece of fiberboard and connect it to the electronic circuitry. The whole receiver assembly should be mounted inside a metal container. Connect the container to the shield of a length of coax which connects the unit to an audio amplifier. An empty soup can with one end cut


Aluminum-foil diaphragm is cemented to center of Saran wrap.

out provided the necessary shielding.

Now try it out

Check the transmitter first. Point its lighted end toward a light surface in a darkened room and talk into it. You should notice a decided variation in the focus of the light beam as you speak. Next hook up the phototube receiver and plug it into an amplifier. Point it toward an ac light or table lamp. You should hear a heavy 120-cycle hum. This will cease as you cover the phototube with your hand. Now you are ready to start.

If possible, mount the transmitter on a tripod and align it with the receiver. Talk into the rear of the transmitter and your voice will come out of the speaker of the amplifier with a surprising amount of volume. Keep moving the transmitter away from the receiver until you lose contact entirely. This maximum distance depends completely on the accuracy of the alignment of the optical system and on the brightness of the bulb in the transmitter. END

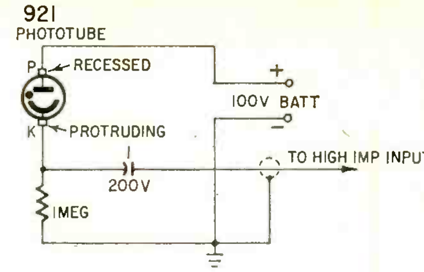


Fig. 4—Receiver circuit.

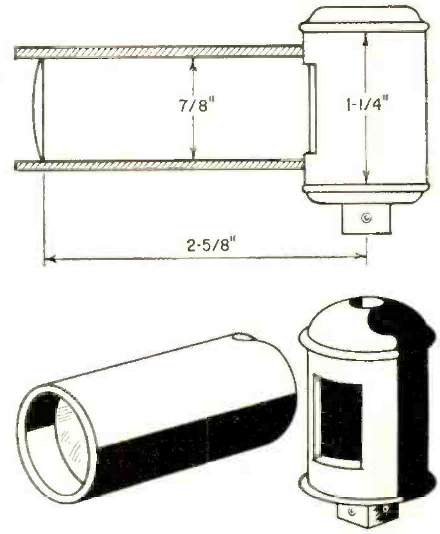


Fig. 5—Physical setup for receiver.

Set of cardboard tubes (Edmund Scientific Co., Barrington, N. J. No. 80,043 or equivalent)
Flashlight bulb, No. 42
Set of lenses (Edmund Scientific Co. No. 2 or equivalent)
Type 921 phototube
1-μf, 200-volt paper capacitor
1-megohm, 1/2-watt resistor
Battery, 100 volts
Miscellaneous hardware, wire, cement, black paint, aluminum foil, wrapping plastic, etc.

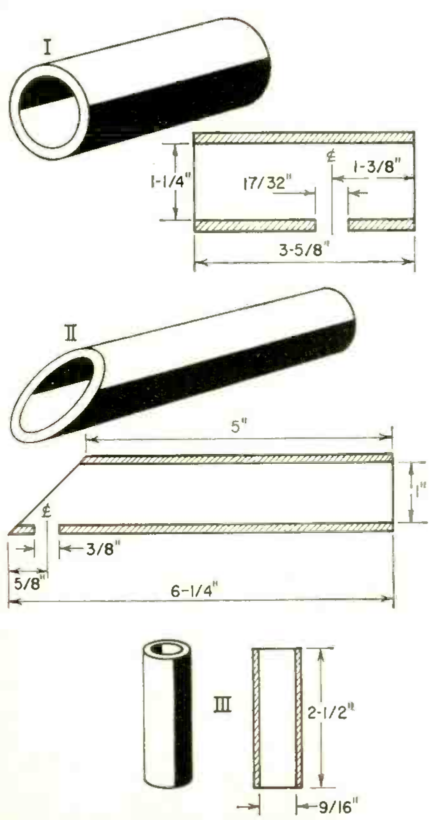


Fig. 3—These three tubes are used to build the transmitter.

Autodyne Converter Troubles

Many technicians will recognize the popular autodyne converter circuit (as shown, or with certain variations) incorporating a 12AU6 pentode, combined local oscillator, mixer, and if amplifier. The following circuit defect is not so apparent, however.

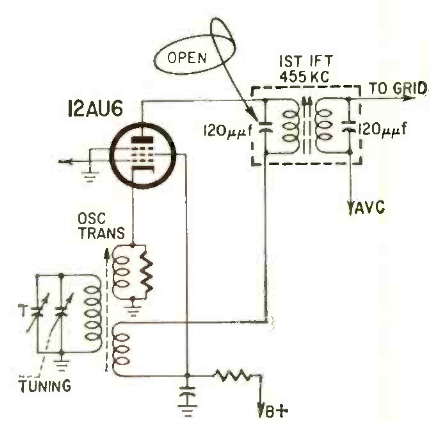
Symptom: Local oscillator refuses to oscillate.

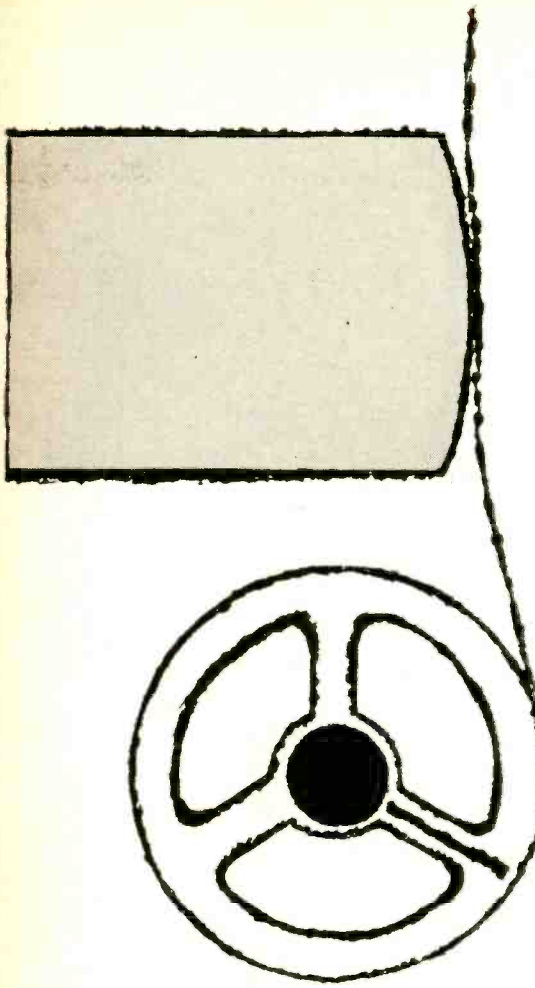
Cause: Fixed-trimmer capacitor in the if transformer base—*open!*

Why it happened:

Random circuit noise is amplified by the 12AU6 and this alternating current is returned by the resonant if circuit to the grounded-grid configuration imposed at the cathode, inductively coupled to the "Meissner tank" which is tuned to a desired oscillator frequency. Properly phased, this feedback is regenerative and when strong enough will sustain oscillation at the correct difference frequency between an incoming signal and that of the oscillator.

If the if L-C network is defective, however, this regenerative feedback voltage is not high enough to sustain oscillation in the cathode circuit and the receiver stops working. The circuit defect is doubly evasive since the if transformer apparently resonates when a 455-kc rf signal is applied to the 12AU6 signal grid, because the coil slug appears to be reaching a peak *as it passes through the coil center!*—*George D. Philpott*





ALL ABOUT TAPE RECORDERS

PART V—BRAKES AND PRESSURE PADS

By JACK DARR

THIS IS THE CONCLUDING SECTION OF this series of articles on tape recorder repairs. It covers two very important sections of the tape recorder, brakes and pressure pads. If the brakes don't work properly, the tape may break or spill out and tangle. If pressure pads are off, the recorder may not play or may distort the sound of the recorded material.

The brakes are just as important as those on a car and have the same effect. If they get too loose, the result is a spill. Of course, the spill is only tape and not people, but it's annoying.

Recorder brakes have a dual function. While the machine is playing or recording, the brake on the feed reel drags just enough to keep the tape at the right tension. When rewinding (or running fast forward), the brakes must stop the reels as soon as possible. Like car brakes, they must take hold smoothly. If they grab on a full stop, the tape will break.

They're actually simple. The brake is just a small felt pad which contacts a smooth drum under the reel hub (Fig. 1). Special cams on the actuating arms give the reel brakes two positions—one for recording and playback in which the brake pad is held lightly against the surface of the drum to provide just the right amount of drag, and the other, a fairly heavy tension, applied when the mechanism is set to the stop position. This tension is regulated by a spring. Actually, the spring tension must be set on the full-stop position, as this is the only time that its full effect is felt. During play, a stop on the brake arm prevents the full force of the spring from being applied.

There are two ways to adjust the brakes. Using the first one, set the brake arm stop for play position. This is usually an adjustable lance. Alternately, you can adjust the spring tension. Watch out for too heavy springs here. They make brakes grab. Service data for each machine usually give the proper procedure for setting them.

There is a very useful rule of thumb for brake adjustments: Run the machine at full speed, then stop it. If the tape stops smoothly, without jerking or running free allowing a loop of slack to form in the tape between reels, it is OK. If slack appears between reels when stopping, the feed-reel brake isn't taking hold quickly enough. This brake should hold slightly harder and actually furnish the major part of the braking force. Let me hit that one again; it's important. **The reel from which the tape is being unwound should furnish the braking, or most of it, to keep the tape taut after a stop.** Check brake tension by trying to turn the empty reels with the machine stopped. Ideally the spindles should move about twice as hard in the direction in which they unwind as that in which they wind.

Pressure pads

Similar to brakes, although they have

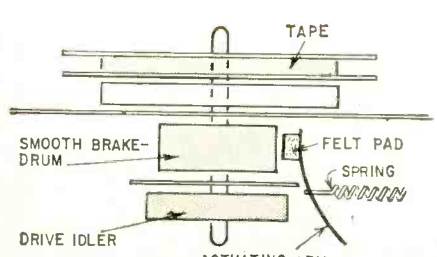


Fig. 1—Typical position of reel brake.

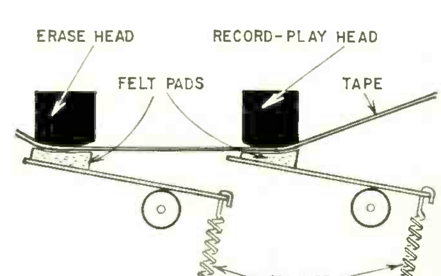


Fig. 2—Pressure pads hold the tape closely against recording and erase heads.

a completely different function, are the pressure pads (Fig. 2). They are small felt pads that hold the tape snugly against the record and erase heads. During rewind or fast forward, the pressure pads are released to let the tape run past the heads without making contact. This reduces head wear, and reduces the familiar "Donald Duck" gabble heard while running tape backward through a recorder.

The presure-pad actuating arms are usually brass or some nonmagnetic material as they work very close to the recording heads. They are moved into place by another arm and spring arrangement usually actuated by the familiar cam or lever on the pushbuttons, or sometimes by a heavy solenoid. The pressure applied to the heads by the pads is usually determined by the spring tension, although some rare machines have direct-drive types, which must be adjusted by bending a tab on the actuating arm.

If the pads press too tightly on the head, the tape is slowed up and wow may result. Too little pressure will cause "dull" recordings.

Clutches and tape tension

The amount of tape tension is regulated by several things, mostly the combined tension exerted by the feed-reel brake drag and the takeup-reel drive. Of course, as we said before, the capstan determines the tape speed. But it can be affected by excessive drag or binding in any part of the tape-transport mechanism—too much pressure on the pressure pads, for example.

At this point, we run into a feature of all machines which deserves discussion —controlled slippage. All tape recorder drives must have a certain amount of slip. When we put a full reel of tape on the feed reel and an empty reel on the takeup, the two hubs must turn at different speeds. To do this, we arrange the drives on each so the driving mechanisms can slip. When separate reeling motors are used, slip is electrical. In idler or belt-driven machines, some type of clutch will be the rule. Some fabric belts are set to have enough slack to allow the necessary slippage.

Some makers use a felt-faced clutch between the reel spindle and the drive (Fig. 3). Here, the reel hub floats completely free from the drive. It rests on a felt-faced disc, which in turn rests on a smooth metal disc, driven by the idler. Therefore, if the tape jams or suddenly gets too tight, there is enough slippage to keep the tape from breaking.

If these felt-faced clutches get oil, grease or dirt on them, they may slip too much or bind unevenly. If this kind of trouble shows up, replace the clutch. If no spare is available, as a stop-gap, wash them with a grease solvent and dry carefully.

Fig. 3 also shows a rather common method of supporting reel spindles and other rotating shafts. The shaft is ground to a point which rests in a cup on the end of an adjusting bolt. This arrangement is often used in setups where the amount of end play on a given shaft must be adjusted. To set up an arrangement like this correctly, loosen the lock-nut, run the bolt up until the shaft begins to bind, then loosen the bolt about a quarter turn, and retighten the lock-nut.

Wow and flutter

One of the worst problems in tape recorders is caused by drive troubles. It is variations in the speed of the tape as it passes the recording head. Slippage anywhere in the capstan drive mechanism will make the tape run below its rated speed, and everything will sound low-pitched.

A periodic variation in speed is called wow or flutter, for reasons which will be immediately apparent once you hear it.

This trouble is always caused by a drive defect. Most of it originates in dirty, greasy or wornout drive idlers. Excessive drag on feed-reel brakes or takeup clutches can also cause it. Grease spots on rubber idlers can cause wow. The slick surface of the drive shaft spins momentarily, causing a sudden variation in the speed of the mechanism.

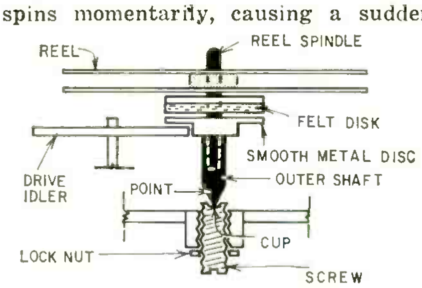
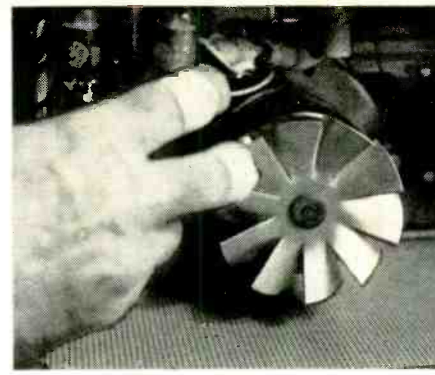


Fig. 3—Felt-faced clutch keeps enough driving tension on reel, but still allows for necessary slippage.

The best check for this is to play a tape with a continuous tone, somewhere around 3,000 cycles. Any tendency toward wow will immediately be heard. Make certain that you become familiar with the way a 3,000-cycle tone should sound on a home recorder that is operating properly before using this test. On no home recorder will the tone sound as steady as the original.

First step when trying to get rid of wow is a thorough cleaning of all rubber drives. Wash them with alcohol or xylene, using a clean rag or cotton swab or new pipe cleaner to apply it. Keep your fingers off the rubber surfaces or the metal drives afterward. Even the cleanest human skin carries enough oil to cause trouble.



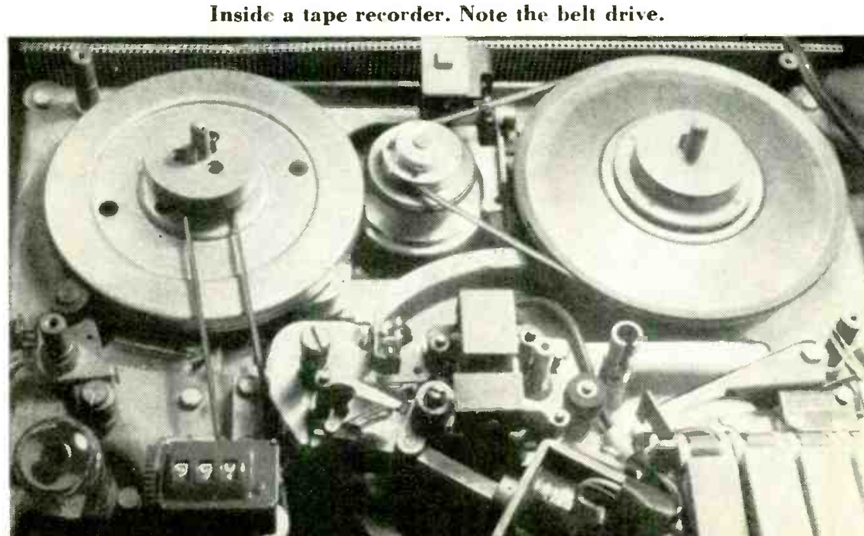
Remove that fan before doing any servicing. It can gash fingers badly.

If the rubber drive is fairly old, its contact surface may develop a glaze from constant friction against the smooth metal drive shafts. These should be replaced. If replacements are not available, the idler can be resurfaced with fine sandpaper or handier still, an emery board sold in the cosmetic department of drug stores. When resurfacing, remove all rubber dust from the mechanism and cover bearings to protect them.

Dents in the rubber drive of an idler also cause wow. If the machine is stored or left idle for long periods in hot weather, the drive shaft resting against the soft rubber drive will cause a dent (Fig. 4). If the dent isn't too deep, it can sometimes be removed by running the machine for a long time to knead the drive idler enough to remove the dent. Don't try to sand it off. This is useless. The voice of experience!

Another obscure cause of wow is a bent or off-center capstan. This is the result of dropping the machine or other abuse. The degree of wobble which can be tolerated in the capstan is very small and may be undetectable by the naked

Inside a tape recorder. Note the belt drive.



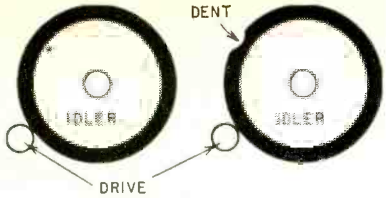


Fig. 4—Dents in idlers are often caused by a drive being left engaged when not in use. The dents cause wow.

eye. Run the machine and hold a sharp-pointed object like a pencil very close to the capstan, watching it through a magnifying glass or jeweler's loupe. If necessary, clamp the pencil or pointer to the top of the machine to get it steady enough. Wobble can be detected in this way. If the capstan is badly off center, the pencil will touch only one side, leaving a mark which can be seen when the machine is stopped.

Incidentally, a bent spindle in one of the tape reels can cause the same symptom, so watch out for this, too. Sometimes, you can spot this quickly by observing the reel as it turns. If the spindle is off center, the reel will wobble up and down. However, try several different reels just to be sure. A plastic reel will often wobble naturally from being stored in hot places.

Checking tape speed

There are several ways to check tape speed. The quickest is with a stroboscope. Several firms make this instrument. One very small one is placed on top of the capstan idler. Another is a strobe disc, about the same general dimensions as the familiar strobe disc used to check record changer speeds.

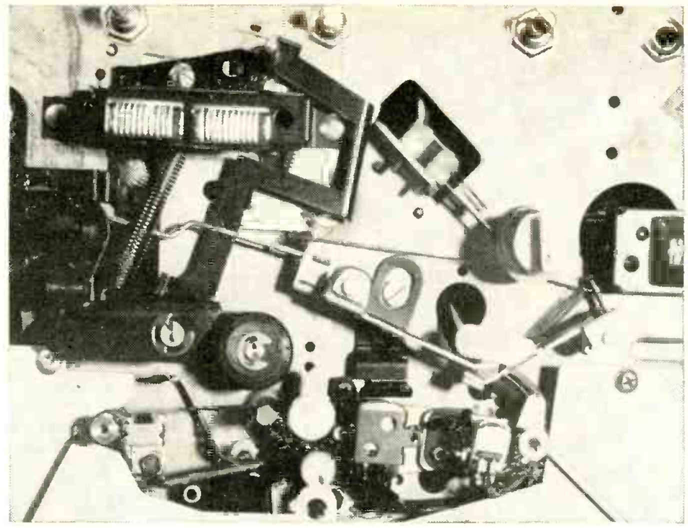
Mounted on a handle, it is held against the tape while it is running. A special endless-loop strobe tape is also available. It is placed on the machine and illuminated by a neon or fluorescent light, just like the others.

One word of caution here. **Never attempt to check tape speed by placing a strobe disc on the reels themselves.** As we explained before, the reel speed is always proportional to the amount of tape left on it, and only if the amount of tape on each reel was exactly equal would this be a valid measurement. So no matter what method you use, be sure to apply the measuring device directly to the tape itself, preferably at a point where it passes over the capstan or one of the tape guides.

General service hints

The driving motors of these machines normally have small metal fans to keep them cool. Stamped out of sheet metal, they have very sharp corners. So, to avoid being called Stubby for the rest of your life, remove the fan before attempting any service work underneath the machine.

Also watch out for tricks in design. Now and then, you'll run into some very unusual things. I recently ran into trouble while repairing a Bell & Howell 785 recorder. The complaint was no recordings. A quick check with a scope disclosed that there was no bias. Tracing the bias oscillator circuit, I found the plate supply running through what appeared to be a standard dpdt slide switch. Ohmmeter tests showed the switch bad.



Part of the mechanism of a 4-track stereo tape recorder.

A frantic examination of 47 switches finally turned up one that was an exact duplicate. Removing the old switch, I saw that one of the little metal contacts in the fiber disc was completely gone. No wonder it wouldn't work.

The switch was replaced, all the wires soldered very carefully back to where they came from. (Three green wires went to the top right contact, two yellow wires to the top left.) (By the way, these were voice-coil wires, and the schematic we had on this machine showed this as a muting switch, with the voice-coil leads broken by it.) The red B-plus leads went to the bottom terminals.

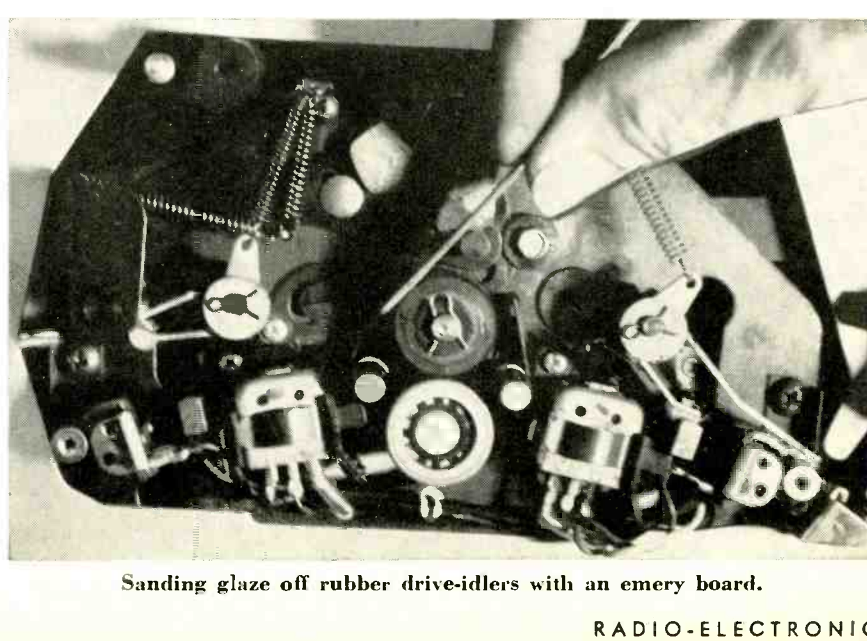
So I happily turned the machine on, and punched the record button. Scope check showed lots of bias now. But only one small defect still remained. Before, the machine had played back beautifully, but wouldn't record. Now, it wouldn't do anything! No playback, no record, no nothing!

Hmmm. Go back, check the wires on the switch. Even according to the service information, they were OK. To make a *very* long, painful story a lot shorter, about 10 hours of detailed checking later, I finally removed the switch and took off the top contacts, leaving the red wires (to the bias oscillator). The machine played perfectly.

After I had cooled down somewhat, I reached the obvious conclusion. This was not a standard dpdt switch. The missing contact was not accidentally lost, but had been removed deliberately. The two top contacts on the switch were merely being used as tie points to hold the voice-coil leads. When I installed a dpdt switch, the voice coil was firmly shorted out whenever I switched the machine to either play or record.

Watch out for such tricks. Fortunately, they are rare.

Well, we've come to the end of the road. The tape recorder has been covered from top to bottom. I wish there were more service hints that I could offer, but you'll just have to learn the rest by experience. END



Sanding glaze off rubber drive-idlers with an emery board.

By JOSEPH MARSHALL

Practical alignment of Hi-Fi FM TUNERS

The Fisher FM-100 tuner.

Forget about that sweep generator and oscilloscope; use your vtvm and signal generator

Every service technician "knows" that the only "proper" way to align an FM tuner is with a sweep generator and oscilloscope. Yet, the majority of shops use a signal generator—or the signal of an FM station—and a vtvm, or just the tuning meter on the tuner. This article describes a simple but accurate alignment method that eliminates the need for the scope and sweep generator, yet results in accurate alignment. For those who insist on the ultimate—an absolute minimum of distortion—a second method, using an FM generator and a distortion meter, will be described next month.

As nearly as I can determine, all current tuners—and most of those made after 1955—use loaded transformers and have a single-peaked response curve. Overcoupled transformers with their double-humped curves are rare. A tuner with this single-peaked curve can be aligned at least as accurately by peaking with a signal generator (or station signal) and vtvm or tuning meter as with the visual method. And, the signal-generator-plus-vtvm method is not only far simpler to use but requires less expensive instruments and a relatively simple alignment procedure and setup.

Let me make clear that this does not mean that visual alignment should not be used. It has its share of advantages as well as disadvantages. On the other hand, don't apologize if you use the generator-plus-vtvm approach. Furthermore, if you have been afraid to undertake FM tuner alignment because you did not have the right equipment for visual alignment, you can put your fears at rest. Simpler methods can do a good job.

Is realignment necessary?

Most tuner alignment instructions assume that a complete realignment job is necessary. They detail a rather complicated procedure which takes considerable time and equipment. Actually the need for realigning good FM tuners is greatly exaggerated. A really significant departure from the design frequency and response curve is likely to occur only when there is a breakdown in one of the circuit components. The small drift due to aging is made pretty harmless by the wide-band detectors found in most modern tuners. So if a tuner has not been touched since leaving the factory, it is likely that the if and detector stages are peaked well enough to provide high performance even after 2 or 3 years of use.

Misalignment is far more likely in the rf and converter stages. You will probably get greater improvement from realigning these.

Alignment procedure

Most of the time the following technique will be both adequate and efficient: Always start by letting the tuner warm up at least a half hour, to stabilize its operation. If you tune in a station and connect the tuner to an amplifier and speaker, you can, while doing another job, check for drift and effectiveness of the automatic frequency control by listening with one ear.

When the tuner is warmed up, check the sensitivity. The most elegant and objective way to do this is with an FM generator with calibrated voltage output like the Measurements 78-FM or 210-A. Unfortunately, these instruments are rather expensive and only a shop that handles a great deal of tuner work is justified buying one. A simple alternative is available to everyone. In every location there are weak or marginal stations that can be used to estimate tuner sensitivity. If you are familiar with the stations receivable in your location with your antenna, you can get an excellent estimate of a tuner's sensitivity in one or two sweeps of the band. Note the deflection on the tuning indicator or the degree of noise suppression on the weakest stations.

Check the tubes, and replace any that do not meet normal standards. Check sensitivity again to see if there has been a significant improvement. I have found that a change in tubes makes the greatest single improvement in performance.

Peaking the front end

While checking sensitivity, watch to see how the tuner is tracking in relation to the dial calibrations. Do this, of course, with the afc disabled. FM stations whose frequencies are known to you are by far the best standards for this purpose. The chances are that there will be some departure from accurate tracking in any tuner that has been in use a year or more. If it is serious—a megacycle or more—you have good grounds for suspecting that the tuner has been misaligned and you can at this point do a complete realignment job, using the procedure recommended in the service manual.

In a great majority of cases, you will find only a small departure, which will indicate that the if amplifier is still peaked pretty close to its original frequency. Tracking can be restored by adjusting the oscillator trimmer at the high end of the band. The signal of an FM station in the region between 105 and 108 mc is again best for this purpose. The low end can be tracked by squeezing coils. Work back and forth between the low and high end.

The next step is to peak the rf and converter stages with their trimmers. You can use a relatively weak station anywhere above 100 mc as the signal source, and the tuning meter on the tuner as indicator. Or you can peak for maximum noise at a point around 105 mc where there is no signal and only receiver noise is audible. Although it is usual to peak at the high-frequency end, in fringe areas it may be preferable to peak the front end on the signal of the weakest station. This provides maximum gain at the most needed point. Some sets have interaction between oscillator and mixer trimmers (pulling). This is one job where a sweep generator and scope are lovely.

Checking if response

You can now get a pretty good idea of the shape and symmetry of the if response curve, still using the signal of an FM station and the tuning meter on the tuner. Carefully tune in a station of moderate strength—one that gives a good indication on the meter but does not saturate it. Detune the station by about 100 kc on each side of resonance. Considering the vagueness of modern dial markings, this will involve some educated guessing on your part.

With a station of moderate strength, the signal should be audible for at least 100 kc on each side of resonance. (Of course, the afc is disabled throughout this process.) The tuning should be about the same whether you tune in the station from the upper or the lower side. If it seems sharper from one side than the other, the response curve is not symmetrical and a complete realignment of the if is justified.

Very sharp tuning indicates regeneration. This calls for a close look at the tubes and components of the individual if stages. A new tube that is

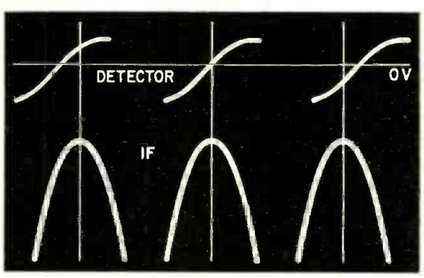


Fig. 1—Detector is properly tuned when center of detector response coincides with peak of if response curve.

exceptionally "hot" may be responsible. Cathode resistors and capacitors, plate and screen decoupling resistors and capacitors, and transformer loading resistors should be checked and replaced if their value is more than 25% off the marked value or that specified in the wiring diagram.

The detector

In the great majority of cases the tuner will pass this check, showing a broad enough response and a reasonably symmetrical one. The detector alignment can be checked next. If the tuner uses a ratio detector, the procedure is:

▶ Carefully tune in a station of moderate strength (one that produces a 50% deflection on the indicator) to maximum swing on the tuning meter or indicator.

▶ Take an electric drill, turn it on and hold it close to the tuner.

▶ A ratio detector provides maximum noise suppression when the input signal is in the center of the detector bandpass. Therefore, when the center of the detector response coincides with the peak of the if response curve, you get maximum noise suppression (Fig. 1). If you get a complete null, you can assume the detector is properly aligned. If you get some noise, detune the tuner slightly on each side of resonance to see if you get less noise to one side or another of the if peak. If this happens align the detector.

▶ Again carefully tune in the station for maximum swing of the tuning indicator. Detune the secondary of the detector transformer so the noise of the drill is plainly audible. Turn the primary slug for maximum noise, then the secondary slug for minimum noise. The primary tunes fairly broadly. Set it for the center of its peak. The secondary is more critical. Adjust it very carefully, rocking the tuning slug to one side and the other to make sure that you get it set at the exact minimum-noise point.

You can also make this adjustment slightly more accurately by injecting a signal into the tuner, anywhere in the FM band, from your AM signal generator. Tune the tuner carefully to resonance as above. Turn on the amplitude modulation and connect an ac vtvm or the ac range of a service vtvm across the tuner output. Detune the secondary of the detector transformer so the amplitude modulation produces a reading on the meter. Now adjust the primary for maximum meter reading, and the secondary for minimum meter reading.

For a discriminator detector, the procedure is:

▶ Again carefully tune in a station of moderate strength to exact resonance.

▶ Connect a dc vtvm (M1) across the detector output load. The simplest connection is across the two cathodes of the detector double diode (Fig. 2). One of them is grounded. A discriminator is properly aligned when the center of the discriminator curve coincides with the peak of the if response curve. At this point, there is zero dc voltage across the detector output.

Therefore, if the vtvm shows a zero reading when you have connected it in this way, the detector is properly aligned. You can check by detuning to one side or the other. If the vtvm gives a zero reading when the tuner is slightly detuned, the detector should be aligned. Retune the signal to exact resonance on the tuning meter. Turn the secondary slug of the detector transformer slowly in the direction that brings the reading on the vtvm closer to zero and adjust it for exactly zero reading. Now move the vtvm across either of the two detector output load resistors (M2 in Fig. 2) and adjust the primary slug for maximum swing on the vtvm. (The swing may be in the negative direction. If it is, change the vtvm polarity.)

With the meter still in this position, peak the slugs of the transformer between the two limiters.

Practically all current high-fidelity tuners, whatever the type of detector, now use a maximum-swing tuning meter or indicator. Some older and one or two current tuners use a zero-center type of meter connected across the detector output to indicate the null point when the signal is properly centered on the detector curve. A couple of deluxe tuners have both a maximum-swing "carrier-strength" indicator and a zero-center type of tuning meter. If the tuner has two meters or indicators, the alignment is very simple. The zero null on the tuning meter should coincide with the maximum-swing peak on the carrier-strength meter. If they do not coincide, tune the tuner for maximum swing on the carrier-strength meter. Now adjust the secondary of the detector transformer for the zero-voltage null on the tuning meter. The primary is best adjusted by connecting a vtvm across one of the load resistors as detailed previously. However, it is possible to adjust it by turning the slug to the point which gives both a zero reading on the tuning meter *and* the loudest output.

If the tuner has only a zero-center type of tuning indicator, connect a vtvm across the grid-return resistor of the first limiter. Now adjust the tuner for maximum swing on the vtvm. This should coincide with the zero null on the tuning meter. If it does, detector alignment is OK. If the tuning meter does not show zero voltage, adjust the detector secondary for the zero reading. Then shift the vtvm to the detector load resistor and adjust the primary for maximum swing as detailed earlier.

The question arises: Which is the primary and which the secondary slug? This is a good one and ought to, but does not, have a categorical answer. It ought to be standardized and, in my own view, the secondary slug should always be the bottom one—so that it will be less likely to be disturbed by an owner with more itch to use his screwdriver than knowledge and skill in employing it. However, there is no standard. More often than not, the secondary is the bottom slug, and the odds are in favor of assuming this. Of course, the safest thing to do is to check the service manual. Sam's *Photofacts* folders do indicate which slug is which. In other cases, you can deduce it from the alignment instructions.

With a little experience, you will soon learn which is which by the audible effect of a slight change in slug position. The secondary slug usually has a far more violent effect on the quality of the sound or on the noise. Primary-slug tuning is usually much broader and

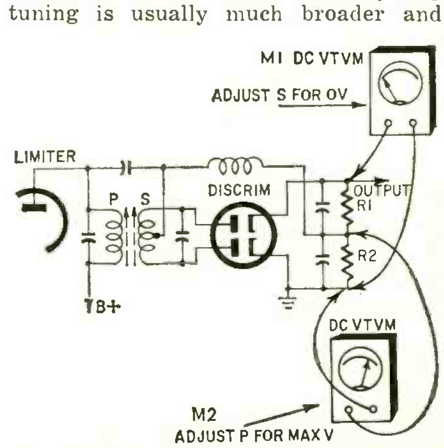


Fig. 2—Connections for discriminator alignment.

tends merely to increase or decrease the volume of sound or noise. Secondary tuning produces a very marked difference in the noise level, the loudness of the modulation or the distortion or all three.

Suppose you're working on a ratio detector with electric-drill noise or a signal generator with AM modulation. Try the bottom slug first and turn it a half turn or so in each direction. Within this one-turn range you should find a point where you get a very definite, sharp null in the noise or AM modulation. If you do, it's the secondary all right, and you adjust the slug for the minimum output point. On the other hand, if instead of a sharp null, you find a peak in the noise with a gradual reduction on each side, you definitely have the primary slug. Tune it for the maximum output point, and then tune the other slug for the minimum output.

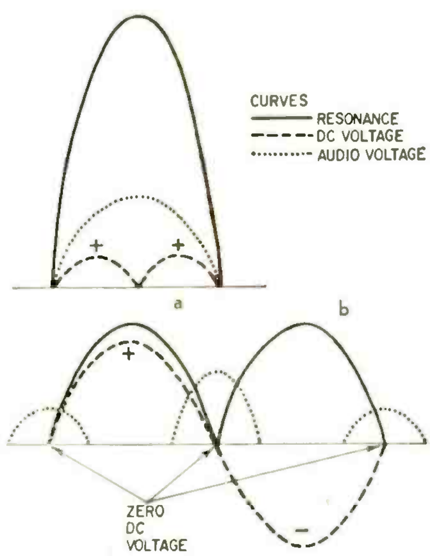
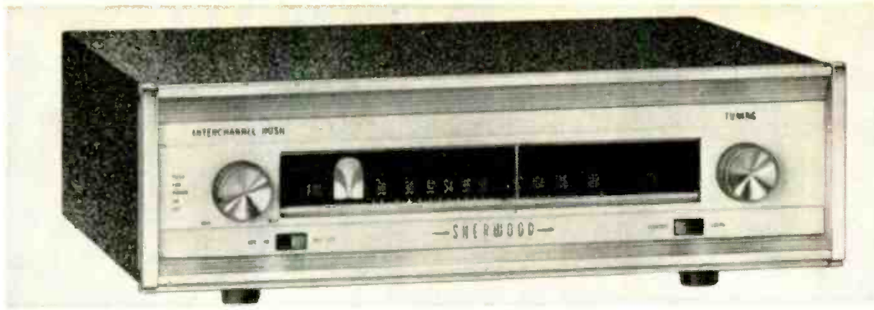


Fig 3—Detector transformer curves: a—primary; b—secondary.

If you're working on a discriminator detector with the vtvm across the detector diodes and an FM station as the signal source, again try the bottom slug first and turn it in both directions slightly. One way will produce a reduced reading on the meter and at the same time increased loudness in the audio output; the other way will produce an increased reading on the meter and a decrease in audio output or an increase in distortion. Turn the slug in the direction that gives the lower voltage and adjust it for zero voltage. Now detune the slug about a turn in each direction.

If you do *not* find another point where you get the combination of zero voltage *and* loud sound, you are actually tuning the primary. On the other hand, if you do find another or possibly two other points where you get the meter null and loud peak, you definitely have the secondary. In that case, adjust for the middle null or, if there are only two points of null, for the one that produces the least distorted sound. Then adjust the primary again as detailed previously.

It may help to keep in mind a picture



Sherwood S-3000 II FM tuner.

of the way the resonant curves of the primary and secondary affect both the dc voltage and the audio at the output of the detector. In Fig. 3-a we have the curves for the primary and in Fig. 3-b the curves for the secondary. The solid curves are the resonance curves, the broken curves represent the dc voltage developed across the detector output, and the dotted curves are the audio voltage developed at the output of the detector.

You will note that in the primary (Fig. 3-a) there are three points at which you can get a zero voltage but only one point at which you get *both zero dc and an audio peak.* On the other hand, in the secondary you can get the combination of zero dc and an audio peak at three points. In the ratio detector, the primary peaks the noise but does not null it. The secondary produces some noise suppression at all three points, but a null only at the middle peak. In a discriminator, there is only one audio peak when the primary is tuned, but three peaks when the secondary is tuned. The right one is always the middle one and is recognizable because it is the least distorted.

In a narrow-band detector the three peaks show up in a few turns of the secondary slug. But it is possible to get confused in a wide-band detector because the additional peaks may not show up in the plus or minus one turn of the slug. Fortunately, you don't need to worry about this because a wide-band detector will almost certainly pass the detector test and give you no justification for trying to align it. Wide-band detectors have enough leeway so that with normal aging they will give the required zero-voltage null even when the coincidence between the centers of the if response curve and the detector curve is not perfect. In the vast majority of cases, the very slight misalignment that may exist because of aging will not significantly affect performance.

If you have trouble distinguishing between primary and secondary, it's a good bet you're dealing with a wide-band detector. In that case, adjust both slugs for the point within the range of about one turn of the original position that yields both a dc null and an audio peak.

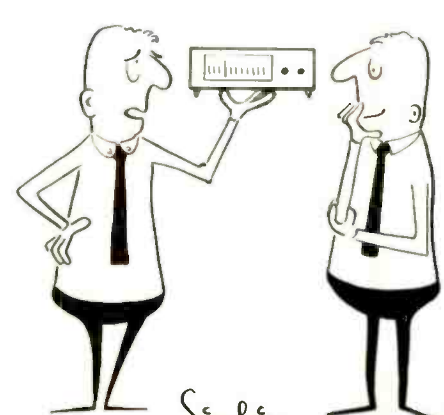
If you run into a wide-band detector that is badly misaligned, the safest thing is to obtain the service manual and align the detector as recommended. If you have an FM generator and distortion meter, you can align it with perfect confidence by the method outlined in a later section. However, you'll be pretty safe if you sweep the range of the secondary slug to find the three audio peaks and dc nulls and adjust for the middle one. On some wide-band discriminators you may find only two peaks. In that case, choose the one which produces the cleanest sound.

Peaking the if

Whatever the type of detector, when you have finished adjusting it, leave the tuner dial (and generator if used) exactly as they were when you completed the detector alignment—in other words, in the position that gave you the meter null. If you have the meter connected to the discriminator output leave it in. Peak the if slugs carefully for maximum swing on the tuning indicator without disturbing the dial (or generator) at any time. If you should disturb the dial setting, reset for the null in the vtvm across the discriminator output and start again.

When you have finished, you can check the symmetry of the response curve and also the coincidence of the if peak with the detector output null. If the voltage or noise null of the detector coincides with the peak of the if response curve, you know the job is done properly.

That winds up FM alignment without a scope or sweep generator. There is another FM alignment method. If you follow it you need an FM generator and a distortion meter. As this is a separate procedure, we will not cover it here. It will appear as an article in next month's issue. END



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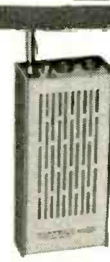

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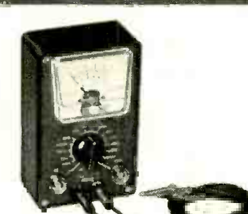

8 New Test Instruments . . . Capacitor Checker, "Handy-Lab," Transistor Tester, Scope, kit & wired VTVM's. Above: **IM-20** "Handy-Lab." 2 lbs. **$14.95**

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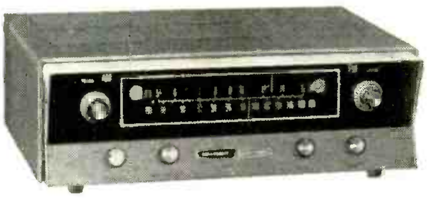

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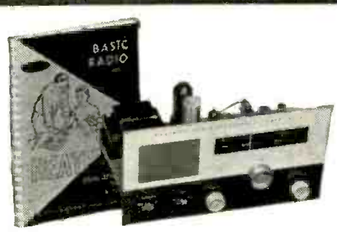

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The Sencore model TR110 in-circuit transistor checker.

Two new instruments let you test transistors without unsoldering them from the circuit

The Hickok model 890 in-circuit transistor checker.

In-Circuit Transistor Testing

Transistors *do* go bad under normal use, in spite of the wealth of scientific "proof" to the contrary. Since they are usually wired into the circuit and hard to remove for testing, manufacturers have developed in-circuit testers. Two separate approaches to the problems of in-circuit testing are presented here.

Both are interesting and well worth considering. Both require that the input circuit impedance be more than about 150 ohms at 1,000 cycles for accurate testing. For this reason, volume controls should be set about halfway when testing audio driver transistors (Fig. 1). Note that either position *a* or *c* will reduce the input impedance of the circuit. A few if circuits similar to Fig. 2-a will have too little impedance for in-circuit testing because the 10-μf capacitor has less than 20 ohms reactance at 1,000 cycles. However, the circuit in Fig. 2-b can be tested since the emitter resistor is larger than 150 ohms (the reactance of the .05-μf emitter bypass is more than 3,000 ohms at 1,000 cycles). The circuit in Fig. 2-c can also be tested since an electrolytic is not used to bypass the lower end of the if input circuit.

Some other circuits, such as direct p-n-p, n-p-n-coupled, etc., may give erroneous results on in-circuits tests. Nevertheless, probably more than 90% of the circuits used today will respond to in-circuit tests. If the transistor checks OK in-circuit, you can assume it is a good transistor. If it checks bad in-circuit, always make an out-of-circuit test for final verification. The circuit itself may be shorted!

One big advantage of in-circuit testing is that by determining which transistors are good, you can concentrate on just the portion of the circuit that tests bad.

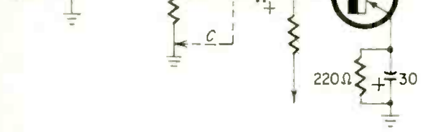


Fig. 1—When testing audio driver transistors in circuit, set volume control halfway (position *b*). Position *a* or *c* will lower the input impedance and make in-circuit testing difficult or impossible.

Sencore Transi-Master

This new Sencore instrument (the TR110) makes both in-circuit and out-of-circuit tests. The in-circuit test determines the ability of the transistor to oscillate as a blocking oscillator. The out-of-circuit check determines leakage and dc beta (gain).

The simplified in-circuit check for a p-n-p transistor is shown in Fig. 3. (N-p-n transistors are checked identically except polarities are reversed by a front panel switch.) Note that the impedances represented by the blocking oscillator windings are quite low in both the input and output circuit so any external circuitry is pretty well swamped.

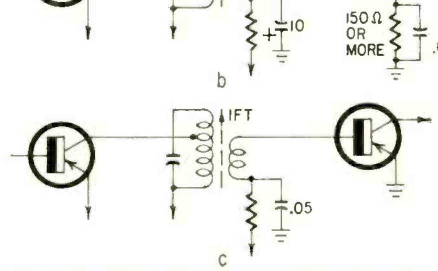


Fig. 2—The circuit at *a* has less than 150 ohms input impedance. However, both *b* and c have more than 150 ohms input impedance and transistors can be tested with in-circuit checkers.

The BIAS SET control is set for the PNP (or NPN) BIAS LINE position so that the transistor is forward-biased. A good transistor will oscillate under these conditions. The meter indicates oscillation since it is connected between the collector and emitter to read the ac output of the circuit.

The Sencore unit does not claim to make an in-circuit gain check but only to indicate whether or not the transistor is operative. For this reason, the meter reading will be approximately the same for all transistors. If a transistor fails to respond, remove it from the circuit and test again. This is necessary because there may be a fault in the circuit itself or the natural impedance of the circuit may be so low that oscillations cannot start.

The TR110 tests transistors out of circuit too (Fig. 4). Set the function switch to OUT OF CIRCUIT. Adjust BIAS SET as indicated by the setup chart. Leakage from emitter to collector with base open is read automatically. Leakage should not exceed that indicated on the chart. Depressing the TEST switch inserts the base into the circuit and forward-biases the transistor. The meter reads collector current. This current is equivalent to dc gain (beta).

For high-power transistors, the 22,-000-ohm limiting resistor in the base circuit is shorted out to lower the

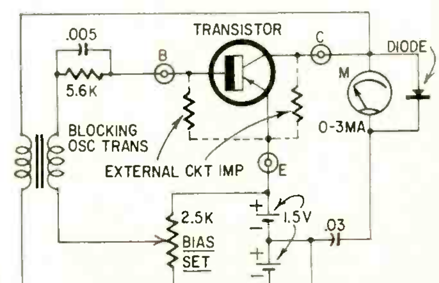
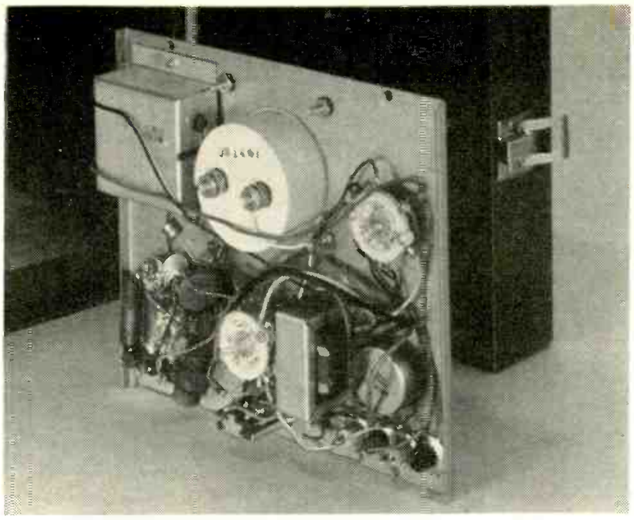


Fig. 3—In-circuit test used in Sencore model TR110.



Inside the Sencore tester. All components are mounted on the back of the front panel.

Sencore Transi-Master Model TR110

Power Requirements: (2) 1.5-volt type-C cells.

Functions: Out-of-circuit test for I_{CEO} leakage and dc beta (gain) for low- and high-power transistors. In-circuit test for transistor's ability to oscillate. Volts dc 0–12. Ma dc 0–50. Audio and harmonic generator.

Size: 7½ x 8 x 3 inches, lid closed.

Meter Size: 3 x 3½ inches, 0–3 ma.

Construction: All metal, mirror in lid.

Price: $49.50

input impedance and, since collector current will be higher, a 33-ohm resistor is shunted across the meter.

In addition to testing transistors, the Sencore instrument includes a harmonic generator (Fig. 5). It is used for signal-tracing transistor radios through rf, if and audio stages. In the AUDIO position, the output is essentially a sine wave. In the RF–IF position the output is rich in harmonics up through the broadcast band. The meter indicates that the generator is putting out.

The meter can also be used to measure battery voltage (0–12 volts) and current (0–50 ma). The current scale is especially useful for aligning transistor radios since, for most radios, there will be maximum current drain with maximum signal.

A special test lead set is included with the instrument. It slips between the battery and its connector to make it easy to check battery current. Another 3-wire test lead set is said to make it easier to connect to the terminals of the transistor in-circuit.

Another method of getting onto the terminals of the printed board is to "ball up" a bit of solder on each of the transistor terminals.

Hickok Model 890

This in-circuit tester measures the dynamic (ac) beta of a transistor by using an ingenious bridge circuit to balance the external input impedance of the transistor circuit out completely. The output impedance is swamped during the test with a 1-ohm resistor. The circuit impedance (at 1,000 cycles) can be read directly on the calibrated potentiometers of the bridge circuit. Another is calibrated so you can read the dynamic input impedance of the transistor itself.

First, the I_C (collector current) control is set to take control of transistor

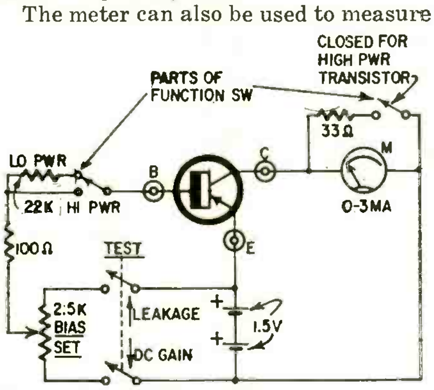


Fig. 4—The TR110 uses this dc leakage-gain test.

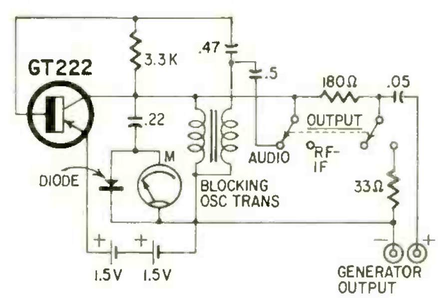


Fig. 5—Harmonic and audio generator in the TR110.

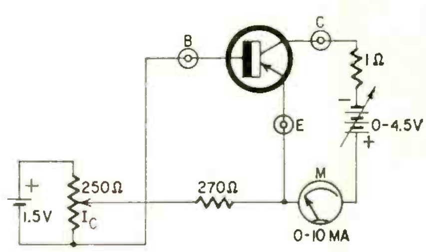


Fig 6—Basic I_C test circuit for p-n-p transistor in Hickok model 890.

Inside the Hickok tester. Batteries are mounted inside the bottom of the case.

Hickok In-Circuit Transistor Tester Model 890

Power requirements: (4) 1.5-volt type-C cells. (1) 22.5-volt battery.

Functions: I_{CBO} leakage (out of circuit only). Collector current. External circuit impedance (Z ohms). Dynamic transistor input impedance (R_{IN}). Beta calibrate and ac beta. (All above, in circuit or out of circuit.)

Size: 9 x 10¾ inches.

Meter Size: 3½ x 3½ inches, 0–50 μa.

Cabinet Construction: All metal with sloping front panel.

Price: $129.50

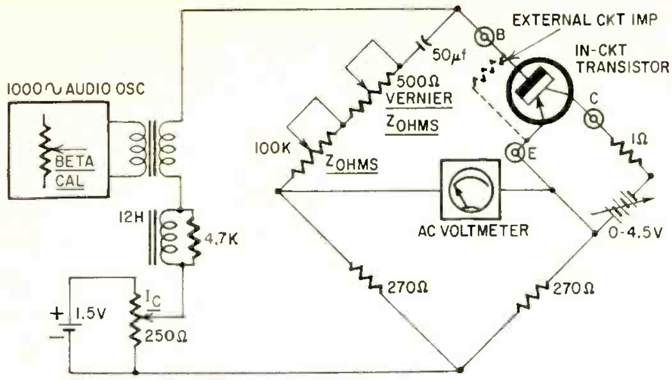


Fig. 7—Z_{OHMS} test circuit in the model 890.

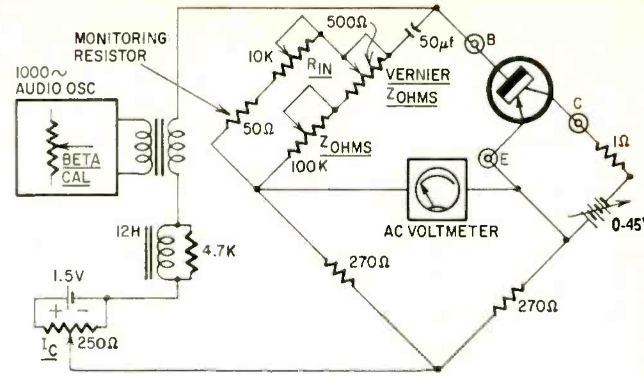


Fig. 8—The 890 uses this R_{IN} test circuit.

currents (Fig. 6). With the I_C control at zero, the meter reads the stray currents in the circuit. These are usually less than 1 ma. The I_C control is then set for an additional 1 ma of collector current. If stray currents are high—3, 4 or 5 ma—the I_C control is set so the collector current is approximately twice the stray-current value.

To test circuit beta accurately, the circuit impedance must be cancelled. This is done by balancing out this impedance in the bridge circuit of the 890, as shown in Fig. 7. The transistor is automatically reverse-biased in this step to prevent its input impedance from affecting the bridge balance.

To balance the bridge, the BETA CAL control is advanced until there is a reading on the meter. Then the Z_{OHMS} controls are rotated until a null (dip in meter reading) occurs. The bridge is now balanced and the circuit impedance effectively cancelled.

There is still one other consideration—the dynamic input impedance of the transistor itself. The R_{IN} potentiometer is switched in parallel with the Z_{OHMS} controls, and the transistor is again forward-biased (Fig. 8). R_{IN} is then set to balance the bridge. Now, with both the circuit impedance and the transistor impedance nulled, we are ready to make the in-circuit beta test.

Ac beta is the current gain of a transistor in a common-emitter circuit. It is the ratio of ac collector current to ac base current, expressed:

$$\frac{I_C}{I_B}$$

The model 890 measures ac beta as shown in Fig. 9. An ac voltmeter is placed across the 50-ohm monitoring resistor in the bridge circuit. The BETA CAL pot (it adjusts the output of the internal 1,000-cycle transistor oscillator) is set so the meter reads at the CAL position. Next the meter is switched across the 1-ohm resistor in the collector circuit and the ac beta is read directly on the meter.

The 890 can also make out-of-circuit tests and one additional out-circuit test is provided—I_{CBO} (leakage, reverse current from collector to base with emitter open). Since the external input impedance (Z ohms) would be infinite, this portion of the bridge is switched out for out-of-circuit tests. Otherwise tests are made identically to the in-circuit mode.

Since the 890 uses a 1,000-cycle bridge, it can measure the impedance or quality of other circuit components—speakers, transformers, and the like—by simply connecting their terminals to the base and emitter leads and rotating the Z_{OHMS} controls for a null on the meter. The impedance of the component at 1,000 cycles can then be read directly in ohms on the calibrated dials. Impedances from almost zero to 100,000 ohms can be read in this manner. END

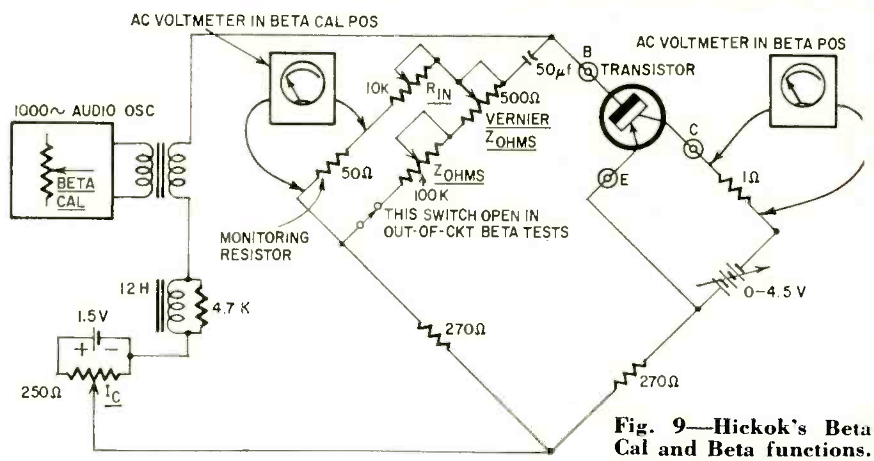


Fig. 9—Hickok's Beta Cal and Beta functions.

Tape-Speed Test Loop

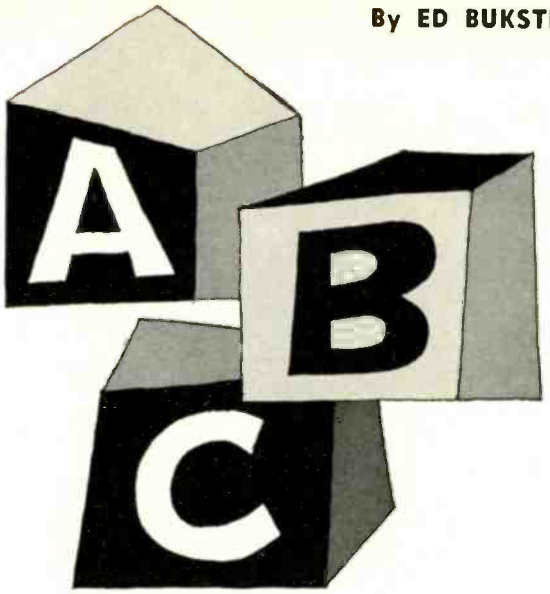
Tape recorder owners and service technicians can make a simple and accurate test tape to check the speed of the tape recorder transport mechanism. Any loss or variation of speed indicates trouble in the drive mechanism caused by worn belts, rubber wheel drives or lack of lubrication.

First, feed a 1,000-cycle tone from an audio oscillator into the tape recorder and record it for a foot or so on good quality tape. Remove the tape, and carefully measure and cut a 1½-inch piece from the recorded section. Then, measure off and cut a 36-inch piece of "clean" nonrecorded tape and splice it to the 1½-inch tone-recorded section. The net result will be a closed-loop tape exactly 37½ inches long.

When the closed loop is played back on the recorder, a series of "beeps" of tone are heard. The frequency of the beeps, or the time interval between them, depends upon the recorder's tape-speed setting.

At a speed of 1⅞ ips, the separation between beeps is exactly 20 seconds; at 3¾ ips, beep separation is 10 seconds; at 7½ ips 5 seconds; and at 15 ips the beep is heard every 2½ seconds, or two beeps every 5 seconds. A fairly accurate watch with sweep-second hand and this easy-to-construct test tape provide a useful and accurate aid for checking the tape transport mechanism.—*Dave Stone*

By ED BUKSTEIN*



INDUSTRIAL ELECTRONIC DICTIONARY

Part III: From carrier-current control to differential amplifier.

Carrier-current control: A system of remote control involving a radio transmitter and receiver coupled through power lines. The power lines serve as the transmission line that carries the rf from the transmitter to the receiver. A relay connected to the receiver can be energized by turning on the transmitter at a remote location served by the same power lines.

Chopper amplifier: A circuit used to amplify low-level dc signals (the output of a thermocouple, for example). Direct-coupled amplifiers may be used, but they tend to drift and are very critical with respect to part values and supply-voltage variations. In the chopper amplifier, the dc signal is periodically interrupted by an electromechanical chopper somewhat similar to the vibrator of an automobile radio. Once the signal has been chopped, it can be amplified by a conventional R-C or transformer-coupled amplifier, eliminating the need for a direct-coupled amplifier. After amplification, the signal can be converted to its original form by a demodulator circuit.

Closed loop: An automatic control system in which the output is fed back to control the input. The feedback signal is compared to a reference quantity and the difference (error) is applied as input. This input, after amplification, alters the output in the direction that reduces the error signal to zero.

Color sensitivity: The spectral response of a light-sensitive device. Phototubes, for example, are rated for color sensitivity as an indication of the response of the phototube with respect to the colors of the spectrum.

Control locus: A curve showing the critical value of grid bias of a thyratron. The control locus curve is plotted with respect to the positive half-cycle of plate supply voltage (Fig. 8). If the thyratron bias at any instant is less than the critical value indicated by the locus, the gas ionizes. The critical grid

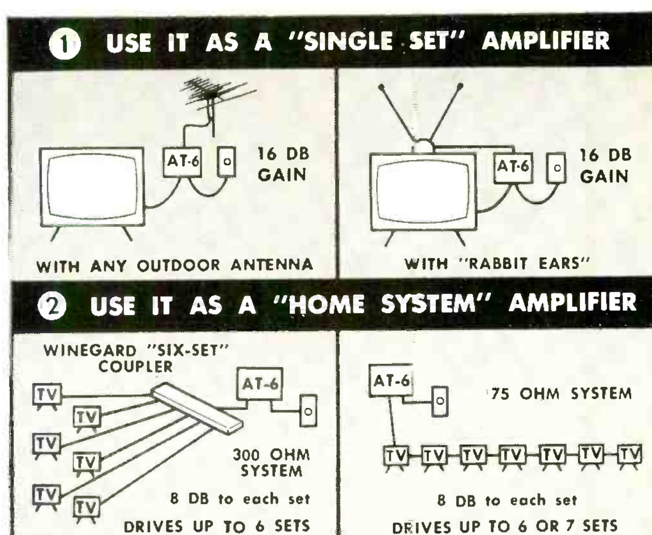
NEW...Home TV Signal Amplifier

Clears up snow, improves contrast, adds miles to reception distance!

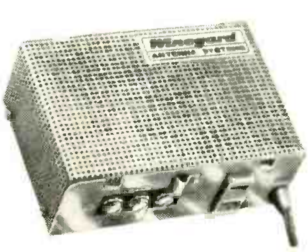
Here's the most unusual (and most useful) home TV-FM signal amplifier you've ever seen! Winegard "Booster-Pack" utilizes new low noise, high gain transistor* to give you a flat gain of 16 db on the low band and FM . . . a flat gain of 14 db on the high band.

Shock-proof . . . full AC chassis with AC isolation transformer (not AC-DC). Draws only 1.2 watts . . . cost only 27c per year to operate if left on continuously. No heat radiation. Can be mounted on back of TV set, on baseboard, in basement, attic, etc. Use "Booster-Pack" as a single set booster or as a home system amplifier for up to 6 or 7 sets. (See right)

*Special transistor so new that this amplifier could not have been produced until now.



No other amplifier under $80.00 has all these features!



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- Gain: Low and FM: 16 db
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- Precision Wiring . . . finest quality throughout

New! Winegard "Six-Set" SIX SET TV COUPLER

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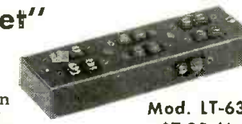

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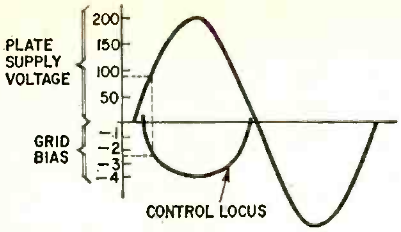

Fig. 8—Control locus curve indicates critical value of grid bias for positive values of plate voltage. Dashed line shows that −2.5 volts bias will allow tube to ionize when plate reaches 90 volts.

Computer Measurements Co.

Fig. 10—Pulse counting instrument uses six decade counters in cascade. Neon lamps indicate number of pulses counted.

bias (dotted line in Fig. 8) is −2.5 volts when the plate supply is 90 volts—if the thyratron bias is adjusted to −2.5 volts, the thyratron will ionize when the plate reaches 90 volts during each positive half-cycle of supply voltage.

Control ratio: The ratio of plate voltage to critical grid voltage of a thyratron. A thyratron having a control ratio of 10, for example, will ionize if the plate voltage is at least 10 times as great as the bias voltage. If the grid bias is adjusted to −8 volts, the plate voltage must be at least 80 volts for the tube to fire. The control locus is a graphical representation of the tube's control ratio.

Counting-rate meter: A frequency-measuring circuit commonly used to indicate the pulse rate of Geiger or scintillation counters. Pulses generated by the counter are applied to a dual-diode circuit (Fig. 9). Each input pulse causes diode V2 to conduct and charge capacitor C. During the interval between pulses, some of the charge leaks off through resistor R. If the pulses

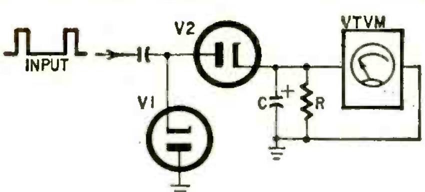

Fig. 9—Counting rate meter indicates frequency of input pulses. Capacitor C charges during input pulse and partially discharges during time between pulses.

occur at a low frequency, there is more time between one pulse and the next and most of the charge leaks off. If the pulses occur at a high frequency, there is less time between one pulse and the next and only a small amount of the charge leaks off. The average charge on C is therefore a measure of the frequency of the input pulses. This charge is read on a vtvm calibrated to read directly in pulses per second or per minute.

D

Dead time: The time, following the application of an input pulse, during which a circuit or component is not receptive to another input pulse. A Geiger tube, for example, will not respond to a second input if the gas is still ionized as a result of a preceding input a short time earlier. Dead time is also known as *resolving time* and is usually specified in microseconds.

Dead zone: The range of values over which an automatic control system will produce no corrective actions. An automatic temperature-control system, for example, may be designed to apply power to a heating element when furnace temperature drops below 250°, and to disconnect the heating element when temperature rises to 260°. The dead zone in this example is 10° wide (250° to 260°).

A narrow dead zone has the advantage of holding the temperature (or other quantity) at a more nearly constant value. A wider dead zone permits greater deviation of the controlled quantity but reduces the frequency of the on–off corrective actions. This feature is desirable because it increases the life of relay contacts, heating elements and other components. The dead zone is also known as the *neutral zone*.

Decade counter: A pulse-counting circuit that produces 1 output pulse for every 10 input pulses it receives. The decade counter usually consists of a four-stage binary counter to which feedback networks have been added to reduce the counting capacity from 16 to 10 (see **Binary counter**). The feedback pulses simulate the effect of 6 input pulses, so that only 10 actual input pulses are required to produce an output. Neon lamps or other special tubes are used as front-panel indicators to display the pulse count.

The instrument shown in Fig. 10 uses 6 decade counters in cascade, each of which has 10 neon lamps numbered from 0 through 9. These lamps light up in sequence as input pulses are applied, and each decade feeds a trigger pulse to the next decade when it returns from 9 to 0. The number of pulses applied during a selected time interval are determined simply by reading the lamps that are on.

Densitometer: A photoelectric instrument used to measure optical density (of a photographic negative, for example). The negative is placed between a light source and a phototube so that the amount of light reaching the phototube depends upon the density of the negative. The output of the phototube is amplified and applied to a meter.

Derivative control: A form of automatic control in which the rate of correction is determined by the rate of change of the error. The corrective action is therefore more rapid when the error is increasing rapidly.

Dielectric heating: A form of radio-frequency heating used to raise the temperature of nonconducting substances: rubber, wood, plastics, etc. The substance to be heated is placed between a pair of metal plates connected to a high-power rf oscillator. The substance to be heated, now the dielectric of a capacitor, undergoes an increase of temperature due to dielectric losses. This type of heating is used in industry for molding plastics, glue setting, rubber curing, etc.

Differential amplifier: A type of amplifier used for measuring (and recording) the difference of potential between two points, neither of which is grounded and either or both of which may be varying with respect to ground potential. This type of amplifier is particularly useful for low-level signals because it rejects noise and stray pickup. One form of the differential amplifier is shown in Fig. 11. If both input terminals change in potential in the same

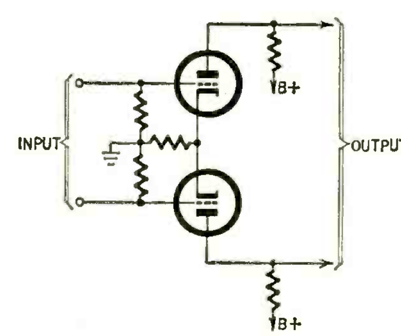

Fig. 11—Differential amplifier responds to difference of potential of input terminals but rejects in-phase interference.

direction and by the same amount (stray pickup, for example), the plate voltages will also change in potential but will still be equal to each other. The circuit, therefore, produces no output in response to in-phase pickup on the two input terminals. If the two input terminals change by different amounts or in different directions, as they would in response to a desired signal, the two plates will differ in potential. This difference is the output of the circuit. TO BE CONTINUED

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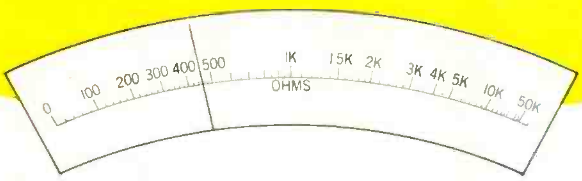

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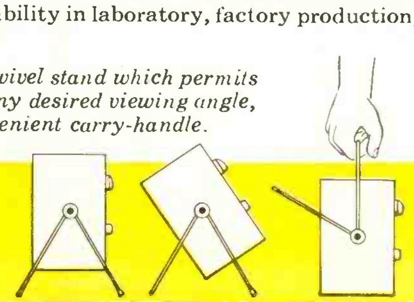

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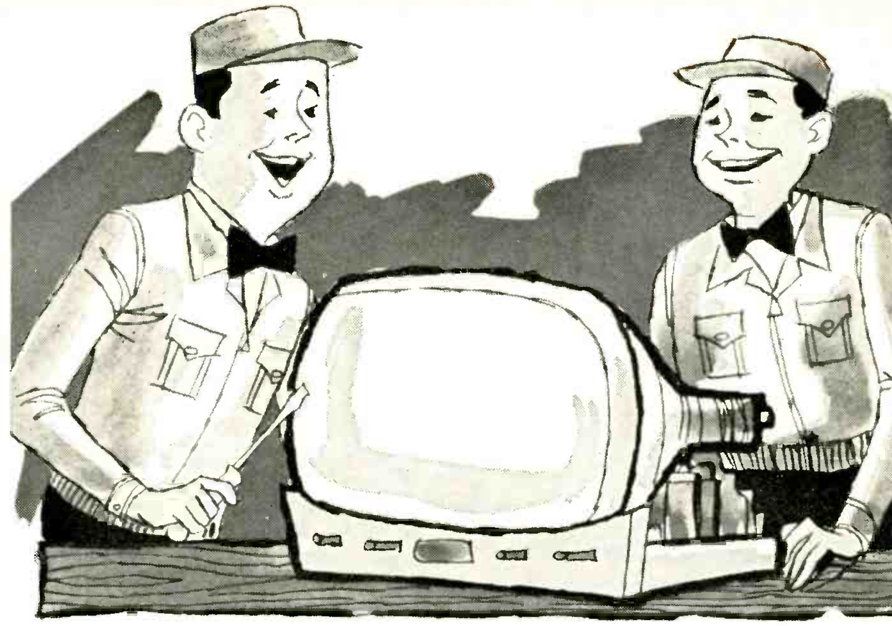

Cy and Lucky whip an intermittent

One vertical dog type trouble that wasn't as bad as it seemed

By WAYNE LEMONS

"I'M having trouble," said Lucky, as his boss came in the door. "Mrs. Kendall brought this Admiral in for us to fix. She says it doesn't have any picture; just a little white line across the picture tube."

"Vertical trouble, of course."

"No doubt about that," said Lucky, "but that's not the problem—not by a long shot! When I turned the set on, there sure enough was just a thin white line. So I checked the tubes and they were OK or at least they seemed to be. Well, right away I knew I was going to have to pull the chassis, so I did. But, when I turned the set back on, *AFTER* I got the chassis out of the cabinet, what do you think happened?"

"You'd dropped a spin wrench on the picture tube and broke it?" Cy asked uneasily.

"No, not that!" Lucky said with a trace of disgust in his voice. "The picture was filled out vertically as nice as you please."

"Oh, is that all?" Cy breathed a sigh of relief.

"That all!" exclaimed Lucky, "Isn't that enough? How you gonna fix a set that there ain't nothing wrong with?"

"Well, Lucky, I've had troubles like this before and I've developed some pretty crude but effective ways of finding them. But first, let's see just how much we know about this set. Did you tap the tubes to see if the vertical would go off?"

"With everything but a sledge hammer," said Lucky.

"Then we know that the tubes are probably not at fault. We also know that there was definitely vertical trouble in the set, because you saw it."

"Right."

"Now, we also know that the trouble seemed to cure itself. This means we could have a burnt resistor, a capacitor that is opening up, a broken connection or a poor solder joint."

"Oh, no you don't," said Lucky. "I've gone over this circuit with a fine-tooth comb. There just aren't any obvious troubles. I took the tweezers and moved each capacitor back and forth and jig-

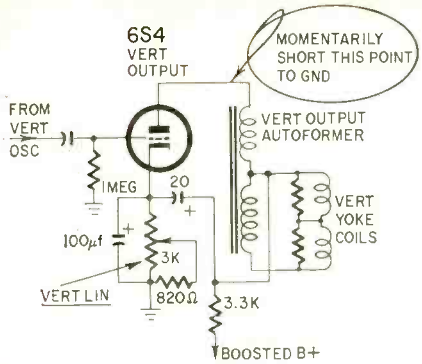

Fig. 1—Vertical output circuit that included the cause of the trouble.

gled every wire and connection in the circuit."

"Fine," said Cy picking up a screwdriver. He studied the circuit a minute, then shorted a point to ground. The vertical collapsed. Cy removed the screwdriver but the vertical deflection did not return.

"What in the world did you do?" asked Lucky.

"Simple, I shorted the plate pin of the vertical output tube to ground." (See Fig. 1.)

"What for?"

"Well, in cases like this, I always suspect transformer trouble. Either the blocking oscillator or the output. When I shorted the plate pin to ground, that placed quite a lot of voltage across the transformer primary."

"I'd say. Over 400."

"Exactly," agreed Cy. "And you see what happened—the transformer opened up."

"But wouldn't any transformer open up with that much voltage across it?"

"Not a good one," retorted Cy. "Any good transformer would have no trouble passing that much current for a moment or so. Of course, you wouldn't want to short the circuit for very long or you'd probably blow a fuse if the transformer happened to be OK."

"What if it had been the blocking oscillator transformer?" asked Lucky. "It has a pretty good size resistor in series with the primary plus the height control also."

"Good thinking," congratulated Cy. "That's why you have to go a step further when checking the blocking oscillator transformer. You take one of our jumper wires with the insulated clip on each end and jump out the height control and the series resistor. Or if you prefer, you can just connect the jumper to any convenient B-plus point and to the B-plus side of the primary of the blocking oscillator transformer."

"Then you momentarily short out the plate side of the winding?" questioned Lucky. (Fig. 2.)

"Right," Cy replied, "and sometimes when you have transformer trouble, the vertical deflection doesn't collapse all the way. You may have insufficient height or the raster may jiggle and jump vertically even when off channel."

"What happens when you short the transformer then?" asked Lucky.

"Just about every time, if the transformer is defective, the vertical will settle down and fill out the screen. May even stay that way an hour or so."

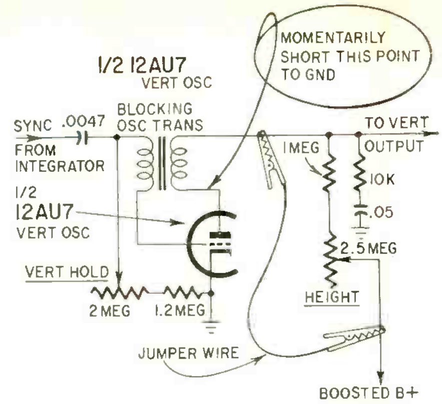

Fig. 2—Handling a set with a blocking oscillator is a little different.

"I'll bet you could use that method to find a noisy if or rf transformer too," reasoned Lucky.

"You sure can, if it's a case of the winding opening up. Lately with these small if's though, the problem is one of leakage between primary and secondary, and usually the best way to handle them is to disconnect the secondary and check for a positive voltage on it."

"Well, I had better install this transformer *before* Mrs. Kendall comes after her set," said Lucky.

"That's the best way," Cy agreed, and smiled broadly at the pained look that crossed Lucky's face. END

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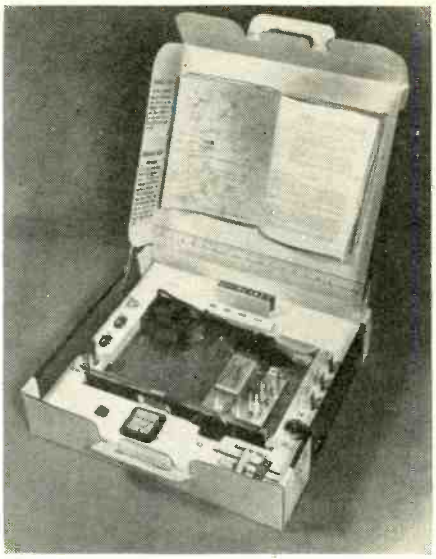
NEW IDEAS IN KITS

A stereo amplifier and an FM tuner.



The LT-10 tuner kit, ready to start wiring.

The completed amplifier and tuner make an attractive matched pair.

By LARRY STECKLER
ASSOCIATE EDITOR

FROM TIME TO TIME WE ALL FIND OURselves on a tight budget. Often, at the same time we are interested in a new TV, radio or hi-fi component. When this happens, we look for the least expensive way of getting what we want. One solution is to buy a kit—a package of parts and instructions that will enable us to build the device we want and save the assembly cost. For hi-fi equipment this is ideal, and many manufacturers offer kits that keep costs to a minimum, yet produce a quality instrument.

The crude kits of just a few years ago have little in common with those available today (except that they are all "kits.") There have been many improvements and changes in a very short time. Let's take a look at two of the newest kits to reach the high-fidelity marketplace. One is a stereo control amplifier and power amplifier combination; the other is an FM tuner. Both are made by an old name in the hi-fi business—H. H. Scott.

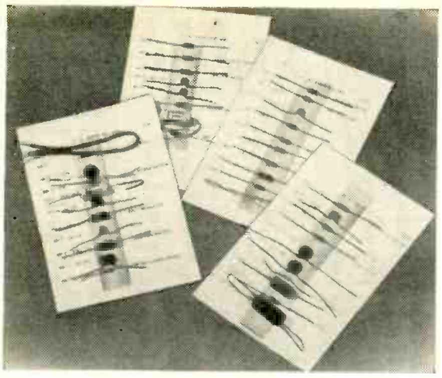
As soon as you open the box, you find a different approach to kits. The box turns out to be the work table. You just open it up on whatever surface you intend to work on, *and do all wiring and assembly right in the packing case.* It holds the chassis, parts *and instruction book* right where you can get at them. And when you're finished for the day, simply close the lid and put the kit away. No more half-assembled kits sitting around on a table top waiting to be completed. (Incidentally, when the kit is completed, save the box it came in. It makes a handy emergency suitcase when the need arises.)

The instruction book too is a great improvement over earlier types. Each page of assembly instructions has its own pictorial diagram showing the arrangement of *only the particular parts* that are installed in the steps *on that page.* And, the diagram is in color. Red leads are red, yellow ceramic capacitors are yellow and resistors have true-to-life color stripes. It adds up to a big help when trying to check connections of a particular lead or component.

TABLE I

CHARACTERISTICS OF THE SCOTT LT-10 FM TUNER

Sensitivity (IHFM)	2.5 μv
Signal-to-noise ratio	60 db below 100% modulation
Total harmonic distortion	0.8%
Frequency deviation	0.2%
Frequency response	20–20,000 cycles ±1 db
Intermodulation distortion	0.3%
Hum	66 db below 1 volt
Audio output (100% modulation)	0.8 to 1.2 volts
Tuning range	87 to 109 mc
Output impedance	3,000 ohms



Parts and leads are mounted on cards and arranged in the order in which they are used.

It is also a safety check against placing the wrong part in the wrong place.

As soon as you start assembling the kit, another surprise greets you. Remember when kits were new and all resistors and capacitors were just lumped together in one big envelope? You picked the particular part you needed out of a heap that contained all the resistors and capacitors in the kit. Later on, the resistors and capacitors were separated into envelopes. And recently, resistors and capacitors have been mounted on cards along with their code numbers for identification—R1, R2, R3, etc. Scott takes this last idea one step further. You don't even have to hunt for parts on the cards. All those little resistors, capacitors, even some of the leads (in the tuner kit) are arranged on cards—*in the order they are used in the construction process.*

For example, on page 15 in the instruction book for the LK-72 amplifier is assembly group BF-5. Step BF5-1 (the first on this page) calls for a 470,000-ohm resistor. At the top of the parts card for this page (also marked BF-5) is a 470,000-ohm resistor marked BF5-1. The next part called for is a 220-$\mu\mu$f ceramic capacitor. It is the second part on the same card. And so on.

An admirable feature is that all sockets and terminal strips are already fastened to that chassis. I like this feature; it eliminates what is the annoying part of kit building to me. I don't mind the wiring and stuff, but the tedious mounting of sockets, only to discover that one is backward or you left off a solder lug, I can do without. Some kit builders feel that since the unit is a kit, they want to do everything and that includes attaching the sockets. Maybe they're right. It might make that particular kit a bit less expensive.

When the kit is completed and you're ready to plug in the tubes, you don't have to consult anything but the chassis of the unit you have built. On that chassis, next to each tube socket is clearly imprinted the tube type. Transformers and electrolytic capacitors are marked in the same manner.

Now that we've seen what makes these kits a pleasure (almost) to build, even for the nonelectronic-minded person, let's see what the kits have to offer on the electronic and high-fidelity side of the ledger. We'll take the tuner kit first.

The LT-10 FM tuner

The unit uses six tubes and two semiconductor diodes. The front end is a pre-aligned unit incorporating a local oscillator and mixer. Construction time from start to finish was 5 hours, and it won't take an unexperienced builder too much longer.

One thing some audiophiles are going to notice right away is the lack of an afc circuit. The Scott tuner has no afc because it doesn't need it. The front end is designed so that, as it heats up, temperature-compensated components adjust (automatically) for any circuit changes that might otherwise cause the tuner to drift. After using the tuner for several months, I can safely testify to the drift-free reception of this unit.

There are two 6AU6 if amplifiers in a high-selectivity if strip that keeps out all stations but the one you want. A station close to the one you have tuned in won't feed through the if strip and appear in the background as a disturbing murmer. A 6U8 (pentode section) limiter with a wide bandpass (2 mc) removes man-made or electrical interference. The detector uses two semiconductor diodes in a ratio-detector circuit which has some additional limiting action of its own. It too is a wideband unit with a 2-mc bandpass.

If you're concerned about adding a multiplex adapter now that FM multiplexing has been okayed by the FCC, you've got nothing to worry about. The tuner is designed with multiplex in mind, and is easily adaptable. Originally the multiplex adapter was to go right on the tuner chassis. Unfortunately, things did not work out this way. When the adapter was mounted on the chassis, tuner sensitivity dropped. Now, a small adapter plugs into the tuner and sits behind it out of sight. The adapter controls mount on the front panel of the tuner.

The adapter kit will include a new front panel for the tuner that will be properly marked for the adapter. Also, the LT-10 meets the requirements for a multiplex adapter. It offers more than just a jack marked multiplex. It has the necessary if bandwidth (to 150 kc), the signal-to-noise ratio (better than 60 db) and the low distortion needed for satisfactory stereo FM multiplex reception. Table I gives a rapid rundown on the important specifications of this tuner. Using the indoor antenna that comes with the kit, I logged 24 FM stations from a location about 20 miles from New York City.

TABLE II

CHARACTERISTICS OF THE SCOTT LK-72 STEREO AMPLIFIER

Maximum power output each channel (music waveform)	36 watts
Total harmonic distortion at rated output	0.8%
Frequency response	20–20,00 cycles $\pm$0.5 db
Intermodulation distortion	0.3%
Signal for rated output (tape input)	3 mv
Signal for rated output (magnetic cartridge, low)	3 mv
Signal for rated output (magnetic cartridge, high)	9 mv
Signal for rated output (tuner, extra, playback)	0.5 volt
Hum and noise (low-level inputs)	80 db below rated power
Hum and noise (high-level inputs)	10 μv
Scratch filter	above 5,000 cycles
Treble boost and cut (at 10 kc)	15 db $\pm$2 db
Bass boost and cut (at 50 cycles)	15 db $\pm$2 db

The LK-72 stereo amplifier

The amplifier half of the hi-fi pair delivers 36 watts of music per channel. It took a flat 12 hours to get it from kit to working amplifier. Eleven tubes and a full-wave selenium rectifier are used. The dual amplifiers are identical so, if we deal with only one channel, we cover both.

The first audio amplifier stage (actually a pre-preamplifier) is a twin-triode 12AX7. Weak signals from magnetic cartridges or tape heads are fed to this stage. To avoid any possibility of hum, this tube along with the 12AX7 amplifier following it have a dc heater supply. Following the pre-preamplifier and first audio amplifier stages is a pentode-triode 7199. It acts as the second audio amplifier and the phase splitter that drives the push-pull out stage. The specially designed phase splitter with matched components eliminates the need for separate ac and dc balance controls.

The output stages use two 7591 pentodes to deliver a 36-watt output. The full 36 watts of output is available over the entire audio-frequency range —from slightly below 20 cycles to slightly above 20,000 cycles.

There are separate bass and treble controls for each channel. The switch-selected volume–loudness control is ganged and adjusts both channels simultaneously. A balance control compensates for minor differences in speakers. A complete listing of the important characteristics of this amplifier are in Table II. END

TV Service CLINIC

conducted by
JACK DARR, SERVICE EDITOR

This is your column in the magazine: the service is absolutely free; there is no charge for answering your questions, and your name and address will be kept confidential if you so wish. The main purpose is to help everyone working in electronics with their unusual problems. Send in your questions; each one gets an immediate personal answer. Later, the more interesting cases are published in the Clinic columns.

Due to the many peculiarities found in commercial TV circuits, you might find a different answer to a question than the one we give, even though the "conductor" of this column is himself a full-time professional TV technician. We would be interested to hear of such cases, as we feel that the more widespread the knowledge of such peculiarities, the better off we'll all be! So, if you have an unusual service job, or one which is giving you trouble from an obscure cause, send in a question on it; we'll answer it promptly and to the best of our ability.

CLEANLINESS IS NEXT TO GODLINESS, AS the old saying goes, and that's never more true than in a TV tuner. Outside of vertical rolling (intermittent, of course), I believe that this is about the most annoying complaint to the customer. The typical symptom: he turns the channel-selector knob to channel 5 and nothing happens! Turning to channel 8, the picture comes in; back to 5 and now he gets a picture. The next thing he gets is a technician!

This trouble is common to all tuners, turret, incremental-inductance or switch types. Even the old continuous jobs such as the Inductuner suffered from it. In the modern tuner, there are a minimum of eight contacts which must be made for each channel.

The switch contacts in practically all tuners are silver-plated over a base of copper, brass, etc. After a certain amount of use and exposure to the atmosphere, these contacts develop a resistive coating. While this is ordinarily called oxidation, it isn't necessarily so. In quite a few cases, this turns out to be sulphation from sulphur-bearing gases in the air. So the coating on the points is a sulphide or sulphate instead of an oxide. Fortunately, the processes for dealing with them are about the same.

The easiest method is to use a spray cleaner. They are packed in pressurized cans and many of them have a long steel needle to allow spraying the cleaner deep inside a tuner without taking it out of the cabinet. *(Keep the set turned off while prodding around inside a tuner with this conductive needle!)*

Many of the later TV chassis have separate tuners, which can be removed for servicing without taking the main chassis out at all. These are simple to clean up, but some of the older ones are more difficult. The shining example of this, of course, being the old set which had the tuner mounted *under* the chassis, so that the set had to be pulled to change the tuner tubes!

However, most tuners are accessible enough for spraying. Spray the cleaner through any accessible holes on the top and sides, while turning the channel-selector switch.

Continue turning, spraying and checking until all stations come in without having to wiggle the knob to make contact. If it won't do this, you'll have to pull the chassis so you can take the tuner apart.

After the chassis is out, remove the bottom shield to expose the switch contacts. On turret tuners, take out enough of the coils to allow access to the row of contact points. Spray cleaner over all switches, turning the selector while this is going on. A good cleaning compound will evaporate almost entirely, leaving only a very thin lubricating film on the contacts. After quite a bit of experience, we wouldn't recommend using carbon tetrachloride for cleaning tuners. Beside the health hazard, it dissolves *all* lubrication, making detents hard to turn, switches drag, etc.

Any lubrication in a tuner must be sparing. Too much grease or oil will eventually find its way onto the contacts and you've got more troubles. Use only the cream type lubricants on detents and other mechanisms. Because of their higher viscosity they stay in place better than the rest.

For cleaning badly worn or dirty contacts, use something that will dissolve the residue of dirt then polish them with a dry piece of cloth. The rougher the surface of the cloth, the better; something like unbleached muslin, old cotton workshirts and such material is fine. The surface of this kind of cloth has just about enough abrasive material to give the contacts a high polish. Switch tuners and other inaccessible places can be cleaned like this by wrapping a very small piece of cloth around the end of a matchstick and *very carefully* polishing them. While poking around inside a tuner, be awfully careful not to move any of the coils or wiring or you may find yourself with a tuner realignment job on your hands!

When you're through, see that the tuner contacts are as dry as you can possibly leave them! This is necessary to avoid a rapid buildup of dust, dirt, lint and other material on the tuner contact points. If you think they must be lubricated, put a very small amount of lubricant on your fingertip, rub your fingers together and then over the surface to be oiled. This leaves a very thin film of lubricant and is usually just about the right amount.

Pipe cleaners are very useful in applying solvents or lubricant to inaccessible places, but be sure that no lint is left where it could get between contacts. They're handy for the process just described. Put a tiny dab of lubricant on the end of the pipe cleaner, then try to wipe it as dry as you can by squeezing it between your fingers. This leaves just the right amount on the tip.

In some cases, you'll find that dirty-contact symptoms are actually caused by loose rivets or bent contacts in the tuner. The rivets can be resoldered. The bent contacts can be straightened with a relay tool—a small metal rod with a split end, used by telephone technicians for adjusting relay points. Often, a soldering aid tool with a split end will do the work, unless the space is too small to allow it to get in there.

One final word, in some tuners the manufacturer placed a special impregnated paper, which was treated with a chemical supposed to prevent sulphation of contacts. The latest word from his service department on this is, and I quote, "Take it out! It didn't work!"

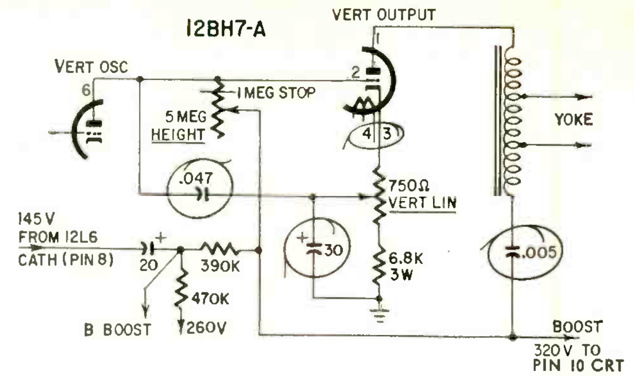


Fig. 1—Circled components show where 60-cycle signal may be getting into vertical circuits.

Vertical distortion

I've got a Crosley H-21COWUc in the shop and the vertical linearity is awful! It's stretched at the top from three-quarters of the way up, and the bottom is compressed. I'm about to give up! Help!—J. F. P., Schenectady, N. Y.

Don't give up; help is on the way. From the symptoms this is probably caused by a good-sized 60-cycle sine wave feeding into the vertical output stage somehow (Fig. 1). Possibilities: heater-cathode leakage in the tube, or a defective electrolytic filter capacitor. The clue here is the excessive stretch at the top and the crowding at the bottom, typical of a vertical sweep which is sinusoidal instead of linear.

Misplaced ion trap?

When is it necessary to misplace the ion-trap magnet to light up a picture tube? I have three sets, and the ion-trap magnets on all of them have to be moved back until they touch the

(*Continued on page* 88)

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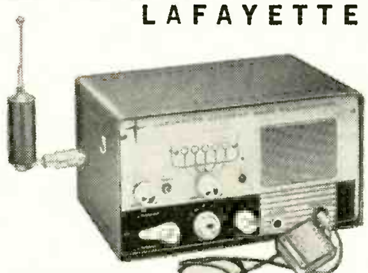

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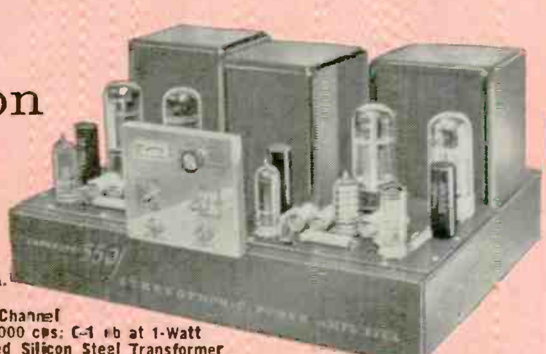

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(*Continued from page* 85)
socket for the brightest picture, and then it's not bright enough.—S. L. O., Duncanville, Tex.

Actually, your ion-trap magnets or beam benders are *not* misplaced. The correct location is where the picture is the brightest. On some tubes, two locations are found—one near the yoke, the other close to the base of the tube. In general, the beam bender should always be set at the location closest to the base. This keeps it from disturbing magnetic fields of the yoke, magnetic focusing devices, etc.

If you are using the original ion-trap magnets on old sets, it is possible that their magnetic strength has fallen off. Try one of the new adjustable types, changing the setting of the shunt bar until the brightest picture is obtained.

To set a beam bender correctly, find the place which gives light on the screen. Then, move the beam bender about this location, back and forth and around the neck, until you get the brightest picture possible. Never adjust the ion-trap magnet to eliminate neck shadows or to position the raster. If the tube uses magnetic positioning and focusing, adjust focus and positioning coils for best results. Then make the final adjustment of the beam bender for *maximum brightness*. This will give best tube life, and avoid ion burns on the CRT screen.

Tuner drift

I have two sets on the bench with the same symptom—frequency drift in the tuner oscillator. This happens after they have been turned on for an hour or so, sometimes not at all.—L. G., Chicago, Ill.

The cure for this is simple. There aren't many parts in the tuned circuits in a TV oscillator! This is obviously a thermal drift. Wrap a piece of heavy wire around the tip of your soldering iron and carefully warm up the small capacitors connected to the *grid* of the oscillator tube. Some sets use capacitors in the plate; check these and any resistors in that circuit too.

Intermittent retrace lines

I have a Packard-Bell 2040 with vertical trouble. It plays, on the bench, for quite a while, then vertical retrace lines show up, and it jitters, then rolls slowly and drifts up and down for 3 or 4 inches.—M. J., Portland, Ore.

This is caused by a weakness somewhere in the vertical oscillator/sync circuits. I'd replace both vertical oscillator and sync tubes first, and check it.

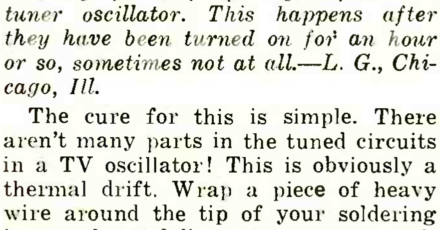


Fig. 2—Leaky capacitors in vertical discriminator may be causing vertical drift.

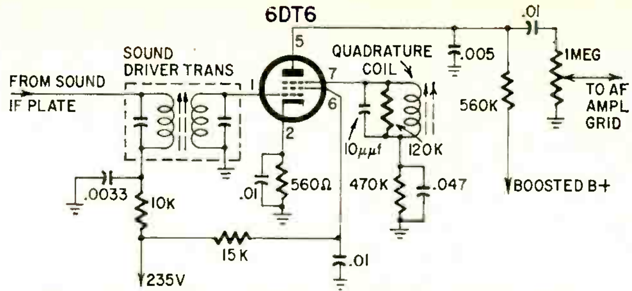


Fig. 3—Check quadrature coil for intermittent sound, also 15,000-ohm screen resistor and all solder joints.

If this doesn't stop the drifting, check operating voltages, especially the plate voltage, around the vertical oscillator and sync separator circuits.

The appearance of retrace lines is just a signal that the set is getting ready to fall out of sync. When they show up, it means that the vertical oscillator is drifting just slightly so as to change the phase of the vertical pulses and you lose cancellation of the retrace lines, and soon she starts rolling.

Trace the sync pulse with a scope. If it isn't high enough, find out why. A plate load resistor in the vertical sync tube rising in value is a common cause of this. Leaky shunt capacitors in the vertical integrator are another common cause (Fig. 2). Check these for leakage, and replace any that show more than just a very slight leakage. Leaky coupling capacitors on the sync input are also good suspects.

Chronic 1X2 breakdown

I have been getting return calls on an RCA CT-1708. The 1X2-B breaks down after a few days. The flyback transformer has been replaced. I also installed a modification suggested by the distributor.—K. A. L., Honey, B. C.

Your trouble is probably caused by excessive filament voltage on the 1X2 tube. When the flyback was replaced, was the 3.3-ohm resistor underneath the 1X2 socket checked? Some versions of this chassis omitted this resistor. If it is not there, add one. This will lower the 1X2's filament temperature and should give longer life.

A test adapter for the 1X2 can be made from a nine-pin socket adapter sold for making voltage measurements on inaccessible sockets. Tack a pilot-light socket to pins 2 and 9, and insert a 1.4-volt flashlight bulb. Plug it into the 1X2 socket and fire the set up. The brightness of the bulb is a surprisingly good way to determine whether an overload exists. If the voltage is too high, install a resistor about 1 ohm higher than the one present.

Intermittent sound

After running an RCA KCS-120 for about an hour, the sound stops suddenly. Picture OK. Sometimes it goes 2 hours, sometimes 3. Banging the chassis or tapping tubes won't bring it back. If I advance the volume control, the sound pops on and then dies out again.—H. S., Chelsea, Mass.

This is most likely to be a defective quadrature coil in the suppressor grid circuit of the 6DT6 (Fig. 3). That or some standard printed-circuit trouble—a bad solder joint somewhere. The quickest way to find trouble like this is signal tracing. After the sound cuts out, inject a signal into the part where the trouble seems to be centered—a 4.5-mc signal into the input, or an audio signal from the volume control on out. Once trouble has been pinned down to a certain section, resolder all the joints in that circuit. This seems to be the most reliable way to do it.

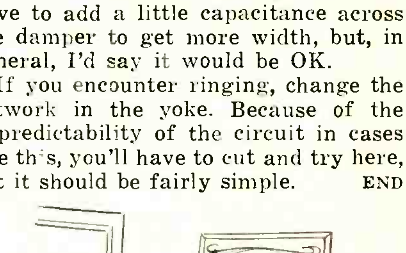
One last check: several cases of puzzling trouble in this circuit are caused by the screen resistor on the 6DT6. Check it!

Pix-tube query

I'm making a custom installation of a Philharmonic 8820 TV. The 21EP4 tube is bad, and I want to use a 21DQP4 to conserve space in the cabinet. Will this work if I use a Stancor DY-13A yoke? There is about 12 kv at the second anode now.—H. W. L., Minneapolis, Minn.

This conversion should work out all right. There should be sufficient reserve power in this chassis to give you the added deflection with the yoke you mention. Your original yoke had a 8.5-mh horizontal winding, while the new one has a 12.5-mh winding. You may have to add a little capacitance across the damper to get more width, but, in general, I'd say it would be OK.

If you encounter ringing, change the network in the yoke. Because of the unpredictability of the circuit in cases like this, you'll have to cut and try here, but it should be fairly simple. END



"The TV sets in the neighborhood are distorting my diathermy machine."

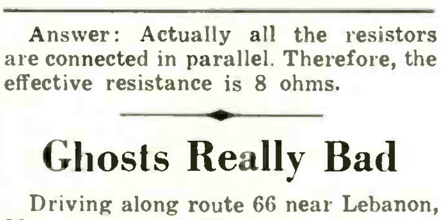
What's Your EQ August Solutions

Yuletide Effect

The 80-μf electrolytic capacitor in the output of the B-supply filter is defective. It had an extremely high power factor, coupled with a severe loss of capacitance, although there was no perceptible hum in the sound. This allowed the horizontal oscillator to receive peaks or pulses probably fed back through the boost in some way and caused it to break into sporadic oscillation on each cycle. This broke up the time-constant circuits in the yoke, etc., and stopped the output stage from functioning properly.

A Lighting Problem

The switching is accomplished by an arrangement of rectifying diodes. In position 1, the positive pulse from the ac generator is passed through the single wire into the box with the bulbs. This pulse is accepted only by the rectifier hooked up in the same polarity and blocked by the other rectifier, the resulting current flow lighting the red bulb. In position 2, the opposite occurs and the blue bulb lights. In position 3, pure ac is passed into the first box and both bulbs light, one from the position pulse and the other from the negative pulse.



Resistor Mixup

Answer: Actually all the resistors are connected in parallel. Therefore, the effective resistance is 8 ohms.

Ghosts Really Bad

Driving along route 66 near Lebanon, Mo. we spotted this new motel sign. Evidently the neon company failed to mask the F in FREE properly, with an eerie result.—*Wayne Lemons*

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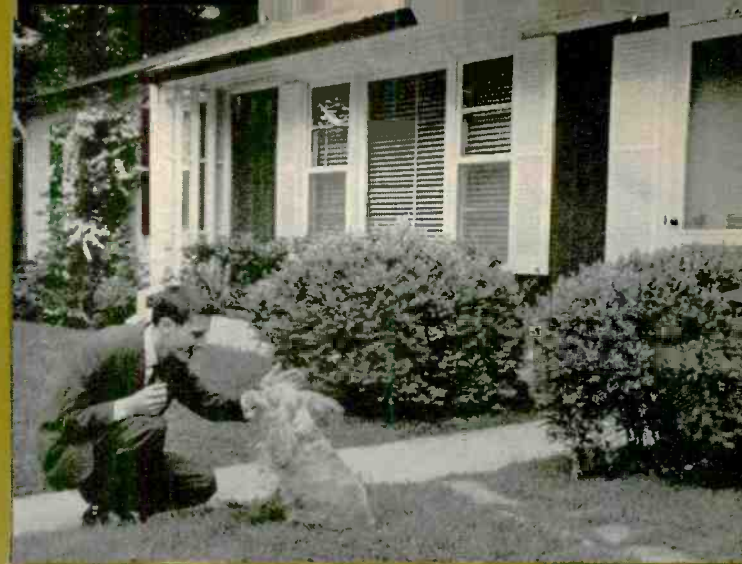

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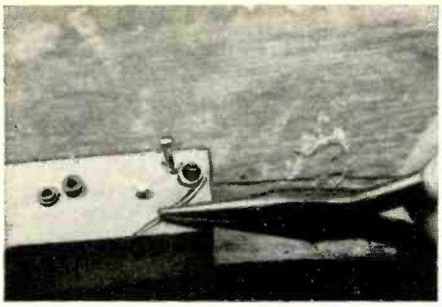

Step in forming contact wire on jig.

Build a simple 1-tube amplifier and add a new dimension to the sound of your electronic organ

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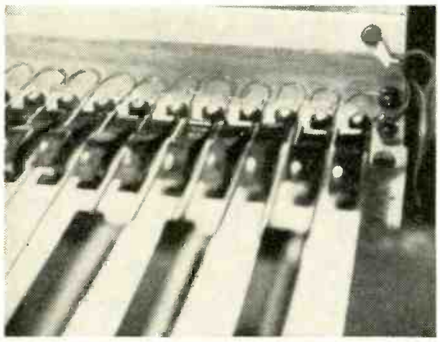

View of contacts mounted in organ.

By J. W. KORTE

THIS unit is adaptable to practically any electronic organ. It is simple to build the one-tube amplifier and add another set of contacts.

The tones produced have the characteristic percussion "plunk" bell-like sound. Perhaps a better way to explain the tone is to say that it sounds as though a hammer was used to hit a tone bar. Any number of notes can be played simultaneously. All keys must be released before the next is played, however. Selective percussion is possible; that is, if the preceding note is held until after the next one is played, no percussion will sound. It is easy to select by striking the keys with hammer-action fingering for the percussion tone, or running the notes together in typical pipe-organ fashion to eliminate the percussion on certain notes.

This unit is easy to build and produces beautiful tones. Any of the regular organ stops can be played along with the new percussion tones, or it can be played separately. A variety of percussion effects can be obtained by having the vibrato on or off, or by using the octave tones separately or together.

Some adaptation of the unit will be necessary, but this should involve changing only the input and output resistors to fit the unit to the signal level of the connecting points on the particular organ. The values shown and the points of connection are for a model K Minshall (Fig. 1). A block diagram is included (Fig. 2) so the arrangement can be compared with other organs.

Basically, the signals are fed to the percussion amplifier from the key buses. These buses generally feed the tone coloring circuits. The signals from the percussion amplifier bypass the tone coloring circuits and are introduced at the point where all the signals combine to enter the preamplifier.

The new key switches are merely a chain of contacts. When any key is depressed, the ground from the end of the string is opened. Then the cathode floats positive, which increases the bias and reduces amplifier gain to produce the percussion effect. The three capacitors and two resistors in the cathode circuit slow the decay to about 2 seconds. When the contacts are all closed again, the time constant is short, however. This restores amplifier gain to normal quickly so the next keys can be played as soon as the preceding ones are released.

If more variety is desired, a slow–fast decay-time switch may be used. This can either switch out the 0.25-μf capacitor on the end of the string of contacts or switch in a large value. If desired, you can get more tone variety by switching a certain tone coloring "formant" filter in the output of the percussion amplifier. Perhaps some similar to those already used in the particular organ would be most suitable. The two 50-$\mu\mu$f capacitors in the amplifier emphasize the higher frequencies for a better volume balance between low and high frequencies.

A good physical location for the percussion amplifier is in the tone coloring section of the organ. It should be installed in a shielded location because of the sensitivity to hum pickup. The contacts, however, are not very sensitive to noise or hum pickup.

Any type of key contacts can be used. Those explained here should fit on most organs and are quite easily constructed. They are set to open when the key is depressed about halfway. This provides a lot of "follow" which causes contact wiping and self-cleaning. Contact current flow is small, so many types of 24-gauge springy wire are suitable.

A jig can be made in a few minutes to facilitate making the wire contacts as shown. They are held in place on the back edge of the keys with insulating washers and wood screws. Walsco No. 7824F insulating washers, obtainable at radio supply houses, are suitable. These are pairs of washers, one flat, the other one with an extruded ridge to keep the contact wire from touching the wood screws. A small dab of lubricant on the wires at the point of contact will reduce any tendency for corrosion. General Cement Lube-Rex appears to work well. END

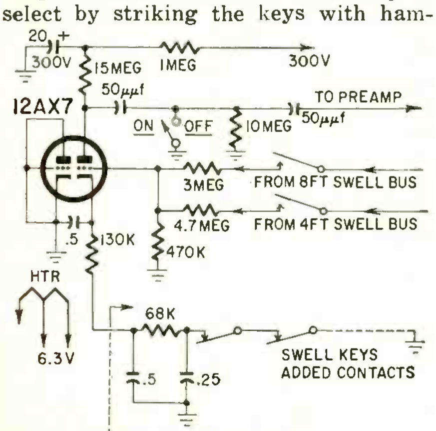

Fig. 1—Circuit of the 1-tube percussion amplifier.

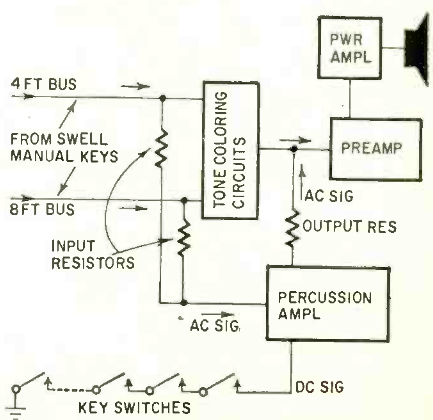

Fig. 2—Block diagram showing how to hook up the percussion amplifier to an electronic organ.

Variation Control For Automation

Self-correcting controls are a vital part of automated systems. How some of them work is our story

By MATTHEW MANDL

AN important aspect of automation is electronic sensing and control of variations or changes in items being processed. Such deviations can be the omission of a particular step, a shift of position of the item on the assembly line or a change in the bulk of the item—a change in thickness or width, or in the case of fluids, of volume.

There are several types of control systems, and the choice depends primarily on whether the variations to be sensed are gradual or abrupt. Initially we'll consider gradual change and show some practical commercial applications. For gradual variations we need a sensing device that will recognize the change as it occurs and then actuate a device to correct it.

One device which will do this is the differential reactor (Fig. 1). It is essentially a coil with a movable plunger acting as an adjustable core, attached to a feeler (or roller) which moves over the material to be tested. The device is basically a transducer—it produces electric signals proportional to physical changes. As the core moves farther into the coil, the coil's opposition to ac (inductive reactance) increases. (Inserting a core into a coil increases permeability and inductance and, as inductance increases, so does reactance.)

To make the device practical, we have to get a dc correction voltage so a change in one direction produces a negative signal while a change in the opposite direction produces a positive one. Such variations can be observed on a center-zero meter or applied to a servo motor to correct the deviations as they occur.

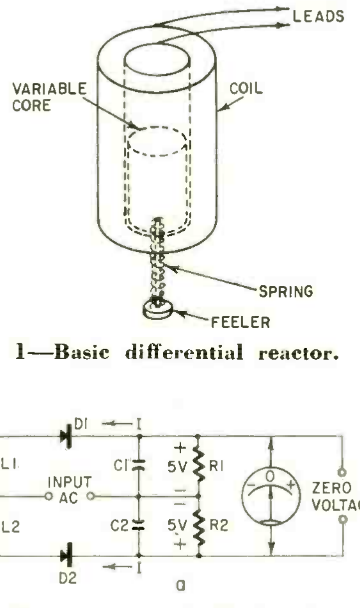

Fig. 1—Basic differential reactor.

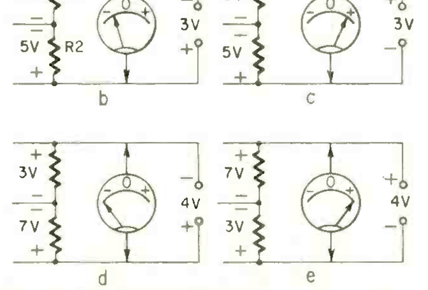

Fig. 2—Null indicator circuit and its possible outputs.

The necessary dc correction voltages can be supplied by a bridge type balanced circuit (Fig. 2-a). Two differential reactors are employed, L1 and L2. If L1 is the sensing device, L2 is adjusted for zero output from the circuit. Assume that both cores are midway within their coils and each presents the same amount of reactance. When the diodes D1 and D2 conduct for a positive alternation of the ac, current flow is in the direction shown by the arrows. But, since the circuit is balanced, the voltage drop across R1 is equal (but opposite in polarity) to the voltage drop across R2. The result is zero voltage output.

If the reactance of L1 goes up, less current flows through D1 and the voltage across R1 goes down. If this decrease is from 5 volts to 2, the voltage output would be −3, as shown in Fig. 2-b. If L1's reactance decreases, more current flows through D1 and the output voltage polarity changes as shown in Fig. 2-c (its value depends on the amount of reactance change).

Where both differential reactors are used for sensing, such as above and below a moving sheet of metal, both reactances vary. Assume, for instance, that the sensing devices are set up to indicate curvature. As the material bends upward, L1's core moves farther into the coil, while L2's core moves out of the core. Thus, the reactance of L1

Model 650
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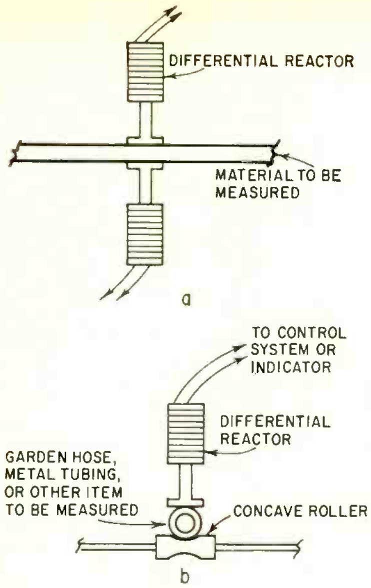

Fig. 3—Two ways of using differential reactors.

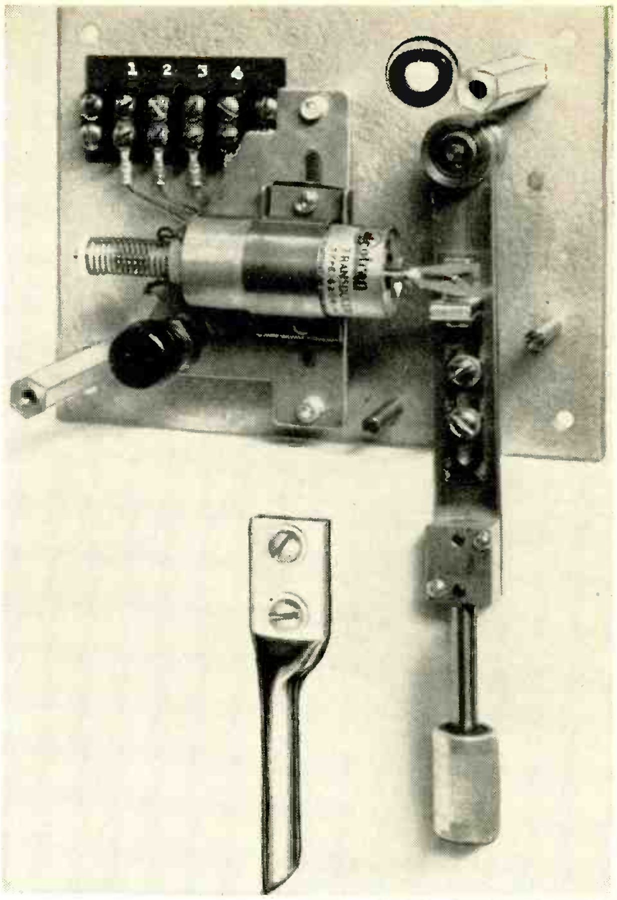

Fig. 4—A lever type edge control.

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increases while that of L2 decreases. Voltages would then have the relationship shown in Fig. 2-d. If the material bends downward to the same degree as it bent upward, the same total output voltage is produced, but of opposite polarity (Fig. 2-e). Thus, the changes in voltage and polarity can be applied to a deviation-correcting device because they give a proportional voltage change for the errors which occur.

Practical application

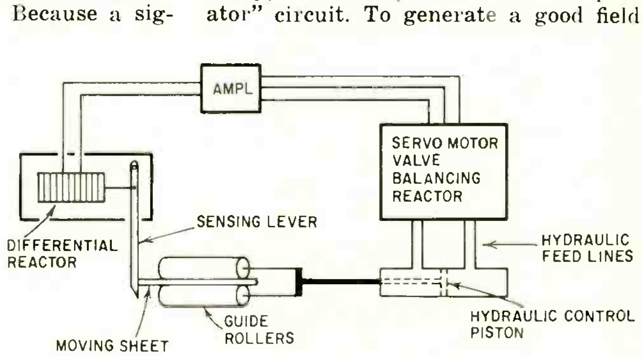
Placing one reactor above the material, and one below, as in Fig. 3-a can be used to sense differences in thickness. If both are wired as shown earlier, however, a change in thickness will result in both reactances changing identically and no correction voltage will be obtained. To measure thickness, the terminals from one reactor must be reversed. A single reactor can be used also, as in Fig. 3-b. Though less output voltage is obtained, increased amplification will compensate for the difference.

In some commercial installations a lever arm is used (Fig. 4). A typical industrial application of this device is shown in Fig. 5. Here, any sideways variations of the continuously moving sheet of material is sensed by the lever arm of the differential reactor. The voltage variations produced are amplified and used to operate a servo motor that rotates in one direction for one voltage polarity and reverses rotation for an opposite polarity. The motor actuates a hydraulic valve that causes the controlling piston to move in the direction necessary for correction. If the edge of the material pushes the sensing lever to the left, for instance, the piston is made to move to the right until a zero voltage is produced. A balancing reactor is used with the differential reactor to get a zero adjustment for proper placement of the material.

The device can also be used to sense abrupt changes. An inductance is still used but, instead of using a movable core, it senses a change by detecting metal passing beneath it. With ac applied to the reactor, the lines of force are cut each time metal passes under the unit, causing a slight change in the circulating current.

A practical application of this device is shown in Fig. 6, where it senses which bottles were not capped in beverage packing industries. Because a signal is obtained every time a metal bottle cap passes beneath the proximity-cell reactor, the *absence* of a cap would produce *no signal*. From a functional standpoint, the reverse should be true. To do this, the proximity-cell device is paired with a photo cell that generates an opposite voltage to form a "comparator" circuit. To generate a good field

Fig. 5—Edge control system.



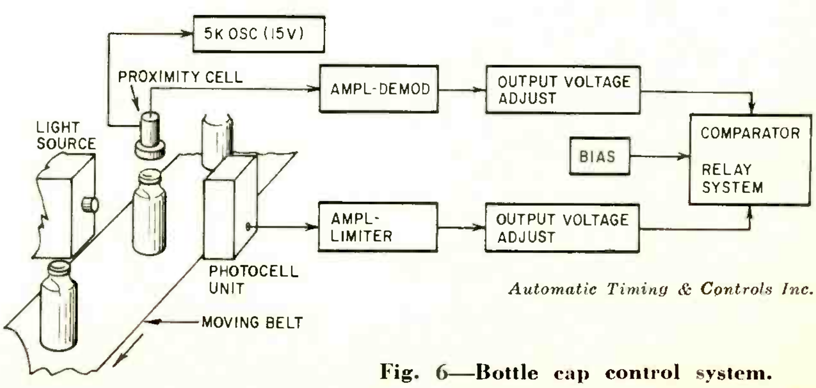


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Fig. 6—Bottle cap control system.

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First, check the batteries with the 0 to 12 voltmeter. If the batteries are O.K., check the current drain with the 0 to 50 milliamp meter. A special probe is provided so that you do not need to break the circuit. Excessive current indicates a short; low current indicates an open stage or cracked board. All PF schematics indicate average current.

If trouble is not located by now, isolate the trouble to a specific stage by touching the output of the harmonic generator to the base of each transistor and note spot where sound from speaker (or scope where no speaker is used) stops or becomes weak. The generator becomes a sine wave generator for audio stages to help find distortion.

If trouble points to a transistor, check it in a jiffy with the exclusive in-circuit power oscillator check provided by the TR110. A special probe is also provided for this.

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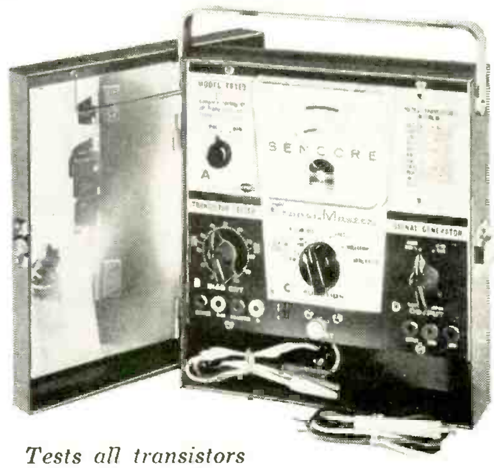

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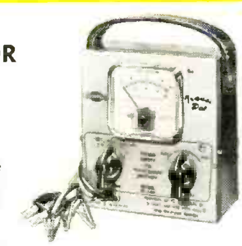

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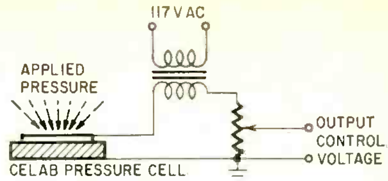

Fig. 7—Typical pressure-cell circuit.

Clark Electronic Labs.

Fig. 8—One type of pressure cell designed to measure liquid pressure.

in the proximity reactor, 5,000-cycle signal is applied, which is amplified and demodulated as shown. As each bottle reaches a position beneath the proximity cell, it also is between the light source and the photo cell, so that both cells produce signals at the same instant.

As shown in the figure, a bias voltage is compared with that produced by the photocell. If there is no signal from the proximity unit (uncapped bottle) a difference voltage is produced. It actuates the relay system that removes the uncapped bottle or stops the conveyor belt. When a capped bottle is sensed, the voltage produced by the proximity cell opposes the difference voltage and prevent the tripping of the reject relay. Thus, uncapped bottles are detected electronically, without any physical contact with the moving items.

High-pressure variations

Variation control is also employed where pressures are high—as in oil lines, gas lines and reactors. Pressure control is a safety factor and, when pressures become excessive, correction consists of closing a valve or controlling check valves that protect the pipe lines.

One commercial sensing device is made from intermetallic resins and rare earths processed with zirconion tetrachloride. Its resistance changes with applied pressure. The cells are available in a variety of mountings and with different characteristics to meet particular requirements. A typical unit is the No. 48 Celab solid-state load cell. It has a resistance of approximately 900,000 ohms at 5 pounds and zero resistance at a pressure slightly over 20 pounds. A typical circuit for the cell is shown in Fig. 7. It will function with dc as well as ac. Fig. 8 shows the housing for the cell where liquid pressure variations are to be sensed.

Overload protection

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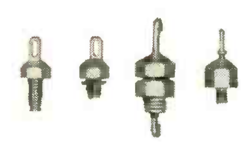
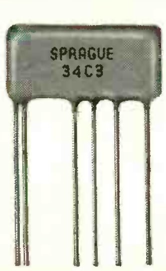


Screw-mounting units with flat disc capacitor elements seated in hexagon head. This series includes feed-thru capacitors for filtering leads through chassis, as well as standoff capacitors for by-pass applications.



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ple, pressure-switch controls are used for overload protection in all phases of industry. Such types are simple in operation and relatively inexpensive. The one shown in Fig. 9 is used to control air, gas or liquid pressure where close on–off deviations must be sensed. This control uses a brass bellows which trig-

United Electric Controls Co.

Fig. 9—Another type of pressure control.

gers a basic single-pole, single-throw switch. Other models have double-throw switches and various pressure ranges.

This pressure control, as well as the other control devices previously described, are adaptable to many control applications. In all instances, however, the basic principles are similar. Initially the variation must be sensed, and the signal produced by the sensing device is employed either for correction, for a metered display, or both. By using electronic circuits to process the signals, they can be amplified to control motors and valves to make corrections.

All must have provision for adjusting the system to the normal or correct setting. That is, the operator must indicate to the system by proper circuit balancing the normal condition, so the electronic devices can sense variations from it and make the proper corrections. After that, the control and correction processes are automatic and need only be checked occasionally as part of routine maintenance. END

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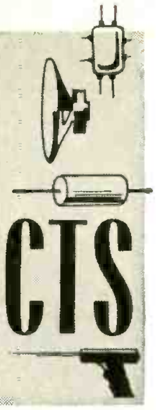

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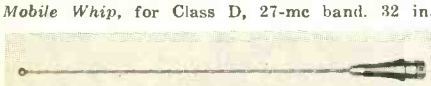

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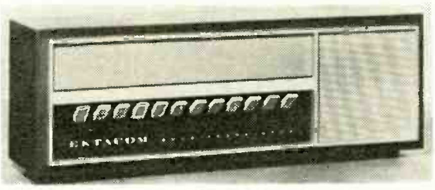

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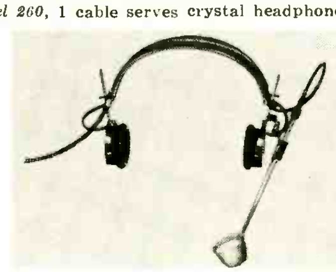

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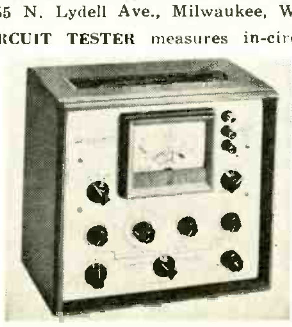

rameters of all low- and medium-power transistors and diodes. I_{CBO} ranges: 0–5 μa, 0–500 μa and 0–5 ma. I_C ranges: 0–1 ma, 0–10 ma and 0–100 ma. Collector voltage variable from 0 to 4.5 in 3 steps. Variable collector current, 0–100 ma. 11¼ x 10¾ x 7½ in. 17 lb.—**Hickok Electrical Instrument Co.**, 10514 Dupont Ave., Cleveland 8, Ohio.

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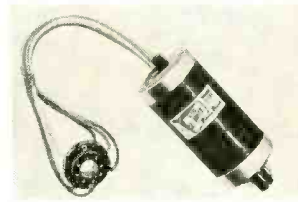

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TUBE TESTER, grid circuit type, *model 650*, tests all standard radio and TV tubes plus 10-pin

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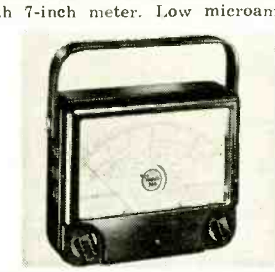

0–50 for *267* and 0–60 for *268*. Sensitivity of ac voltage ranges to 5,000 ohms per volt.—**Simpson Electric Co.**, 5200 W. Kinzie St., Chicago 44, Ill.

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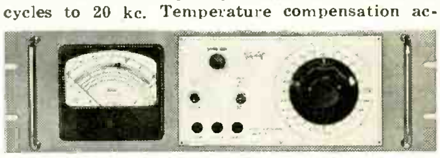

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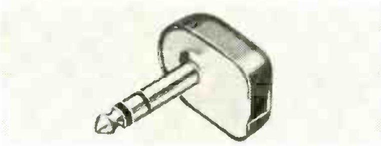
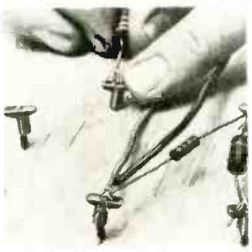


changeable with military type plug PJ-068. *Part No. S-235*, red plastic handle: *Part No. S-230*, black plastic handle.—**Switchcraft Inc.**, 5555 N. Elston Ave., Chicago 30, Ill.

NAIL CLIP *E-Z Hook type 81-1* drives into wood with hammer. Up to 4 or more wires feed through hook or slip under end. Patented con-

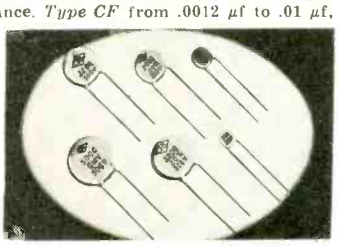


nector, nylon insulator, special T-shape, large bulk head and stainless steel spring and body.—**E-Z Hook Test Products**, 1536 Woodburn Ave., Covington, Ky.

ELECTRONIC CONTACT CLEANER LUBRICANT in an aerosol dispenser. Special plastic

extender for hard-to-reach areas. 6- and 16-oz.—**Krylon Inc.**, Norristown, Pa.

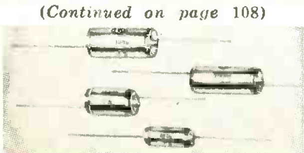
TEMPERATURE-STABLE CAPACITORS. *Type CE*, in values from 150-$\mu\mu$f to .001 μf, 10% tolerance. *Type CF* from .0012 μf to .01 μf, 10%.



500-vdc working voltage. Over 10,000 megohms initial minimum leakage resistance.—**Centralab**, Electronics Div. of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

SEALED POLYSTYRENE CAPACITORS for

(*Continued on page 108*)

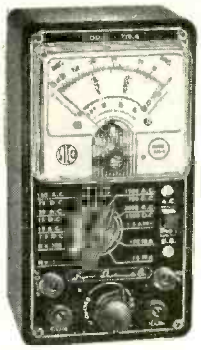


EXAMINE ANY OF THESE TESTERS *BEFORE* YOU BUY!!

Yes, we offer to ship at our risk one or more of the testers described on these pages.

SUPERIOR'S NEW MODEL 770-A

VOLT-OHM MILLIAMMETER



FEATURES:
- Compact—measures 3⅛" x 5⅞" x 2¼".
- Uses "Full View" 2% accurate 850 Microampere D'Arsonval type meter
- Housed in round-cornered, molded case.

SPECIFICATIONS:

6 A.C. VOLTAGE RANGES: 0-15/30/150/300/1500/3000 Volts.

6 D.C. VOLTAGE RANGES: 0-7.5/15/75/150/750/1500 Volts.

2 RESISTANCE RANGES: 0-10,000 Ohms, 0-1 Megohm.

3 D.C. CURRENT RANGES: 0-15/150 Ma., 0-1.5 Amps.

3 DECIBEL RANGES: —6 db to + 18 db, + 14 db to + 38 db, + 34 db to + 58 db.

The Model 770-A comes complete with test leads and operating instructions. **Price is $15.85. Terms: $3.85 after 10 day trial then $4.00 monthly for 3 months.**

SUPERIOR'S NEW MODEL 79

SUPER-METER

WITH NEW 6" FULL VIEW METER

SPECIFICATIONS:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500.
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000.
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes.
RESISTANCE: 0 to 1,000/100,000 Ohms. 0 to 10 Megohms.
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd.
REACTANCE: 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms.
INDUCTANCE: .15 to 7 Henries, 7 to 7,000 Henries.
DECIBELS: —6 to + 18, + 14 to + 38, + 34 to + 58.

The following components are all tested for **QUALITY** at appropriate test potentials. Two separate **BAD-GOOD** scales on the meter are used for direct readings.
All Electrolytic Condensers from 1 MFD to 1000 MFD.
All Selenium Rectifiers. All Germanium Diodes.
All Silicon Rectifiers. All Silicon Diodes.

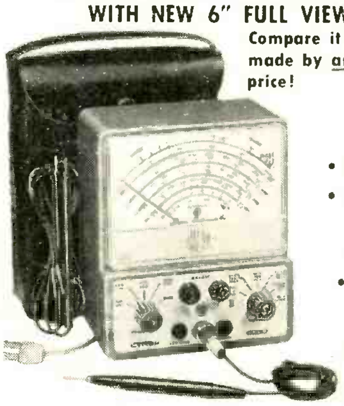
Model 79 comes complete with operating instructions, test leads and carrying case. **Price is $38.50. Terms: $8.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL VIEW METER

Compare it to any peak-to-peak V.T.V.M. made by any other manufacturer at any price!



SPECIFICATIONS:
- **DC VOLTS**—0 to 3/15/75/150/300/750/1500 volts at 11 megohms input resistance.
- **AC VOLTS (RMS)**—0 to 3/15/75/150/300/750/1500 volts.
- **AC VOLTS (Peak to Peak)**—0 to 8/40/200/400/800/2000 volts.
- **ELECTRONIC OHMMETER**—0 to 1000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms.
- **DECIBELS**—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 and carrying case. **Price is $42.50. Terms: $12.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL 80

20,000 OHMS PER VOLT ALLMETER

NOTE: The line cord is used only for capacity measurements. Resistance ranges operate on self-contained batteries.

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.

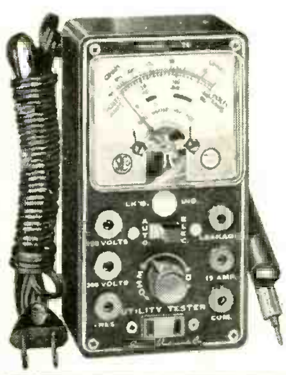
SPECIFICATIONS:

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.

Model 80 Allmeter comes complete with operating instructions, test leads and portable carrying case. **Price is $42.50. Terms: $12.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL 70 UTILITY TESTER

FOR REPAIRING ALL ELECTRICAL APPLIANCES MOTORS ★ AUTOMOBILES



INCLUDED FREE

64 page condensed course in electricity. Profusely illustrated. Written in simple, easy-to-understand style.

As an electrical trouble shooter the Model 70:
• Will test Toasters, Irons, Broilers, Heating Pads, Clocks, Fans, Vacuum Cleaners, Refrigerators, Lamps, Fluorescents, Switches, Thermostats, etc. • Measures A.C. and D.C. Voltages, A.C. and D.C. Current, Resistances, Leakage, etc. • Incorporates a sensitive direct-reading resistance range which will measure all resistances commonly used in electrical appliances, motors, etc. • Leakage detecting circuit will indicate continuity from zero ohms to 5 megohms (5,000,000 ohms).

As an Automotive Tester the Model 70 will test:
• Both 6 Volt and 12 Volt Storage Batteries • Generators • Starters • Distributors • Ignition Coils • Regulators • Relays • Circuit Breakers • Cigarette Lighters • Stop Lights • Condensers • Directional Signal Systems • All Lamps and Bulbs • Fuses • Heating Systems • Horns • Also will locate poor grounds, breaks in wiring, poor connections, etc.

Model 70 comes complete with 64 page book and test leads. **Price is $15.85. Terms: $3.85 after 10 day trial then $4.00 monthly for 3 months.**

DID YOU EVER?

- ▶ Order merchandise by mail, including deposit or payment in full, then wait and write...wait and write?
- ▶ Purchase anything on time and sign a lengthy complex contract written in small difficult-to-read type?
- ▶ Purchase an item by mail or in a retail store then experience frustrating delay and red tape when you applied for a refund?

Obviously prompt shipment and attention to orders is an essential requirement in our business...We ship at our risk!

NO

CONTRACT TO SIGN

CO-MAKERS

EMPLOYER NOTIFICATION

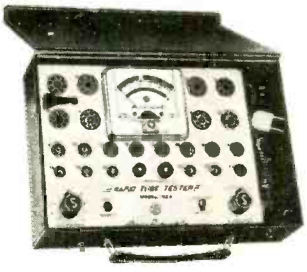
The simple order authorization included in this offer is *all* you sign. We ask only that you promise to pay for or return the goods we ship in good faith.

EXAMINE ANY ITEM YOU SELECT IN THE PRIVACY OF YOUR OWN HOME

Then if completely satisfied pay on the interest-free terms plainly specified. When we say interest-free we mean not one penny added for "interest" for "finance" for "credit-checking" or for "carrying charges." The net price of each tester is plainly marked in our ads—that is all you pay except for parcel post or other transportation charges we may prepay.

SUPERIOR'S NEW MODEL 82A

MULTI-SOCKET TYPE TUBE TESTER



SPECIFICATIONS:

- Tests over 1000 tube types.
- Tests OZ4 and other gas-filled tubes.
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings.
- Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence.
- Dual Scale meter permits testing of low current tubes.
- 7 and 9 pin straighteners mounted on panel.
- All sections of multi-element tubes tested simultaneously.
- Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms.

Model 82A comes housed in handsome, portable, saddle-stitched Texon case. **Price is $36.50. Terms: $6.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL TUBE TESTER

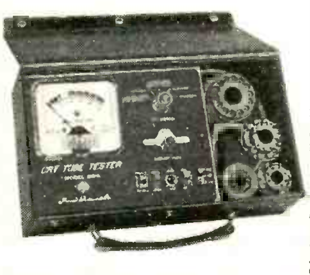
- Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test.
- Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large-easy-to-read type.
- **NOISE TEST:** Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.
- **SEPARATE SCALE FOR LOW-CURRENT TUBES**—Previously, on emission type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

The Model TW-11 comes housed in a handsome, portable, saddle-stitched Texon case. **Price is $47.50. Terms: $11.50 after 10 day trial then $6.00 monthly for 6 months.**

SUPERIOR'S NEW MODEL 83A

C.R.T. TESTER

Tests and Rejuvenates ALL PICTURE TUBES



ALL BLACK AND WHITE TUBES
From 50 degree to 110 degree types—from 8" to 30" types.

ALL COLOR TUBES
Test ALL picture tubes —in the carton —out of the carton —in the set!

Model 83A provides separate filament operating voltages for the older 6.3 types and the newer 8.4 types.

Model 83A properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.

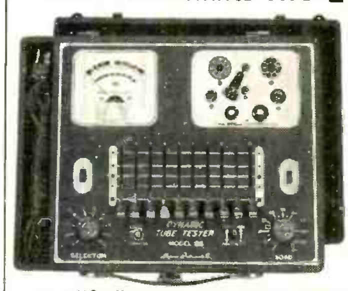
Model 83A will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus.

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

Model 83-A comes housed in handsome portable Saddle-stitched Texon case—complete with socket for all black and white tubes and all color tubes. **Price is $38.50. Terms: $8.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL 85

TRANS-CONDUCTANCE TYPE TUBE TESTER



- Employs latest improved **TRANS-CONDUCTANCE** circuit. Test tubes under "dynamic" (simulated) operating conditions. An in-phase signal is impressed on the input section of a tube and the resultant plate current change is measured as a function of tube quality. This provides the most suitable method of simulating the manner in which tubes actually operate in radio, TV receivers, amplifiers and other circuits. Amplification factor, plate resistance and cathode emission are all correlated in one meter reading.
- **SYMBOL REFERENCES:** Model 85 employs time-saving symbols (*, +, ●, ▲, ■;) in place of difficult-to-remember letters previously used. Repeated time-studies proved to us that use of these scientifically selected symbols speeded up the element switching step. As the tube manufacturers increase the release of new tube types, this time-saving feature becomes necessary and advantageous.
- **"FREE-POINT" LEVER TYPE ELEMENT SWITCH ASSEMBLY** marked according to RETMA basing, permits application of test voltages to any of the elements of a tube.
- **FREE FIVE (5) YEAR CHART DATA SERVICE.** Revised up-to-date subsequent charts will be mailed to all Model 85 purchasers *at no charge* for a period of five years after date of purchase.

Model 85 comes complete, housed in a handsome portable cabinet with slip-on cover. **Price is $52.50. Terms: $12.50 after 10 day trial then $8.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL TV-50A

GENOMETER
7 Signal Generators in One!

- **R.F. Signal Generator for A.M.**
- **R.F. Signal Generator for F.M.**
- **Audio Frequency Generator**
- **Bar Generator**
- **Cross Hatch Generator**
- **Color Dot Pattern Generator**
- **Marker Generator**

A versatile all-inclusive **GENERATOR** which provides **ALL** the outputs for servicing:

A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV

The Model TV-50A comes absolutely complete with shielded leads and operating instructions. **Price is $47.50. Terms: $11.50 after 10 day trial then $6.00 monthly for 6 months.**

SUPERIOR'S NEW MODEL 88

TESTS ALL TRANSISTORS AND TRANSISTOR RADIOS

AS A TRANSISTOR RADIO TESTER
An R.F. Signal source, modulated by an audio tone is injected into the transistor receiver from the antenna through the R.F. stage, past the mixer into the I.F. Amplifier and detector stages and on to the audio amplifier. This injected signal is then followed and traced through the receiver by means of a built-in High Gain Transistorized Signal Tracer until the cause of trouble is located and pinpointed.

AS A TRANSISTOR TESTER
The Model 88 will test all transistors including NPN and PNP, silicon, germanium and the new gallium arsinide types, without referring to characteristic data sheets. The time-saving advantage of this technique is self-evident. A further benefit of this service is that it will enable you to test new transistors *as they are released!*

Model 88 comes housed in a handsome portable case. Complete with a set of Clip-on Cables for Transistor Testing; an R.F. Diode Probe for R.F. & I.F. Tracing; an Audio Probe for Amplifier Tracing and a Signal Injector Cable. Complete —nothing else to buy! **Price is $38.50. Terms: $8.50 after 10 day trial then $6.00 monthly for 5 months.**

SEND POSTCARD TODAY (NO POSTAGE NECESSARY)

Try any of the instruments on this or the facing page for 10 days before you buy. If completely satisfied then send down payment and pay balance as indicated on coupon. No interest or Finance Charges Added! If not completely satisfied return unit to us, no explanation necessary.

MOSS ELECTRONIC, INC., DEPT D-903, 3849 TENTH AVENUE, NEW YORK 34 N.Y.

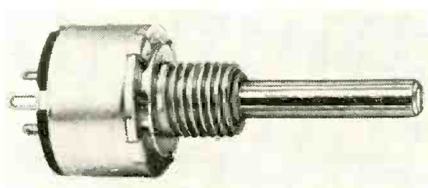
(Continued from page 103)

long-life applications. Leakage resistance in excess of 500,000 megs/μf. 25-, 125- and 500-volts dc units available with 2.5%, 5.0%, 10% or 20% tolerances.—**Centralab, Electronics Div. of Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.**

POTENTIOMETER, *Series 60M Cap-Pot* in resistance ranges of 10 to 10,000 ohms. Wirewound, rated at ½ watt at 40°C. Linear taper. Resist-

ance tolerance ±10%. Overall miniaturization, weather- and, explosion-proof.—**Clarostat Mfg. Co. Inc., Dover, N. H.**

MOLDED CARBON POTENTIOMETER, *series 63M, style RV-6*, withstands 750 volts rms at sea level, 350 volts rms at 50,000 feet for 1 minute. ½-in. diameter. Rated at ½ watt at 70°C. Re-

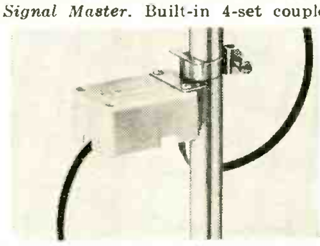


sistance values 100 ohms to 5 megohms. Linear tapers. Resistance tolerance ±10%. Mechanical rotation 295° ±3°.—**Clarostat Mfg. Co. Inc., Dover. N. H.**

ATTENUATOR-RESISTOR BANK, *model 511A Attenu-Load*, follows typical T-pad design. Maximum power dissipation rating 50 watts at input

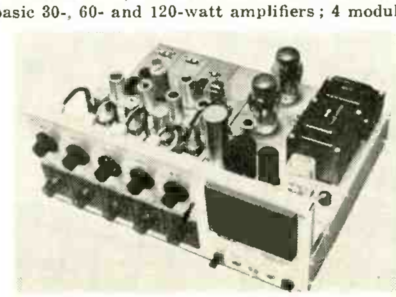
connector. 10-db power reduction ratio represents power stepdown of 10:1.—**Seco Electronics Inc., 5015 Penn Ave. S., Minneapolis 19, Minn.**

TRANSISTOR ANTENNA-MOUNTED BOOSTER, *AB-4 Signal Master*. Built-in 4-set coupler. Re-



mote power supply uses 4 flashlight cells. Noise figure, 3 db on low band, 6.5 db on high.—**Blonder-Tongue Labs Inc., 9 Alling St., Newark 2, N. J.**

AMPLIFIERS, for public address, *Moduline:* basic 30-, 60- and 120-watt amplifiers; 4 modules;

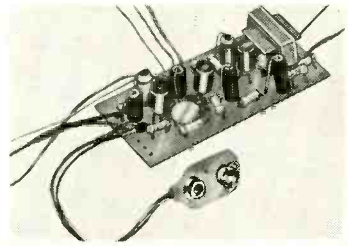


front-panel can be used for VU meter or monitor speaker. *Commander* series: 12-, 35- and 100-watt amplifiers; master volume and fader-mixer controls.—**Harman-Kardon Inc., Ames Court, Plainview, N. Y.**

BROADBAND AMPLIFIER for master TV systems. Up to 35-db gain. Power rating under 50 watts. 2 volts output. Separate inputs for high or low band with link for use with combined

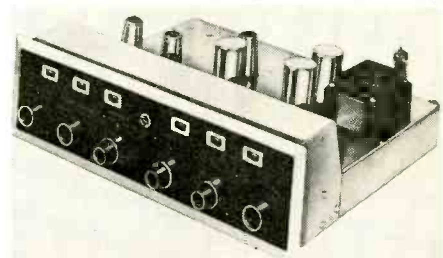
high/low band inputs. Weatherproof container available.—**Benco Television Assoc. Ltd., 27 Taber Rd., Rexdale, Ontario, Canada.**

AUDIO AMPLIFIER, *PK-522*, subminiature type, 3 transistors. 2 input leads for use with tape recorder record/playback heads, radio tuner, crystal or ceramic phono cartridge and crystal or ceramic microphone: 2 output leads for 2 to 10-ohm speakers; 2 leads for on-off spst switch;



3 leads for volume control; 2 leads terminating in battery clips. 2 13/16 x 1¼ x 3¼ in. 8 oz.—**Lafayette Radio Electronics Corp., 165-08 Liberty Ave., Jamaica 33, N. Y.**

PREAMPLIFIER KIT, *LC-21*. Components arranged on cards and correlated with step-by-step full-color instruction book plus container-storage



area and work bench. 5 pairs of stereo inputs, derived center-channel output, stereo tape recorder outputs. 14 front-panel controls. 80-db hum level. Distortion 0.1% at 2.5 volts output. Input sensitivity 2.4 mv. Frequency response 8–50,000 cycles ±1 db.—**H. H. Scott Inc., Dept. P, 111 Powdermill Rd., Maynard, Mass.**

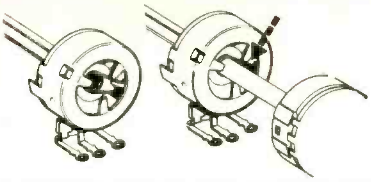
MONOPHONIC TAPE RECORDER *model 101*. Playing and recording time of over 8½ hours on 1 reel. 1⅞-, 3¾- or 7½-ips tape speed. VU meter,

tape lifters and dynamic microphone.—**Superscope Inc., 8150 Vineland Ave., Sun Valley, Calif.**

AUTOMATIC TURNTABLE AND RECORD CHANGER, *Miracord Studio H*. Synchronous hysteresis motor. One-piece nonferrous turntable

weighs almost 7 lb. Transcription tone arm with adjustable counterbalance and springless construction.—**Benjamin Electronic Sound Corp., 97-03 43rd Ave., Corona 68, N. Y.**

STEREO CONTROLS from manufacturer's dual concentric controls with use of specially tempered spring that inserts between shafts of



front and rear controls and provides sufficient tension to insure their simultaneous rotation.—**Centralab**, Electronics Div. of Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

STEREO TUNER/AMPLIFIER, *KN-300.* Separate FM and AM tuner sections, built-in preamps and complete stereo amplifier with 30-watt IHFM

music power output. Amplifier response ±0.5 db, 15–30,000 cycles. Tuner sensitivity 2½ µv for 20-db quieting on FM; 15 µv on A.M.—**Allied Radio Corp.,** 100 N. Western Ave., Chicago, 80, Ill.

STEREO TAPE-HEAD KIT with simple, illustrated mounting directions. Quarter-track record—playback stereo tape head, 3-inch reel of azi-

muth alignment tape, electrical connector and necessary hardware.—**Fidelitone Inc.,** 6415 Ravenswood Ave., Chicago 26, Ill.

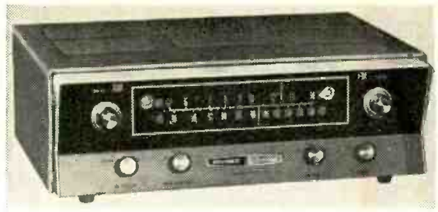
STEREOPHONIC MASTER CONTROL-AMPLIFIER, *X-202-B.* Combined music power output of 75 watts. Harmonic distortion 0.5% at 70 watts rms. Intermodulation distortion 1% at 70 watts

rms. Overall frequency response (1 watt) 20–20,000 cycles ±1 db. Power amplifier hum and noise more than 90 db. Stereo channel separation at 1 kc better than 50 db. Output impedance at speaker terminals 4, 8 or 16 ohms. 20 front-panel controls.—**Fisher Radio Corp.,** 21-21 44th Drive, Long Island City 1, N. Y.

STEREO PHONO CONSOLE, *GDW-41.* 2 full-range, cylindrical, ported enclosures mounted on vertical axes and mechanically linked so can be rotated in opposite directions by equal

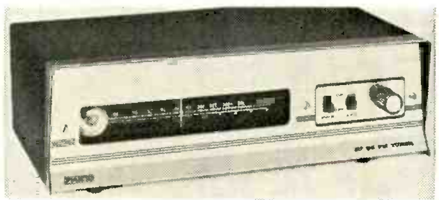
amounts. 4-speed automatic stereo record changer with diamond (LP) and sapphire (78) styli, 30-watt amplifier and built-in stereo speaker system. 50½ x 31 x 18 inches.—**Heath Co.,** Benton Harbor, Mich.

AM/FM TUNER, *AJ-11,* with separate tuning indicators for AM and FM. 3-position afc and AM fidelity switches. Individual flywheel tuning



for both AM and FM. Separate terminals for outside AM and FM antennas. Multiple signal output jack.—**Heath Co.,** Benton Harbor, Mich.

FM TUNER KIT, *model ST-25.* 2 limiter stages coupled with wide-band ratio detector and afc. Sensitivity 1.5 µv for 20-db quieting; IHFM sensitivity 4 µv. Signal-to-noise ratio 50 db at



15 µv, full limiting. Output, 1 volt rms minimum. Maximum distortion 1%. Bandwidth, 250 kc; antenna input, 300 ohms. Main and multiplex outputs. Fully wired and prealigned front end.—**Paco Electronics Co. Inc.,** 70-31 84th St., Glendale 27, N. Y.

BOOKSHELF SYSTEM, *model SP-10S,* with 30-watt power capacity. Pair of specially designed cone-type tweeters in tuned cabinet ducted with plastic tubing. Foam-suspended woofer. Swedish walnut finish. 23½ x 14 x 11¾ in.—**Monarch Electronics International Inc.,** 7035 Laurel Canyon Blvd., North Hollywood, Calif. END

All Specifications from Manufacturer's data.

TECHNICIANS' NEWS

TECHNICIAN JAILED

Los Angeles, Calif.—Oscar Singer, an LA TV repairman, is serving 90 days in jail after being found guilty of allegedly phony TV repairs. The charges stated that a total of $120 in overcharges were collected on repairs of three sets installed in homes of undercover city agents.

MINIMUM PAY

Santa Clara Valley, Calif.—Endorsement by the Santa Clara Valley and Santa Cruz chapters of the California State Electronics Association of a $3 an hour minimum wage has been announced to their members. The pay rate is for journeyman technicians. The pay rate has been adopted by the apprenticeship committee to determine the pay scale for apprentices in approved shops.

SRTT MEETING

San Fernando Valley, Calif.—About 40 technicians met at the Sky Trails for the first meeting after elections. In his inaugural speech on forthcoming plans of the group, president Dudley Anderson said, "Programming will be geared to more and better technical meetings, with transistors and color television given a high priority. A recent survey has shown a demand for this type of meeting and this we shall have for you."

PARTS BAG

There's a little business builder G-E has made available to technicians through their distributors that can help you. It's a small paper bag to hold defective parts which you have replaced. The bag is given to your customer when you have completed a repair.

The message imprinted on the bag reads: "We have bagged your troubles. Your set has been completely serviced by a qualified technician and all parts and tubes found to be defective have been replaced with first-quality material. We appreciate your confidence and intend to earn and keep your TV–radio service business by providing prompt, reliable service at fair prices."

There is room on the bag to write the name of the customer and the service shop doing the work.

CODE OF ADVERTISING ETHICS

Milwaukee, Wis.—The local TESA in an attempt to eliminate unethical advertising has adopted into its constitution the following 14 points on advertising:

1. *Deception:* It shall be considered an unfair trade

practice to use advertising of any nature which has the tendency or capacity to confuse or mislead the public regarding the nature of the service provided, or the cost of such service, or in any other respect.

2. *No fix-no pay:* The use of this phrase or any statement of a similar nature shall not be used.
3. *Price:* There shall be no reference to the amount charged for a house call unless the advertisement clearly sets forth the amount of time to be devoted to such call, the labor charge per hour for time in excess of the stated period, and providing the advertising clearly states that parts are extra, if that is a fact.
4. *Identification:* Firm shall have an established shop where the servicing work is performed and the address shall be clearly stated in its advertising. No false address shall be used.
5. No reference shall be made to the number or percentage of sets repaired in the owner's home.
6. *No telephone number* shall be advertised unless there is an existing electronic service shop at that number.
7. *Credit:* When an offer of credit is made in an advertisement, it should be accompanied with the statement "Usual Finance Company Requirements" or the equivalent.
8. *One-hour service:* Advertisements shall not contain such statements as "24-hour service," "Service within one hour," etc.
9. *Free offers:* The word "free" cannot be used if a purchase of any kind is required, except where services are rendered in connection with a new product sale.
10. *Bonded, etc.:* Words such as "bonded," "insured," etc. which suggest protection of any nature shall not be used unless the exact nature of such coverage, or the protection provided, is fully explained, and in no instance unless coverage is in behalf of the set owner.
11. *Engineer:* The term, "engineer," or words or terms having similar connotation shall not be used in advertisements offering radio or television service unless a degree in engineering or the like has been conferred on the principal of the company by a recognized school of engineering.
12. *Authorized:* When the word "authorized," or others of similar connotation, are used in an advertisement offering radio or television service, and which advertisement lists one or more names of manufacturers or makes of television sets, the advertiser must possess and have available for inspection written authorization to perform such service from the manufacturers or franchised distributors of the sets named.
13. *License:* When the word "license," or similar connotation, is used, it must be specifically stated by whom they are licensed.
14. *No secondary ficticious name or prefix* shall be used by an existing shop for the purpose of obtaining advantageous position in the Telephone Directory advertising or in any other media.

LICENSING IN N.C.

Durham, N. C.—A TV service licensing bill has been introduced into the North Carolina State Legislature. If passed, it will create a State Board of Home Electronic Service Certification to certify and regulate the installation of radio and TV receivers and other home electronic devices. The bill would state that those who service and install home electronic equipment should be individuals of proven skill.

The board this bill sets up would consist of five members to be appointed by the Governor. Three would be practicing service technicians, one an instructor of electronics or electronic servicing and one a consumer with no connection with the sale or servicing of home electronic items.

ELECTRONICS COUNCIL MEETS

Yakima, Wash.—On the agenda for the annual meeting of the Washington State Electronics Council was the election of officers. By the time the meeting was over Dick Brinkerhoff was chairman; Dick Jones, vice chairman; Ansel Heckman, secretary-treasurer. Other business included a report on future plans including methods of encouraging attendance from areas not already represented.

ELECTION NEWS

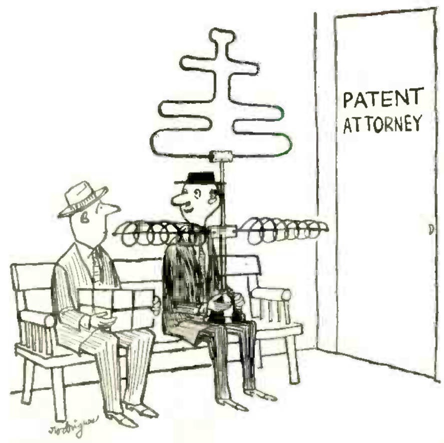
Indianapolis, Ind.—Delegates from service associations throughout the state associated with the Indiana Electronic Service Association elected their officers for the coming year. LaMar Zimmerman, who served as secretary last year, was elected chairman; Robert Luecke, vice chairman; Clyde Smeltzer, secretary, and Jay Schupbach, treasurer.

Binghamton, N. Y.—At the last meeting of the Empire State Federation of Electronic Technicians Associations, the following officers were elected: Douglas W. Cook, president; Don Roberts, vice president; O. Capitelli, corresponding secretary; Anthony Ferris, recording secretary; Warren Baker, treasurer; Ben DeYoung, segeant at arms.

Vancouver, B. C., Canada—Newly elected officers of the Radio Electronic Technicians Association, Vancouver chapter, are: Julius Cotter, president; Ted Bernard, vice president; Maurice Doyon, secretary; Ray Sarky, treasurer, and A. Curtus, recording secretary.

Gloucester, N. J.—Members of the Allied Electronic Technicians Association of N. J. voted the following officers to head their group: Tony DeFranco, president; Ray Dellinger, vice president; Joseph Papovich, re-elected secretary, and Joseph Eberhardt, re-elected treasurer.

Kansas City, Mo.—At a regular meeting of Team, the electronic association of Missouri, Ralph McClellan was elected president; Jay Oliver Johnson, vice president; P. C. Brink, secretary treasurer; Richard Lagle, recording secretary, and Fred Loeb, sergeant-at-arms. New directors were also elected. They are Ralph McClellan, Joy Oliver Johnson, P. C. Brink, Richard Lagle, Fred Loeb, Joseph Garner, Tather Jones, Manuel Emerick, Earl Davis, Ed Ruttinger and W. W. Miller. END



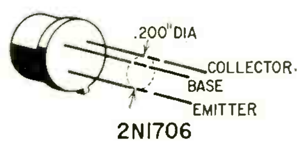
"It'll completely eliminate the need for outdoor antennas."

NEW TUBES and SEMI-CONDUCTORS

THERE ARE SOME INTERESTING AND REALLY new devices this month. You will find the first group of noval tubes, two 150-watt power transistors, and a different switching device called a Dynaquad.

2N1706

A p-n-p germanium alloy junction transistor intended for use in class-A and class-B audio output stages. It features high reliability, excellent life and environmental characteristics.



Maximum ratings of the Tung-Sol 2N1706 are:

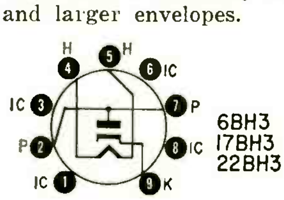
V_{CBO}	25
V_{EBO}	5
V_{CER} (R_{BE} = 1 k)	18
P_C (mw)	200
I_C (ma)	400

Electrical characteristics at 25°C are:

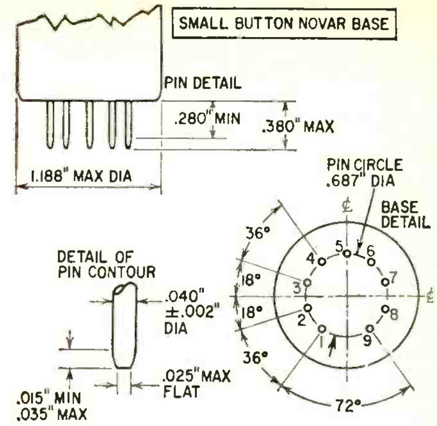
f_{ab} (frequency cut off) (typical) (mc) ($V_C = -6$ v, $I_C = 1$ ma)	3
h_{fe} (current gain) (typical) ($I_C = 10$ ma, $V_{CE} = -5$ v, f = 1 kc)	9
h_{FE} (dc current gain) (maximum) ($I_C = 20$ ma, $V_{CE} = -1$ v)	120

6BH3, 17BH3, 22BH3

A group of half-wave vacuum rectifier tubes designed as damper diodes for black-and-white TV receivers. They are *novar* tubes which have all-glass 9-pin bases but are not to be confused with standard 9-pin miniature tubes. The novar tubes have a relatively large pin circle and larger envelopes.



The three tubes are identical except for heater ratings which are: 6.3 volts at 1.6 amps for the 6BH3, 17.0 volts at 600 ma for the 17BH3, and 22.4 volts at 450 ma for the 22BH3. Both the 17BH3 and 22BH3 have controlled warmup for series-string heater arrangements.

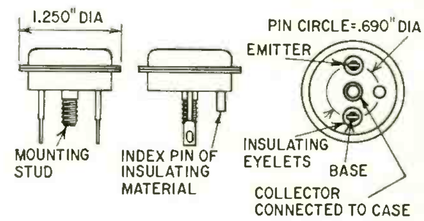


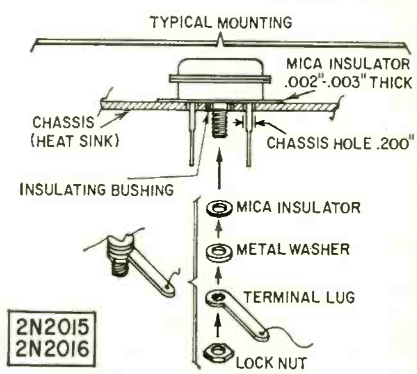
Maximum ratings in damper service for these RCA tubes are:

V_P (piv)	5,500
I_P (peak ma)	1,100
I_P (dc ma)	180
P_P (watts)	6.5
$V_{htr\text{-}cath}$ (peak)	
(htr neg with respect to cath)	5,500
(htr pos with respect to cath)	300

2N2015, 2N2016

Two diffused-junction power transistors of the silicon n-p-n type. They have very high power-dissipation capabilities (150 watts) and are intended for a variety of applications in military and industrial equipment. They are particularly useful in power switching circuits of dc-to-dc converters, inverters,





choppers and relay-control equipment. They are also useful in oscillator, regulator and pulse amplifier circuits, and as class-A and -B push-pull amplifiers for audio and servo applications.

Maximum ratings in industrial service for the RCA 2N2015 and 2N2016 are:

	2N2015	2N2016
V_{CB}	100	130
V_{CEO}	50	65
V_{EB}	10	10
I_C (amps)	10	10
I_E (amps)	13	13
I_B (amps)	6	6
P_{total} (watts)	150	150

Dynaquad

This alloy-junction 4-layer device introduced by Tung-Sol is a natural switch which has both turn-on and turn-off control at its base. The unit is a germanium, 3-terminal p-n-p-n device packaged in a standard transistor case. Basically, it is a 2-position switch that works in the megacycle range with rise times in the order of 0.1 μsec. Because of its bistable nature, a single Dynaquad can replace a number of transistors and associated components in many applications, and in simple on–off switching it behaves like a pulse-operated latching relay with no bounce, chatter or sticking contacts.

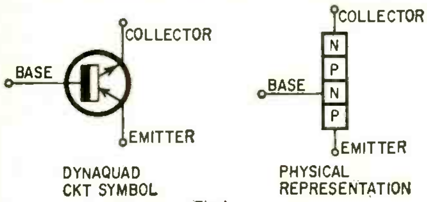


Fig.1

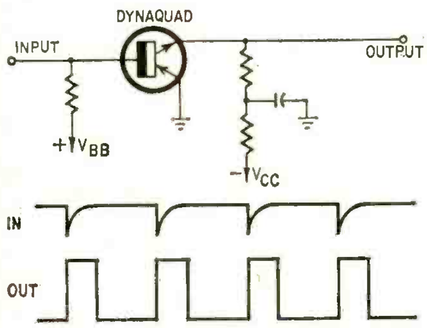
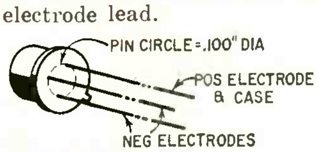


Fig.2

The construction of and symbol for the Dynaquad are shown in Fig. 1. A circuit showing the device used as a monostable multivibrator is in Fig. 2.

T1925, T1975, T1976

Three germanium tunnel diodes designed for low-level switching and small-signal applications. They have closely controlled peak-point current and low series resistance and inductance. The T1976 has a maximum frequency of oscillation in excess of 950 mc, the T1975 oscillates beyond 1,200 mc, and the T1925 beyond 1,500 mc. All are in hermetically sealed cases. They have two parallel negative electrode leads to reduce inductance and one positive electrode lead.



T1925,T1975,T1976

Maximum ratings of these Philco units are:

	T1925	T1975	T1976
Forward current (ma)	3	3	15
Reverse current (ma)	3	3	15
I_P (peak-point current) (typical) (ma)	1	1	5
I_P/I_V (peak-to-valley-point current ratio)	5	8	6
V_P (peak-point voltage) (mv)	55	55	55
V_V (valley-point voltage) (mv)	320	320	320
V'_F (forward voltage) (max mv)	525	525	515

END

Technotes

DIS IS FOR DE BOIDS!

If you put up a couple of fine big metal trumpets at the football field a few years ago and they bellowed loud and clear for a mile or so, but you can't hear them so good of late and the announcer keeps turning up the gain of the PA system and complains because the people can't hear him, you'd better look into the speakers. And I mean look into them literally!

This happened to me. Somehow, I took a look into the mouth of one of the horns out on the field and saw telltale pieces of straw sticking out. Taking the speakers down and disassembling them, this is what I found (see photo)! For the last 4 or 5 years, they had been used as a birdhouse, although it must have been pretty hard for the birds to get any sleep on Friday nights during the football season!

They were packed absolutely full of birds' nests! The sound couldn't get out through feathers and goop. Remedy: clean 'em out, wash off and reassemble, this time placing a heavy screen of hardware cloth (a heavy wire screening) across the bell of each horn.—*Jack Darr*

INOPERATIVE POWERED AUTO ANTENNA

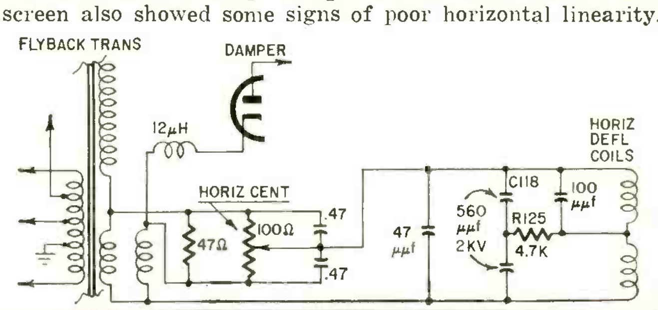
Freqently, checking an inoperative automobile radio antenna reveals that the nylon cord which raises and lowers it is pulled out of the metal ferrule crimped around the cord to attach it to the top section. While the proper repair is a new top section and cord assembly, when they can't be found at the moment you can make a satisfactory repair by inserting a punch of the proper size inside the ferrule. Then tap the outside with a small hammer to remove as much of the crimping as possible.

Next, scrape and sand the cord until it is a push fit into the ferrule. Then drill a hole (using a smaller than 1/16-inch drill) through both ferrule and cord. Now you can insert a small pin through ferrule and cord. Rivet it on both sides, then file smooth to allow entrance into the second antenna section.

This repair will last as long as a new assembly.—*Henry Josephs*

RCA 800 SERIES COLOR SET

Our man brought the set to the shop. Its focus was shot and there was nothing wrong with the focus control. The screen also showed some signs of poor horizontal linearity.



WE BUY TECHNOTES

RADIO-ELECTRONICS wants Industrial Technotes. These should cover equipment (including closed-circuit television) actually used in industrial work, or technotes on counters, controls and other apparatus whose uses are largely industrial. Unillustrated Technotes pay $5; circuit diagrams raise the price to $9 and acceptable photos are worth $7 each. Send your technotes from industry to Technotes Editor, RADIO-ELECTRONICS, 154 W. 14th St., New York 11, N. Y.

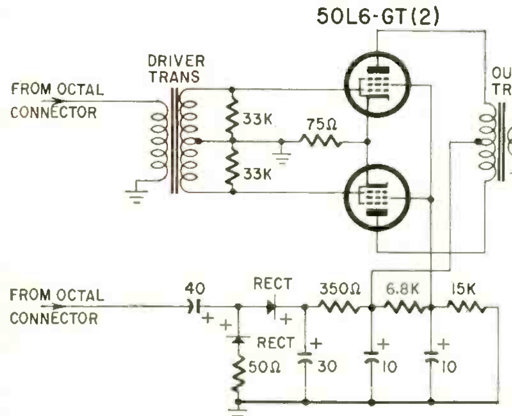
After much careful troubleshooting, we found that resistor R125 in the horizontal section of the yoke was slightly charred, indicating leakage through capacitor C118. We replaced the capacitor, a 560-$\mu\mu$f 2-kv unit, and the resistor to restore normal operation.—*C. S. Lawrence*

PHILCO 9L35

There was only about 5 inches of width in the center of the screen with very little brightness. Voltage and waveforms were normal in the horizontal oscillator and output circuit. Transformer and yoke tested OK on yoke tester. Yet the yoke was bad—it would break down and short only under heavy current flow.—*W. G. Eslick*

CRESTWOOD CP-201 TAPE RECORDER

Complaint: Intermittent and noisy sound on playback. The intermittent condition was more noticeable when the recorder was played back using low volume settings, and at times the sound would become very noisy.



Cure: A scope check was made on the power amplifier chassis, and the trouble was isolated to a intermittent connection in the center tap of the driver transformer. Replacing this transformer cured the trouble.—*George P. Oberto*

ZENITH 16C20-U

Poor vertical linearity was the complaint. A defective vertical oscillator–amplifier was the cause. But the way this tube caused the trouble was unusual and interesting and could happen in any circuit of a receiver.

On the bench, the set presented a picture stretched so much out of proportion that a man's head resembled a cucumber, legs were stovepipes. All individuals were flat-topped. No adjustment of the vertical height or linearity controls would compensate for the condition. Even the customer's face was long. The 6CY7, vertical tube, checked good in the tube checker. All voltage and resistance checks proved normal. Apparently, this dog had a new trick for the audience to figure out.

A casual, lucky glance at the 6CY7 solved the problem. Although the tube had checked perfect in the tester, half of one triode section of filament was not burning. This loss in electrons in the triode section of the tube was enough to ruin its operating efficiency (under load), but not enough to show in the checker. A new tube corrected the trouble. The linearity controls again worked as they should have and the customer's face came back to normal.—*George D. Philpott*

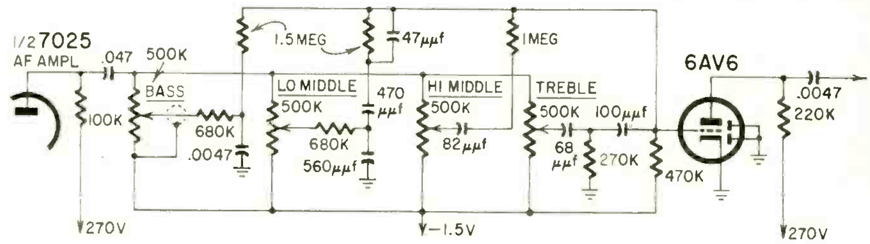
END

NOTEWORTHY CIRCUITS

UNUSUAL TONE CONTROL

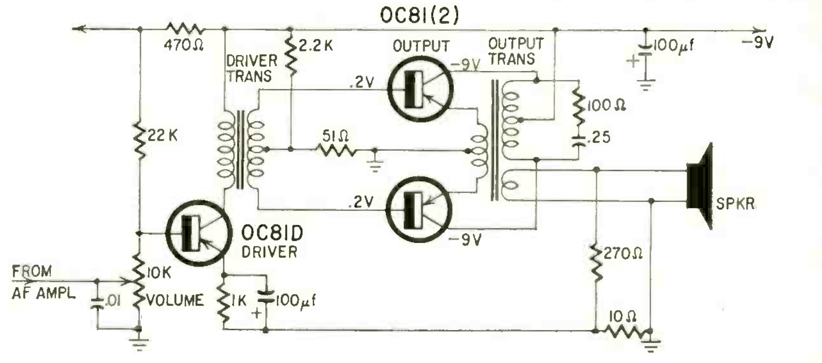
This four-channel tone control or audio equalizer may well be the start of a trend among audio design engineers. This circuit, used in the Blonder-Tongue model A-1 amplifier, breaks the spectrum between 50 and 8,500 cycles into four segments or channels to simplify correcting for deficiencies in recordings and speaker systems and to provide various special sound effects.

The BASS control provides a 6-db boost and 10-db cut at 50 cycles. The LO MIDDLE and HI MIDDLE controls provide a boost of up to 15 db and cuts of 20 db at 300 and 1,600 cycles, respectively. The TREBLE control has a maximum boost of 15 db and cut of 6 db at 8.5 kc. Greater boost and cut are obtained by operating more than one control. With the controls in the flat position response is flat within ±½ db from 30 cycles to 15 kc.



TRANSISTOR OUTPUT CIRCUIT

The diagram shows the rather unusual output stage in the Roberts (British) RT7 two-band AM transistor portable. The driver is transformer-coupled to the bases of the output transistors. The output stage is operated as a split-load class-B amplifier. A part of the load is in the emitter circuits and the larger portion of the load is in the collector circuits. This split-load arrangement requires more drive than the conventional collector-loaded push-pull amplifier but greatly reduces crossover distortion, which tends to increase as battery voltage drops off. Negative feedback voltage is tapped off a voltage divider across the voice coil and fed to the driver's emitter.

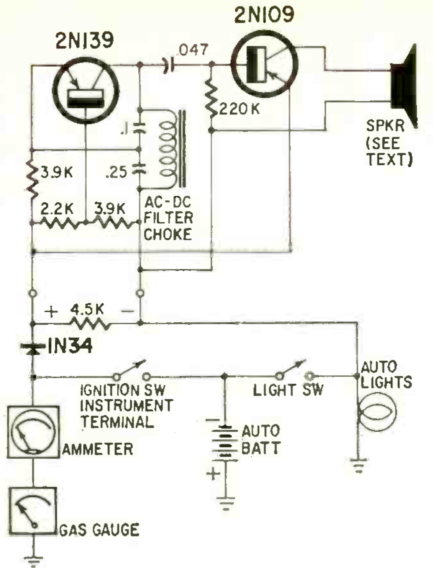


HEADLIGHT REMINDER

Installed on your car, this simple electronic circuit sounds an alarm when the ignition switch is turned off and the light switch is on. The reminder circuit consists of a 2N139 Colpitts oscillator and 2N109 af amplifier.

Note the connections between the reminder and the car's instrument panel. One terminal of the ignition switch goes to the gauges. With the lights on and the ignition off, current flows through the low-resistance gauges, the 1N34 and 4,500-ohm resistor. The drop across the resistor (about 6 volts) operates the oscillator and amplifier. When the ignition switch is turned on, the resistor and diode are shorted by the two closed switches and the reminder circuit is inoperative. The diode prevents reverse current from flowing through the resistor when the ignition is on and the lights are off.

The speaker is a reproducer or driver unit from an antique horn speaker. Many antique and second-hand shops have a few of these around. If you can't



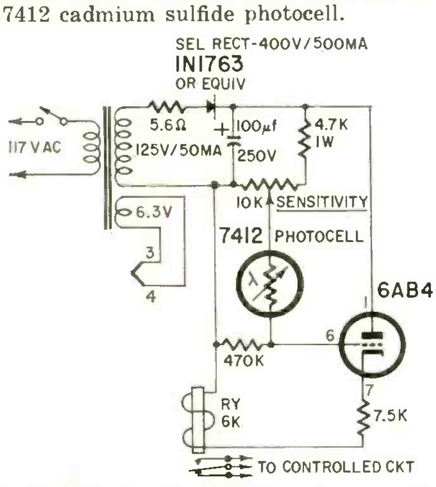
find one, use a large earphone. You can use a standard PM speaker if you build more gain into the amplifier by using transformer coupling between oscillator and amplifier and use an output transformer to match the speaker.

When I installed the reminder on my car, I tapped on to the hot lead to the tail lights for the negative or collector lead and tapped the gauge terminal for the positive lead.—*Robert E. Flanagan*

(Why not use one winding of the interstage transformer in place of the oscillator inductor? The other winding could then be connected to the amplifier's base. Juggle values of the two oscillator tuning capacitors for desired tone and reliable oscillation.—*Editor*)

PHOTOELECTRIC RELAY

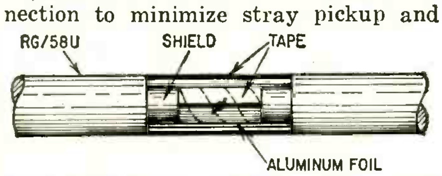
Photoelectric relays are used in control circuits, counting devices, monitors, alarms and many other applications in the home, shop and industry. The diagram shows the circuit of a photorelay taken from the RCA data sheet on the 7412 cadmium sulfide photocell.



In this circuit, the relay is normally energized when light strikes the photocell. The relay drops out when the light beam is interrupted or when the light level drops below a level set by the potentiometer. The relay may be a Sigma 11F-6000G or equivalent. (The frame of the 11F series relay is at armature potential and must be insulated from the common chassis for safety). END

SPLICING COAX CABLE

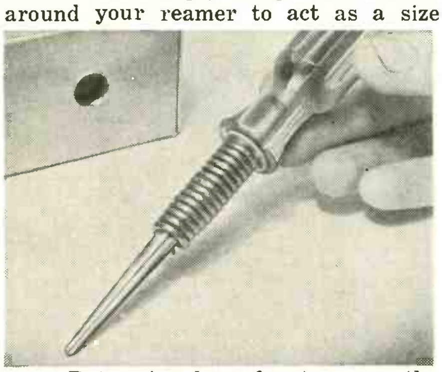
When splicing RG-58/U or similar coax, use aluminum foil as a shield connection to minimize stray pickup and



keep impedances constant. Solder and insulate the "hot" lead in the usual way and use a short length of bare wire to connect the shield ends. Over this, wrap several layers of the aluminum foil as shown in the drawing and cover with tape. The resulting joint is neat and electrically similar to the coax.—*William H. O'Brien*

SOLDER MAKES REAMER STOP

To avoid the possibility of reaming a hole too large, wrap wire solder around your reamer to act as a size



stop. Determine how far to wrap the reamer by guess or by measuring the diameter with a micrometer.—*Scott Mock*

INSULATE THAT FUSE HOLDER

Recently, while building a compact amplifier I was forced to use a clip type open fuse holder. This caused a shock hazard which I minimized in the following manner.

Starting with a piece of 5/16-inch

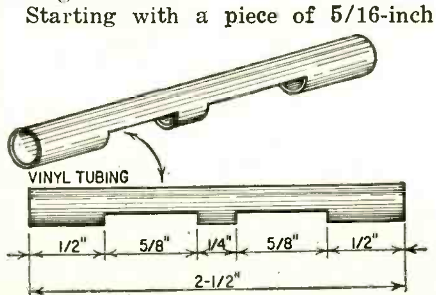


Fig.1

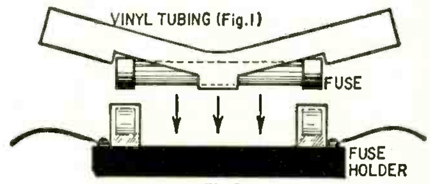


Fig.2

diameter vinyl tubing, cut it to the shape shown in Fig. 1. For easy cutting, squeeze it flat and use a pair of scissors.

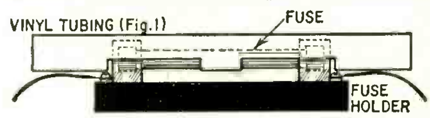


Fig.3

Slip the fuse through the middle band (Fig. 2). Then push the fuse into its holder. Next, fit the slit portions of the tubing over the exposed clips—tug the ends for a snug fit (Fig. 3). Fuse and holder are now fully insulated.—*Alan M. Palmer*

HANDY PARTS HOLDER

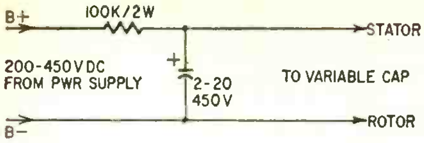
Often a set that needs a special part that must be ordered from the manufacturer comes into the shop. This means that the set will be stored until the part arrives. During this waiting period I find that the knobs and hardware have a tendency to disappear, and much time is wasted trying to find substitutes.

I remedied this situation by stocking my shop with about 10 empty coffee cans. As soon as a set is dismantled, the parts are put into one of these cans. If the set must be stored for a few days, the can is stored right along with it. This has entirely eliminated the loss of parts, and prevents the parts of two or more sets getting mixed.

Any can could just as easily be used, but a coffee can is large enough to get your hand into to pull out parts one at a time. This eliminates dumping the entire contents to find a particular part. —*A. J. Krukowski*

CLEARING VARIABLE-CAPACITOR SHORTS

Radios still use variable capacitors and they still get dirty. At some time we all have applied high voltage from a power transformer secondary to the plates of a variable capacitor to remove dirt and other small shorting or conducting particles. Here's a new and better way to do this job, one that averts the risk of burning out a transformer or blowing a fuse.



Use the dc B-plus supply to charge an electrolytic capacitor through a 100,000-ohm 2-watt resistor. Use the arrangement shown in the diagram. The full charge on the capacitor is available to burn out the short and, if the short remains, the capacitor simply will not charge again. A voltmeter connected across the capacitor acts as an indicator. If the voltage stays at the B-plus value, the variable is OK, but if it drops to zero, you've got a stubborn short which simply won't burn out. Some other correction, such as shims or mechanical realignment of the plates, may be needed. An occasional fluctuation in the reading simply shows that the electrolytic capacitor is doing its job of burning out shorts and then recharging. Don't forget to disconnect any coils across the variable capacitor while doing this cleanup job.—*Rudolf F. Graf*

THIRD HAND

Need a third hand? Mount spring type clothes pins as shown and you can hold and rotate small objects to

the position desired. The base of an old 8-inch electric fan is generally heavy enough to stand upright, but if not fill its base with plaster of Paris or sidewalk cement.—*I. C. Chapel*

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
Practical Electrics	1921
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 September, 1911, *Modern Electrics*

Wireless on Motor Boat, by Richard H. Foster.
Transmitting Condenser, by H. V. Roome.
High Powered Condensers, by Frank C. Perkins.
Ducretet Rotary Spark Gap.
Long Range Potentiometer.
A Novel Condenser, by R. S. True.
Wireless Telegraph and Telephony System, by John B. Brady.
Improvement on Loose-Coupled Tuning Coils, by P. Mertz.

new PATENTS

IMPROVED SPACISTOR

Patent No. 2,958,022

Erick M. Pell, Scotia, N. Y. (Assigned to General Electric Co.)

A spacistor is an n-p junction with an intermediate space charge or intrinsic (I) region. As shown in Fig. 1, it is reverse-biased by a battery. Region I, which is nearly free of charges, generates the full battery drop along it, as shown in Fig. 2.

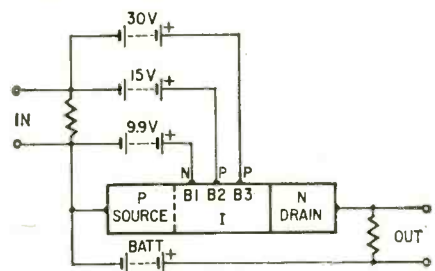


Fig.1

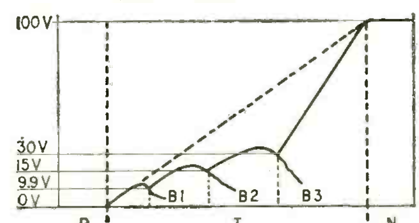


Fig.2

The new spacistor is processed for a very long I region. It has three connections: B1, injector; B2, modulator, and B3, buffer. Each is positively biased with respect to the source electrode, but is *negative* with respect to the semiconductor at the point of contact. This is shown in Fig. 2, where the dotted line represents voltage drop due to BATT. B1 is connected at a point where the semiconductor is more positive than 9.9 volts, for example.

B1, being n-type and more negative than the material surrounding it, emits electrons into the I region, and these are drawn toward the positive drain electrode. B2 is p-type so it is reverse-biased with respect to the semiconductor. The input signal arrives at B2 and modulates the electron flow. B3 is also reverse-biased. It prevents feedback between output and input. B2 and B3 act like a control and a screen grid, respectively.

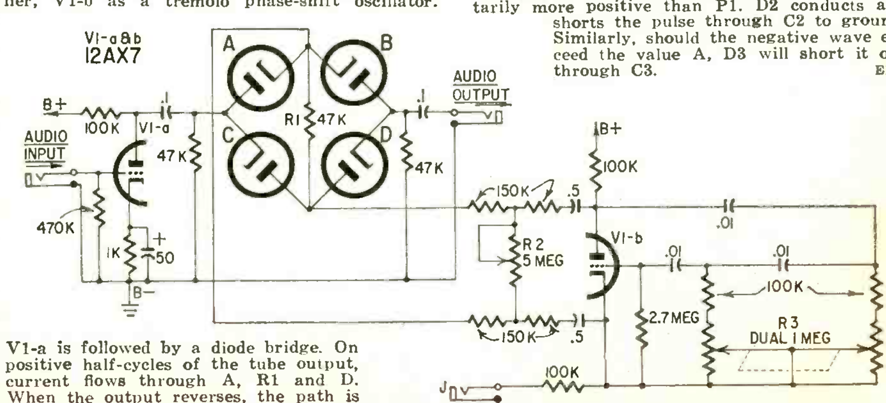
The very long I region makes it easier to make connections to it. Also, it lowers the internal capacitance between source and drain.

TREMOLO

Patent No. 2,967,909

Joseph Rice, 103-26 68th Ave., Queens, N. Y.

Two triodes are used, V1-a as an audio amplifier, V1-b as a tremolo phase-shift oscillator.



V1-a is followed by a diode bridge. On positive half-cycles of the tube output, current flows through A, R1 and D. When the output reverses, the path is through C, R1 and B.

The rectified audio across R1 is modulated at a very low frequency by the output from V1-b. Note the isolating H-pad after V1-b. R2 adjusts the output level from the oscillator, R3 sets its frequency.

The tremolo effect is turned on and off by a switch or key plugged into J. The double triode may be 12AX7.

NOISE LIMITER

Patent No. 2,961,532

Robert J. Rowley, Cedar Rapids, Iowa. (Assigned to Collins Radio Co., Cedar Rapids, Iowa.

This limiter is adjustable for any desired percentage of modulation. For example, Fig. 1 shows a 50% AM signal. After detection, it looks like Fig. 2, the negative half (below 0)

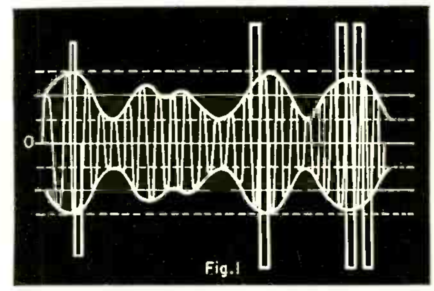


Fig.1

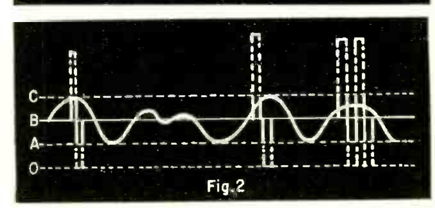


Fig.2

having been wiped out. B is the average carrier level, and A and C are instantaneous audio peaks. This limiter circuit can be set to eliminate any noise pulses having amplitude greater than C or A.

Fig. 3 shows the circuit. The last if stage of a receiver feeds D1 (detector), C1 (rf bypass) and three parallel paths. The center path is tapped by equal resistors R3. Thus the potential at point P2 is proportional to the instantaneous audio wave coming from D1. R1, R2 are chosen to make P1 proportional to the peak C, and P2 proportional to A. Since this makes P1 more positive than P2, and P2 more positive than P3, diodes D2 and D3 do not conduct. Since C2 and C3 are relatively large, the potential at points P1 and P3 cannot follow rapid changes in signal as P2 can.

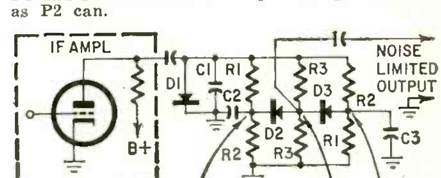


Fig.3

If the instantaneous audio voltage should become greater than C (due to a noise pulse, for example, as shown dotted), P2 becomes momentarily more positive than P1. D2 conducts and shorts the pulse through C2 to ground. Similarly, should the negative wave exceed the value A, D3 will short it out through C3. END

BUSINESS and PEOPLE

Arthur E. Davis (left) was appointed to the new post of executive vice president of Allied Radio Corp., Chicago. He had been vice president, and continues

as treasurer. **Alfred W. Preskill** (right), former vice president for marketing and administration, assumes the new position of vice president-general manager. **Alex Brodsky** was newly named as vice president and general manager of the Mail Order & Stores Div. He was previously vice president-general marketing manager. He has been with Allied for over 30 years. **Robert Markens** now heads the Industrial Div. as general manager. He was formerly controller.

Vernon A. Kamin (left) is now marketing manager, ceramic products, and **Bruce Vinkemulder**, marketing manager, electromechanical products, in an expansion of the marketing organization at Centralab, Div. of Globe-Union, Milwaukee, Wis. Kamin joined Centralab in 1959 and had previously been with RCA and Motorola. Vinkemulder has been with the company for over 6 years and before that with several leading component manufacturers in various marketing capacities.

Sol S. Sparer, executive vice president of Pacotronics Inc., Glendale, N. Y., was elected to the board of directors.

Louis Kahn was appointed vice president in charge of engineering for Astron Corp., East Newark, N. J. He comes to the company from Aerovox, where he held various management and engineering positions.

Neil M. Blair, president of the RF Products Div. of Amphenol-Borg Electronics Corp., Broadview, Ill., has been named president of the recently acquired FXR Div., Woodside, N. Y. **Henry Feldmann**, chairman and president of FXR Inc. before it merged with Amphenol-Borg, will continue as chairman of the division.

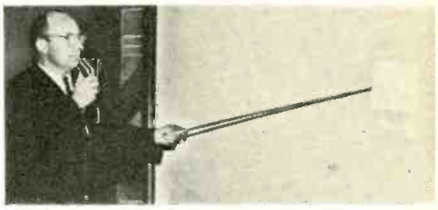
A. C. "Chuck" Elles was named vice president of Regency Electronics Inc., Indianapolis, Ind. He was promoted from general sales manager.

Earl W. Gray joined Hallicrafters Co., Chicago, as product manager for Citizens-band radio equipment. He comes to Hallicrafters from Florsheim Shoe Co., where he was Midwestern sales representative.

CBS Electronics, Danvers, Mass., will concentrate its future efforts on semiconductors, microelectronics and other electronic products, discontinuing its receiving tube operations at Danvers and Newburyport, Mass., according to an announcement by president Clarence H. Hopper. **Raytheon Co.** purchased a portion of the CBS entertainment type receiving tube inventory and is offering sales and service of these products to CBS customers.

Jerrold Electronics Corp., Philadelphia, Pa., presented its Rep of the Year Award to the Heimann Co. of Minneapolis. Walter Goodman, manager of the Jerrold Distributor Sales Div. (right), is shown making the presentation to Jack Heimann.

Sencore Inc., Addison, Ill., is continuing its series of service clinics throughout the nation. Ed Flaxman, vice president–sales, personally conducted the most recent tour through Texas and



Southern California. He is shown here lecturing to a group in Los Angeles.

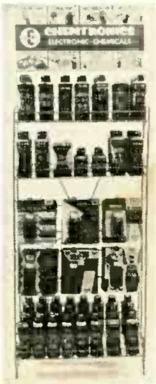
Bogen-Presto, Div. of the Siegler Corp., Paramus, N. J., reported such success with its Champagne Line of Sound exhibition at the Electronic Parts Distributors Show in Chicago in May that it has taken the "show on the road." Plans have been made for shows in key cities throughout the United

States. Director of sales, Mort Sumberg (right), is shown pointing out features of the new intercom line to an interested visitor at the New York showing.

Winegard Co. and **Channel Master Corp.** have agreed on a royalty-bearing patent license based on termination of a pending action in a manner agreeable to both parties.

Audiotex Manufacturing Co., Div. of GC-Textron Electronics, Inc., Rockford,

Ill., is packaging its tape recorder and phonograph accessories on blister card displays.



Chemtronics, Inc., Brooklyn, N. Y., is providing distributors with a display rack for its line of electronic chemicals. END

new 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.

CITIZENS-BAND novice will find much to instruct him in *Radio Communications for Everyone*. Booklet also suggests proper equipment for industry, farming, emergency and safety work, the professions and beginning amateur and SWL use.—Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y.

PILOT LIGHT AND TRANSISTORIZED NEON INDICATOR LIGHTS are brought up to date in these presentations of recent developments in the field, *Digest of Pilot Lights, Form L-161C*, and *Transistorized Neon Indicator Lights, Form STI-166A*. Pilot-light digest, 24 pages, 8½ x 11 in, includes life-size illustrations, catalog numbers, lamp data, physical and electrical characteristics, charts, etc. Bulletin on transistorized neon indicator lights, 2 pages, 8½ x 11 in, gives life-size illustrations, specifications, schematic and charts and ordering information.—Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.

SOUND OF MUSIC describes and illustrates award-winning controlled background music system that includes playing equipment, speakers and tape cartridge music library. Built-in loudspeaker available.—Musi-Pak Corp., Dept. M3, 103 E. Hawthorne Ave., Valley Stream, N. Y.

SOUND-SYSTEM ENCLOSURES *Catalog SC-61* replaces manufacturer's *Catalog CS-59*. Large illustrations with one baffle of each size shown so that actual size comparison can be made more easily. Shows corner, thinline wall and space-saver hi-fi baffles.—Argos Products Co., Genoa, Ill.

BI-PHONIC COUPLERS, the self-baffled *440* and 3⅝-in thin *Modulaire*, described and illustrated in 4-page booklet. Complete specifications and demonstrates decorating possibilities.—Advanced Acoustics Corp., 391 Lakeside Ave., Orange, N. J.

STEREO FM BROADCASTING is explored thoroughly in pocket-size booklet *Factual Answers to Your Questions about Stereo FM Broadcasting*. Text prefaced by brief history of how stereophonic FM broadcasting came into being, consists of 27 questions and answers on the subject.—**Zenith Radio Corp.,** 6001 W. Dickens Ave., Chicago 39, Ill.

SPACE FLIGHT is a compilation of references to authoritative works on this subject written on a level between popularized scientific articles and highly technical textbooks. The 12-page booklet outlines courses, dictionaries and guides to further reading.—**Bell Telephone Laboratories Inc.,** 463 West St., New York 14, N. Y.

TRANSISTOR REFERENCE CHART shows expanded transistor line of high-frequency communications, control and switching transistors, high-speed switches and military types. Organized by categories of application with a summary of electronic characteristics. Dimensional outlines and mechanical specifications are shown actual size.—**Philco Corp.,** Lansdale Div., Church Rd., Lansdale, Pa.

TRANSISTORIZED CAR RADIOS acquaints the car-radio service technician with time and money-saving servicing methods based on practical experience with transistor receivers. An introductory survey is followed by discussion of transistor theory, transistor receiver servicing methods and circuits of manufacturer's 1961 all-transistor car radios. Many figures and photos.—**Motorola Consumer Products Inc.,** 9401 W. Grand Ave., Franklin Pk., Ill., 50¢

CITIZENS BAND RADIO, Littlefone, Model CB-3, and its applications in home, office, auto, boating, farms and industry are presented in a 4-page illustrated brochure. Technical specifications.—**Hallicrafters Co,** 4401 W. Fifth Ave., Chicago 24, Ill.

HARNESSES, ADAPTERS, SOCKETS for servicing all types of TV receivers using any 110° tube illustrated in vivid white-on-black diagrams.—**Eby Sales Co. of N. Y.,** 148-05 Archer Ave., Jamaica 35, N. Y.

MAST-MOUNTED TV/FM BOOSTER, *model AB-4,* is described and illustrated in a 2-page leaflet. Technical specifications and features are included.—**Blonder-Tongue Labs Inc.,** 9 Alling St., Newark, N. J. END

CORRECTION

There were a few errors in J. H. Thomas' article "CB Transceiver from Car Radio" in the July 1961 issue.

In Fig. 3-b, the parts layout on the printed board, R4 and R5 are transposed, R9 is R8, R10 is R9, R11 is R10 and R12 is R11.

In Fig. 3-a, the printed side of the board, a few additional holes are needed: a hole for R9 in the foil connected to pin 2 of V2, a hole for the other end of R9 in the foil connected to pin 3 of V2, a hole for the ground side of C6 in the foil connected to pin 8 of V2. The grounds for V1 and V2 are interconnected by the shield can of if transformer T2.

A complete corrected printed-circuit board is available from Irving Electronics Co., PO Box 9222, San Antonio, Tex.

new BOOKS

RADIO-TELEVISION and BASIC ELECTRONICS (2nd Edition), by R. L. Oldfield. American Technical Society, 848 E. 58 St., Chicago 37, Ill. 5½ x 8¼ in. 400 pp. $4.95.

Beginners need a clear text and plenty of diagrams. Both will be found here. The book begins with a study of circuits, magnets and tubes. Then it goes on to power supplies, amplifiers and microphones. With this preparation, the author proceeds with a study of FM, AM, hi-fi, TV and transistors. Where simple equations appear, examples are usually provided.

ELEKTRONISCHE MUZIEK-INSTRUMENTEN IN THEORIE EN PRAKTIJK (ELECTRONIC MUSICAL INSTRUMENTS IN THEORY AND PRACTICE), by H. Meijer Jr. and W. Heggie. De Muiderkring, N.V., Bussum, The Netherlands. 5½ x 8½ in. 168 pp. Florins 7.50.

BANDRECORDING-GELUID EN MAGNETISME (TAPE RECORDING—SOUND AND MAGNETISM), by A. van Maaren. De Muiderkring, N.V., Bussum, The Netherlands. 5½ x 8½ in. 112 pp. Florins 5.50.

Electronic Musical Instruments is a comprehensive manual on the construction and theory of do-it-yourself electronic organs. It contains a wealth of information on mechanical detail not usually found in electronic organ books. Written in Dutch, the manual contains many clear illustrations of mechanical constructions which are often a real stumbling block to the home construction of an electronic organ. The volume also contains instructions on troubleshooting and a chapter on how to play the particular organ which provides the central theme of the book.

Tape Recording, a relatively brief introduction to the principles and theory of magnetic recording is quite comprehensive in its theoretical discussions of the recording, reproduction and erasure processes used in tape recording. Written in Dutch.—*TJ*

ELECTRONIC ORGAN HANDBOOK, by H. Emerson Anderson. Howard W. Sams & Co. Inc., 1720 E. 38 St., Indianapolis, Ind. 5½ x 8½ in. 270 pp. $4.95.

This book explains the operation of eight manufactured organs. It details check-out and maintenance procedures in language that a radio technician can understand.

HOW TO GET THE MOST OUT OF TAPE RECORDING (Stereo Edition), by Lee Sheridan. Robins Industries Corp., Flushing 54, N. Y. 6 x 9 in. 128 pp. $1.

This book shows how to install and operate, how to edit and splice. It suggests ways to use the recorder to make money and save time. Interesting stories tell of tape used for business and pleasure by such personalities as Emory Cook, Marvin Miller and Russ Molloy.

Photos are a big attraction. They show typical equipment and accessories, tape technicians at work, unusual applications for recorders. Listings include suggested tape recordings and tape-corresponding clubs throughout the world.—*IQ*

MARINE ELECTRONICS HANDBOOK (1st Edition), by Leo G. Sands. Howard W. Sams & Co. Inc., 1720 E. 38 St., Indianapolis, Ind. 5½ x 8½ in. 232 pp. $3.95.

Written for the boat owner and service technician, this book discusses equipment used for communications, direction finding, depth sounding, steering and radio location. Typical equipment is illustrated with photos and schematics. Methods and instruments for transmitter testing and receiver alignment are explained. Mf, vhf and uhf are included.

The book contains maritime channel lists, weather broadcast schedules and radio beacon charts.—*IQ*

MAGIC OF ELECTRONICS, by Edward J. Bukstein. Frederick Ungar Publishing Co., 131 E. 23 St., New York 10, N. Y. 6 x 9 in. 256 pp. $1.75.

This is an illustrated, brief account of modern electronic devices and their application. It is written for nontechnical readers to help them appreciate the wonders of modern science. Each page is devoted to a different topic. They include tubes, television, phototube, lie detector, industrial controls, and many others. Each device is illustrated by a photo or a simple diagram.

VACUUM TUBE CHARACTERISTICS, edited by Alexander Schure. John F. Rider Publisher Inc., 116 W. 14 St., New York 11, N. Y. 5½ x 8½ in. 89 pp. $1.80.

Tubes continue to be important components in electronic circuits. This book discusses them from a theoretical viewpoint and shows how to use them to best advantage. It discusses diodes, triodes, multigrid tubes and special types. Diagrams, formulas and examples are included to explain load lines, transconductance, power output and distortion measurements. Simple algebra is sufficient. END

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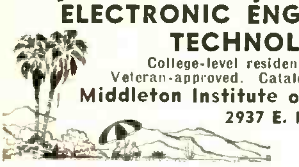

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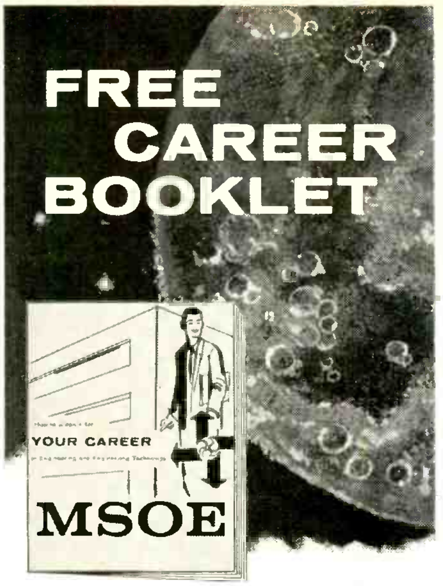

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ADVERTISING INDEX

Radio-Electronics does not assume responsibility for any errors appearing in the index below.

September 1961

SCHOOL DIRECTORY PAGE 127

Printed in USA

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1R5	.62	6BF6	.44	12AQ5	.52
1S5	.51	6BG6	1.66	12AT6	.43
1T4	.58	6BH6	.65	12AT7	.76
1U4	.57	6BH8	.87	12AU6	.50
1U5	.50	6BJ6	.62	12AU7	.61
1X2	.82	6BK7	.85	12AV5	.97
2AF4	.96	6BL7	1.00	12AV6	.41
2CY5	.71	6BN4	.57	12AV7	.75
2EA5	.70	6BN6	.74	12AX4	.67
3AL5	.42	6BQ5	.65	12AX7	.63
3AU6	.51	6BQ6GT	1.05	12AZ7	.86
3AV6	.41	6BQ7	1.00	12B4	.63
3BA6	.51	6BR8	.78	12BA6	.50
3BC5	.54	6BU8	.70	12BD6	.50
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3BN6	.76	6BZ6	.55	12BF6	.44
3BU8	.78	6BZ7	1.01	12BH7	.77
3BY6	.55	6C4	.43	12BL6	.56
3BZ6	.55	6CB6	.55	12BQ6	1.06
3CB6	.54	6CD6	1.42	12BY7	.77
3CF6	.60	6CF6	.64	12BZ7	.75
3CS6	.52	6CG7	.61	12C5	.56
3DG4	.85	6CG8	.77	12CN5	.56
3DK6	.60	6CM7	.66	12CR6	.54
3DT6	.50	6CN7	.65	12CU5	.58
3S4	.61	6CR6	.51	12CU6	1.06
3V4	.58	6CS6	.57	12DE8	.75
4BC8	.96	6CU5	.58	12DL8	.85
4BQ7	1.01	6CU6	1.08	12DQ6	1.04
4BS8	.98	6CY5	.71	12DS7	.79
4BZ6	.58	6CY7	.71	12DW8	.89
4BZ7	.96	6DA4	.68	12DZ6	.56
4CB6	.56	6DB5	.69	12ED5	.62
4CS6	.61	6DE6	.58	12EL6	.50
4CY5	.71	6DG6	.59	12EG6	.54
4DE6	.62	6DQ6	1.10	12EZ6	.53
4DT6	.55	6DT5	.76	12F8	.66
5AM8	.79	6DT6	.53	12FM6	.45
5AN8	.86	6DT8	.94	12K5	.65
5AQ5	.52	6EA8	.79	12SK7GT	.74
5AT8	.80	6EM7	.91	12SN7	.67
5BK7A	.82	6EU8	.79	12SQ7M	.78
5BQ7	.97	6GH8	.79	12U7	.62
5BR8	.79	6H6GT	.58	12V6GT	.53
5CG8	.76			12W6	.69
5CL8	.76	6J5GT	.51	12X4	.38
5EA8	.80	6J6	.67	17AX4	.67
5EU8	.80	6K6	.63	17BQ6	1.09
5J6	.68	6S4	.51	17C5	.58
5T8	.81	6SA7GT	.76	17CA5	.62
5U4	.60	6SK7	.74	17D4	.69
5U8	.81	6SL7	.80	17DQ6	1.06
5V6	.56	6SN7	.65	17L6	.58
5X8	.78	6SQ7	.73	17W6	.70
5Y3	.46	6T4	.99	19AU4	.83
6AB4	.46	6U8	.83	19BG6	1.39
6AC7	.96	6V6GT	.54	19T8	.80
6AF3	.73	6W4	.60	21EX6	1.49
6AF4	.97	6W6	.71	25BQ6	1.11
6AG5	.68	6X4	.39	25C5	.53
6AH6	.99	6X5GT	.53	25CA5	.59
6AK5	.95	6X8	.80	25CD6	1.44
6AL5	.47	7AU7	.61	25CU6	1.11
6AM8	.78	7A8	.68	25DN6	1.42
6AQ5	.53	7B6	.69	25EH5	.55
6AR5	.55	7Y4	.69	25L6	.57
6AS5	.60	8AU8	.83	25W4	.68
6AT6	.43	8AW8	.93	25Z6	.66
6AT8	.79	8BQ5	.60	35C5	.51
6AU4	.82	8CG7	.62	35L6	.57
6AU6	.52	8CX8	.93	35W4	.42
6AU7	.61	8EB8	.94	35Z5GT	.60
6AU8	.87	11CY7	.75	50B5	.60
6AV6	.41	12A4	.60	50C5	.53
6AW8	.90	12AB5	.55	50DC4	.37
6AX4	.66	12AC6	.49	50EH5	.55
6AX7	.64	12AD6	.57	50L6	.61
				117Z3	.61

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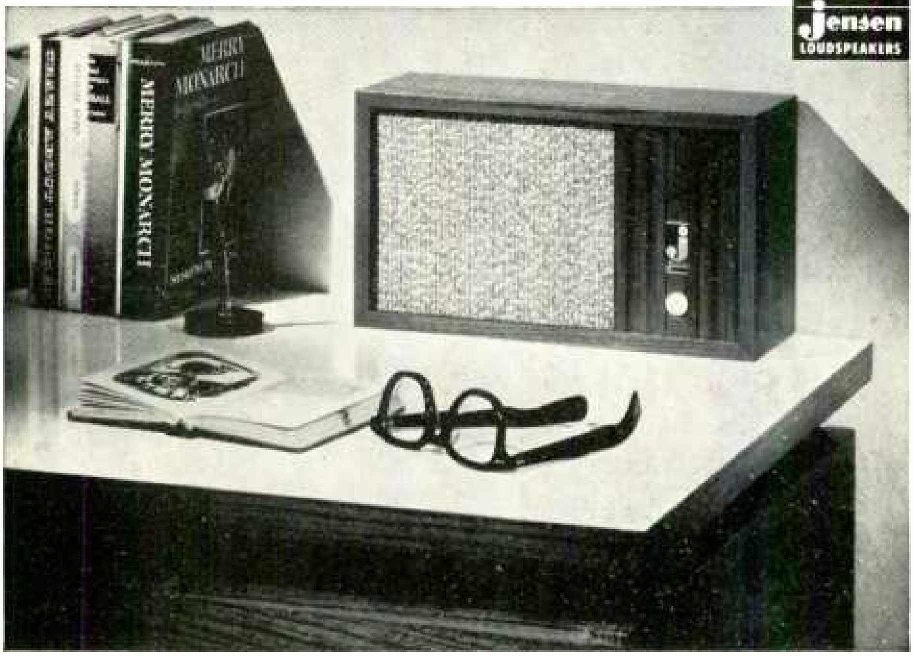
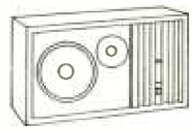
So Compact... X-10



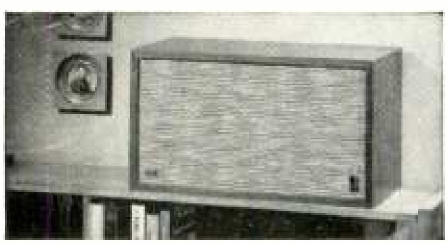
A startling achievement—an ultra-compact (7¼" H, 13" W, 4⅝" D) 2-speaker system capable of sound you'd expect from a much larger unit. Volume control on front. Perfect for FM Multiplex, very low cost stereo, other-room extensions.

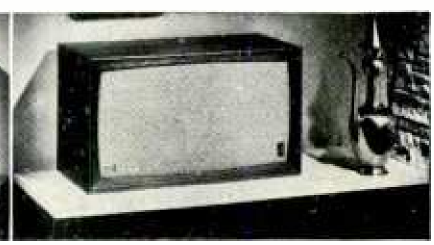


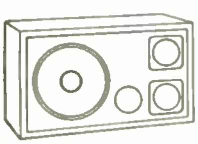
X-10 2-speaker 2-way system for use with amplifier having 4, 8, or 16 ohm output. Power rating 6 watts. Adequate room sound with 1 watt to speaker.
In Oiled Walnut..............**$29.75**

So Big in Sound... TF-2 TF-3

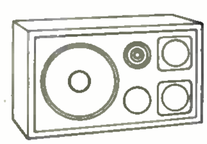
Strikingly beautiful compact bookshelf systems—perfect for every stereo or mono hi-fi need. Recent "blindfold" tests by audio experts proved a preference for the TF-3 *and* TF-2 over "rated" systems costing much more. Make your own careful comparison. You will be delighted with such big sound in small space.







TF-2 3-speaker 2-way system. Full size Flexair* woofer for distortion-free bass response, plus two special direct radiator tweeters giving extended smooth highs. 13½" H, 23¾" W, 11⅜" D.
In Oiled Walnut........................**$79.50**
Unfinished Hardwood..................**$64.50**



TF-3 4-speaker 3-way system. Covers full frequency range with Flexair* woofer in Bass-Superflex* enclosure, two coloration-free midrange units, and the sensational Sono-Dome* Ultra-Tweeter. 13½" H, 23¾" W, 11⅜" D.
In Oiled Walnut..**$99.50**
Decorator Styling.......................................**$109.50**
Unfinished Hardwood.....................................**$79.50**

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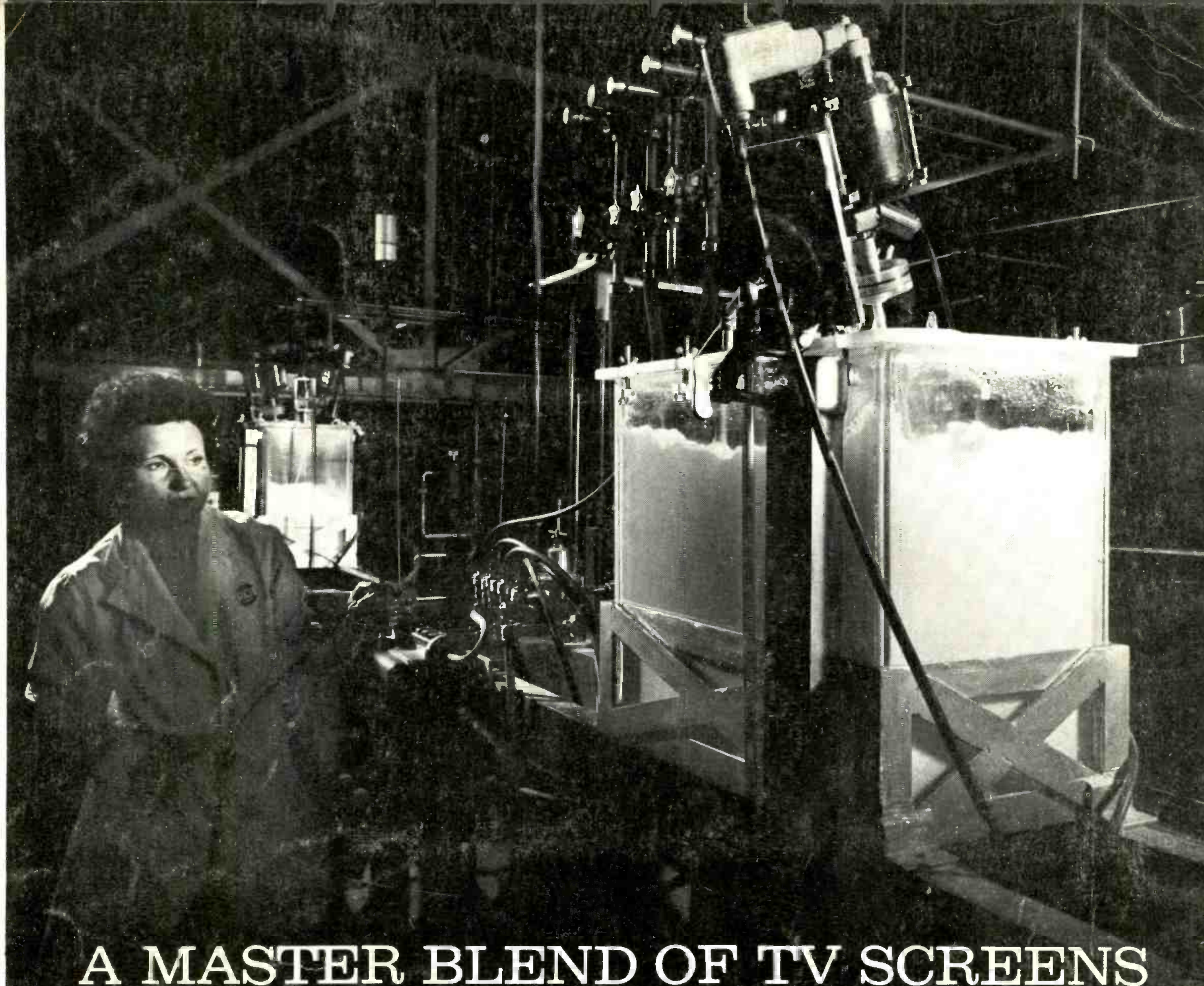
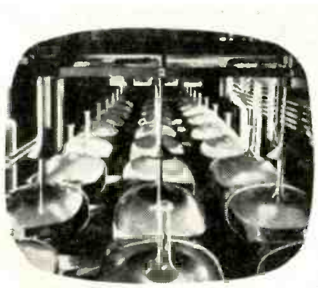


RCA's Precise Control of Phosphors Assures Finest Picture Quality

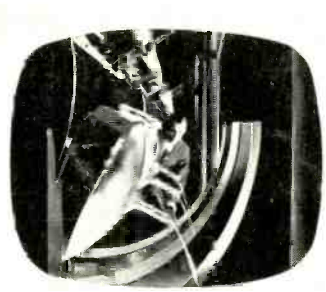
Here RCA Silverama Picture Tube screens have their beginning. Phosphor in a solution of demineralized water (impurity level: less than 1 part per million!) is continuously agitated by electric blenders to maintain uniform suspension. When mixing is complete, solution is sprayed into Silverama's glass envelope which has been scrubbed and rinsed until it is chemically clean. Then with tube on slow-moving, vibration free settling belts (below), phosphor settles evenly over the entire faceplate to provide the smooth, grain-free screen for which Silverama is famous.

This same painstaking care goes into every part of RCA Silverama picture tubes. It is your assurance that every Silverama is the finest replacement picture tube modern science and technology can produce. It contains a precision electron gun—the finest parts and materials, plus a thoroughly clean and inspected reused envelope. Such built-in quality means a better picture in your customers' sets—and therefore, more business, fewer call-backs and valuable word-of-mouth advertising for you. See your Authorized RCA Distributor this week.

129
123
124
101
98



Settling belt moves at less than 10 inches per minute to give ample time for gradual settling and smooth adherence of phosphor to faceplate.



When settling is complete, excess liquid is poured slowly and gently from neck of envelope to avoid disturbing smooth phosphor coating.

RCA ELECTRON TUBE DIVISION, HARRISON, N. J.

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