Solar power & basic IC projects

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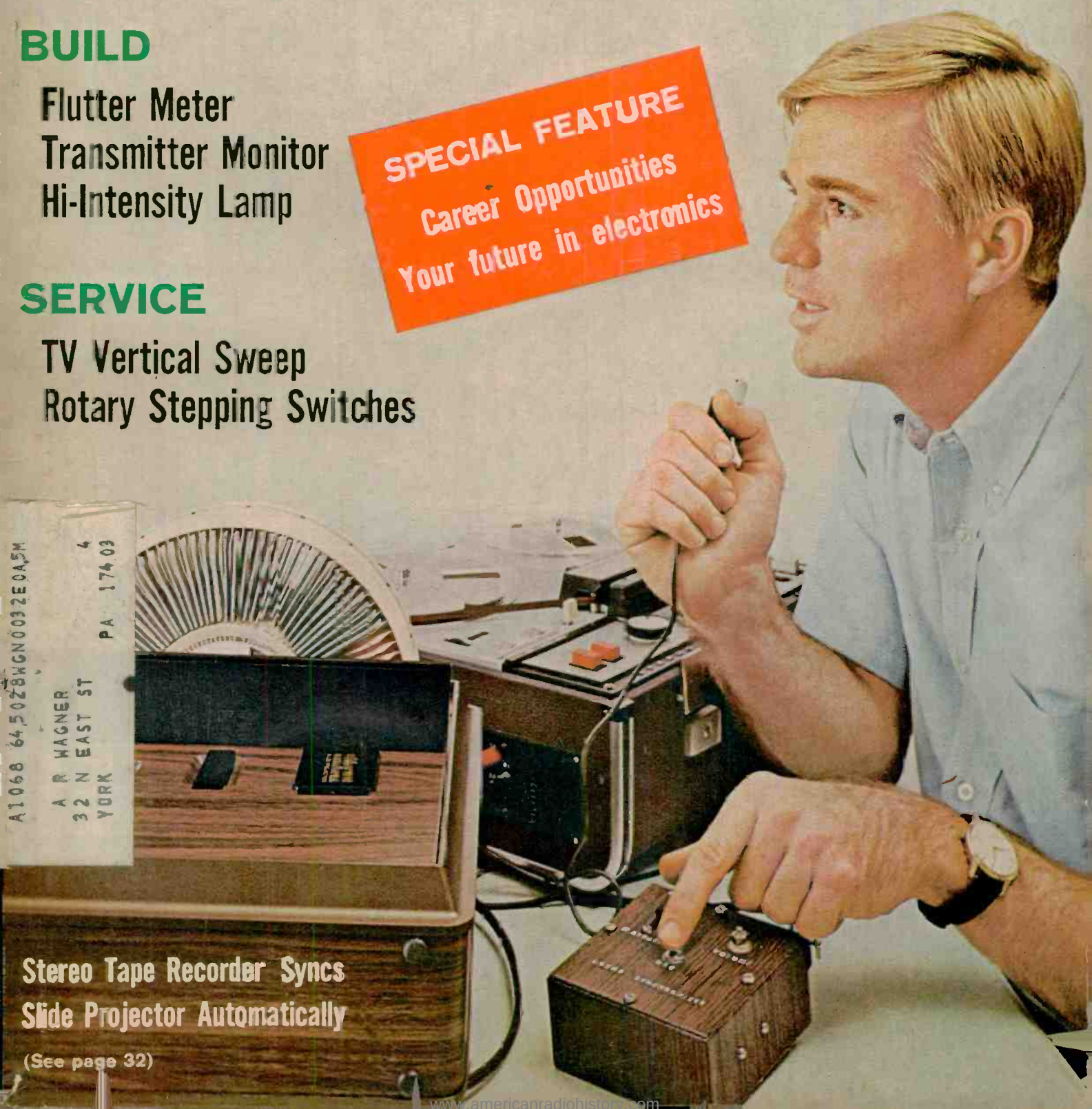

Stereo Tape Recorder Syncs
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(See page 32)

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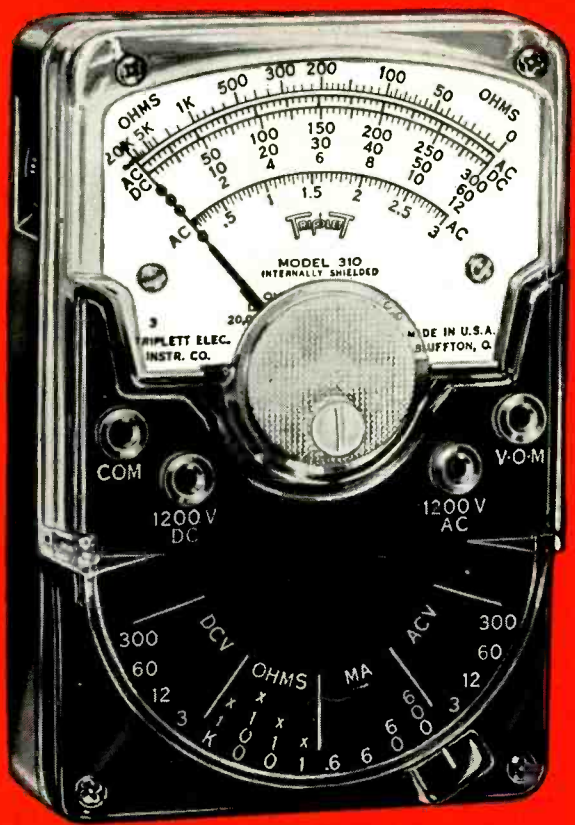

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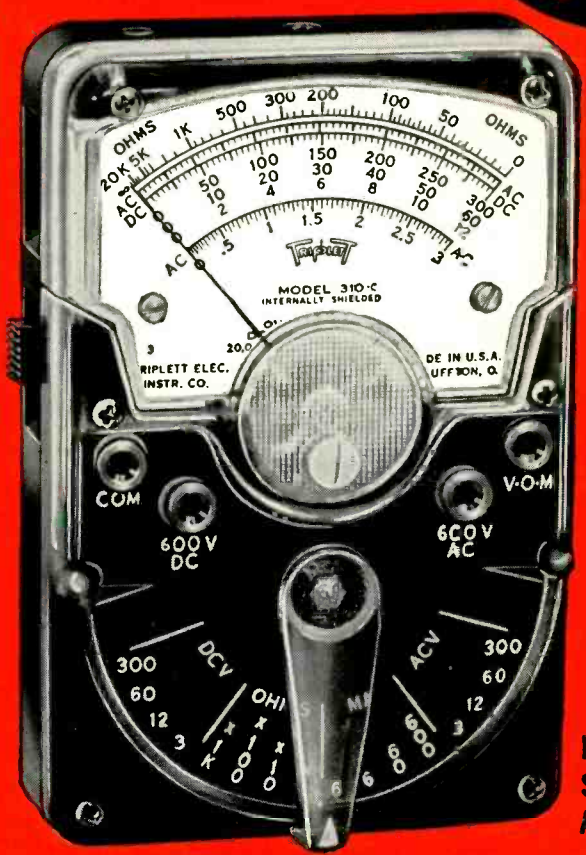

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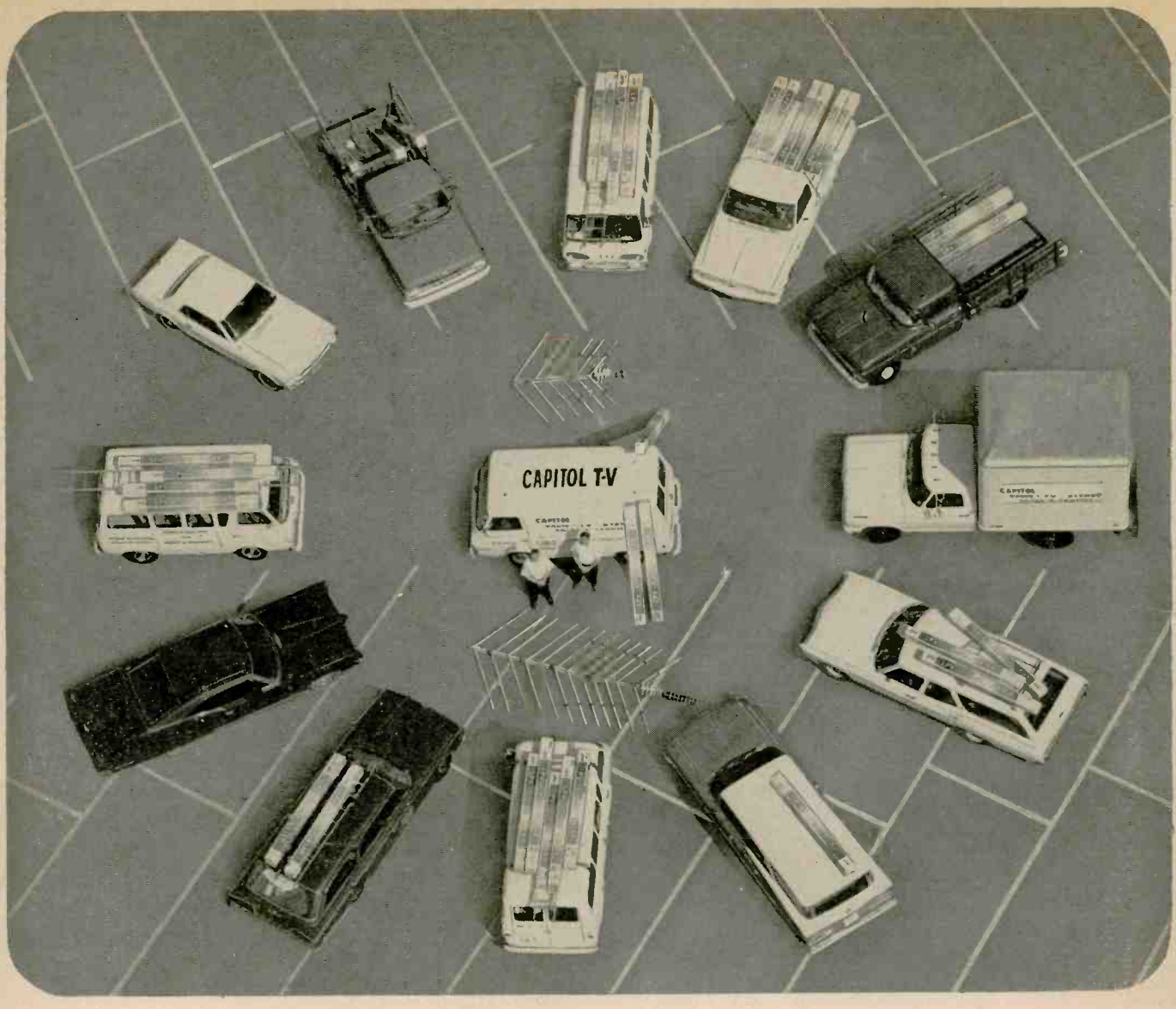

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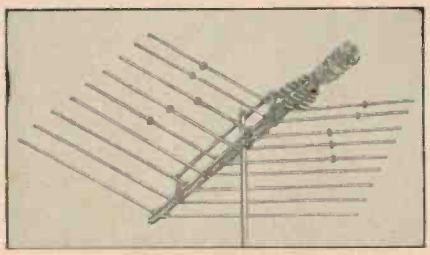
George Comer and Bob Garrison know from experience—like other professionals



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Radio-Electronics

December 1967 VOL. XXXVIII No. 12
Over 55 Years of Electronics Publishing

p 38–BETTER JOBS AHEAD

RADIO-ELECTRONICS, DECEMBER 1967, Volume XXXVIII, No. 12, Published monthly by Gernsback Publications, Inc., at Ferry St., Concord, N. H. 03302

Editorial, Advertising, and Executive offices: 154 West 14th Street, New York, N. Y. 10011. **Circulation Office, Boulder, Colo. 80302.**

Second-class postage paid at Concord, N. H. Printed in U.S.A. One-year subscription rate: U. S. and possessions, Canada, $5. Pan-American countries, $6. Other countries, $6.50. Single copies: 60c.

POSTMASTERS: Notices of undelivered copies (Form 3579) to Boulder, Colo. 80302.

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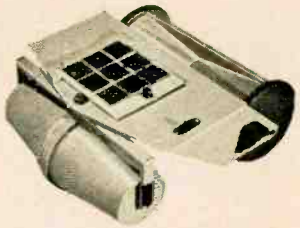
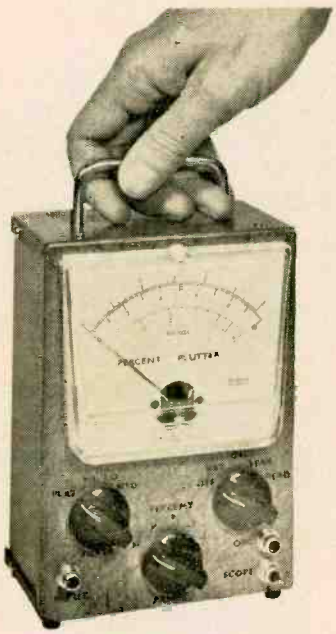


p 34–IT RUNS ON SUNLIGHT

CONSTRUCTION PROJECTS



p 52–FLUTTER METER

SERVICING

GENERAL ELECTRONICS

THE DEPARTMENTS

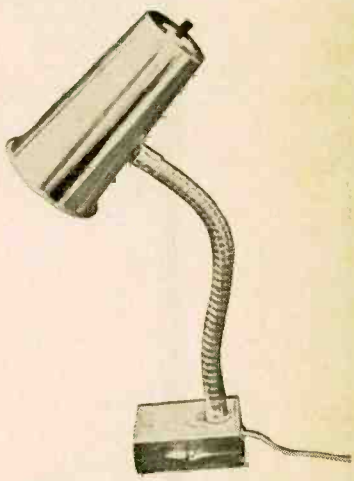
p 56–XMTR MONITOR

p 49–VERTICAL BUGS

COVER FEATURE

p 32–SLIDE TRIGGER ON TAPE

Equipment shown on cover: Sony Superscope Tapecorder TC-200 and Nikkormat Autofocus Slide Projector.



p 59–HI-INTENSITY LAMP

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Radio-Electronics is indexed in *Applied Science & Technology Index* (formerly *Industrial Arts Index*)

NEWS BRIEFS

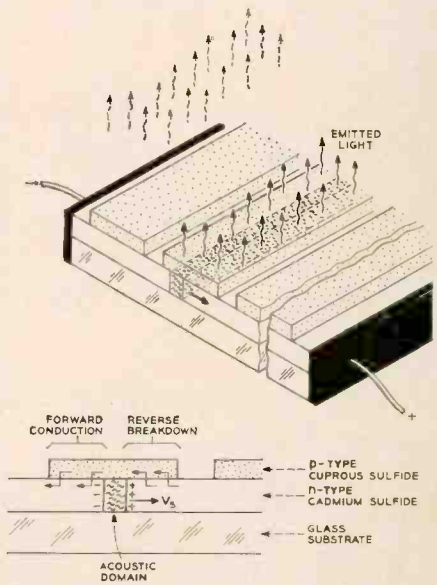
TRANSISTORS—THREE FOR A PENNY?

That's the prediction of a major semiconductor manufacturer. By 1970, according to Philco-Ford's Microelectronics Division, the cost-per-transistor will be a few tenths of a cent. By 1975, cost should be down to a few hundredths of a cent.

The reason is LSI, or large-scale integration. Now being produced is an IC package containing 10 IC's, each of which contains 1,200 transistors fabricated at the same time. The package total is 12,000 transistors in a space only slightly larger than an ordinary IC.

NEW LIGHT GENERATOR AND DETECTOR

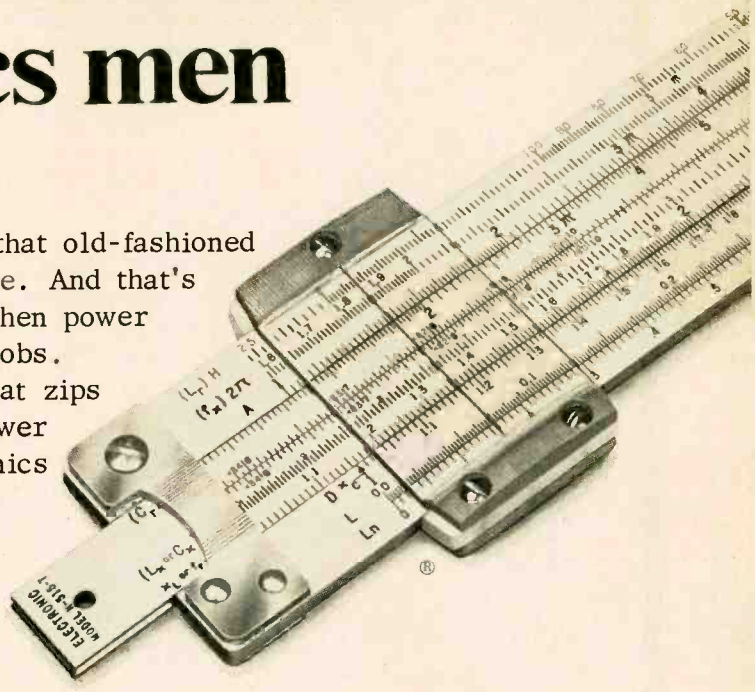
An *acoustic domain*—a concentration of crystal lattice vibrations moving at the speed of sound—has been used by Bell Telephone Laboratories to generate light from an array of pn junctions (see sketch).



When excited by an external electric field, SALS (for Solid-state Acoustoelectric Light Scanner) emits light. Unlike other light-emitting solid-state devices, each SALS pn junction need not be connected in the circuit; the acoustic domains travel down the rows, exciting each junction in turn.

Depending on junction breakdown voltage and applied voltage, SALS may also be used as a light detector. **R-E**

Amazing "power tool" for electronics men



Still working electronics problems with that old-fashioned manual tool, the pencil? You're not alone. And that's kind of a shame in this wonderful age when power tools have speeded up so many manual jobs. Now here is an amazing "power tool" that zips through electronic calculations like a power saw through soft pine. The CIE Electronics Slide Rule. It has a special scale that works reactance problems in seconds. And another scale that does the same for resonance problems. Plus two more scales that tell exactly where the decimal points go.

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Correspondence

INSTRUCTIVE AND ENJOYABLE

Why not more of your articles on "Learn Color the Programed Way". It was very instructive and enjoyable to read. And for Jack Darr, once again, he is very helpful with his articles in "Service Clinic".

ANTHONY POLLIFIONE
Fairview, N.J.

More of these articles coming up, Tony.

RADIATION AND CROWD CONTROL

Do private and government broadcasting stations control crowds and riots by various and varying pulsations? I am interested in city planning and would like to know if the street lighting and ground pulsations of a city affect outer space radiation.

OTIS H. MCLAUGHLIN, JR.
Oklahoma City, Okla.

Don't know about street lighting and ground pulsations, but the broadcast stations use propaganda and advertising to move crowds. However, it's an idea: could try modulating the lights and the earth's tremblings.

TAPE/SLIDE SYNCHRONIZER

In your June, 1967 issue there is an article by Lyman E. Greenlee describing a voice-controlled sound relay. I would like to control a slide projector from a specific sound recorded on a tape. Do you suppose Mr. Greenlee could write another article showing how this could be done?

ROBERT C. GAYHART
Boulder, Colo.

Bob, you must have been doing some mindreading . . . *see page 32.*

INFO ON HYPERBOLIC HORNS WANTED

I am taking your suggestion and writing to tell you what I would like to see in R-E. I liked Novak's article on speakers and enclosures ("Baffle: Speaker-Air Interface," June 1967). How about having him write an arti-

(continued on page 12)

Radio-Electronics

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NEW YORK, N. Y. 10011

HUGO GERNSBACK (1884-1967)
editor-in-chief and founder
M. HARVEY GERNSBACK, *publisher*
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Cover by Harry Schlack

RADIO-ELECTRONICS is published by Gernsback Publications, Inc.
President: M. Harvey Gernsback
Vice President-Secretary: G. Aliquo

ADVERTISING REPRESENTATIVES

EAST
John J. Lamson,
RADIO-ELECTRONICS, 154 West 14th Street, New York, N. Y. 10011, 212-255-7755

MIDWEST/N.&S. Car., Ga., Tenn.
Robert Pattis, the Bill Pattis Co., 4761 West Touhy Ave., Lincolnwood, Ill. 60646, 312-679-1100

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J. E. Publishers Representative Co., 8380 Melrose Ave., Los Angeles, Calif. 90069, 213-653 5841; 420 Market St., San Francisco, Calif. 94111, 415-981-4527

UNITED KINGDOM
Publishing & Distributing Co., Ltd., Mitre House, 177 Regent St., London W.1, England

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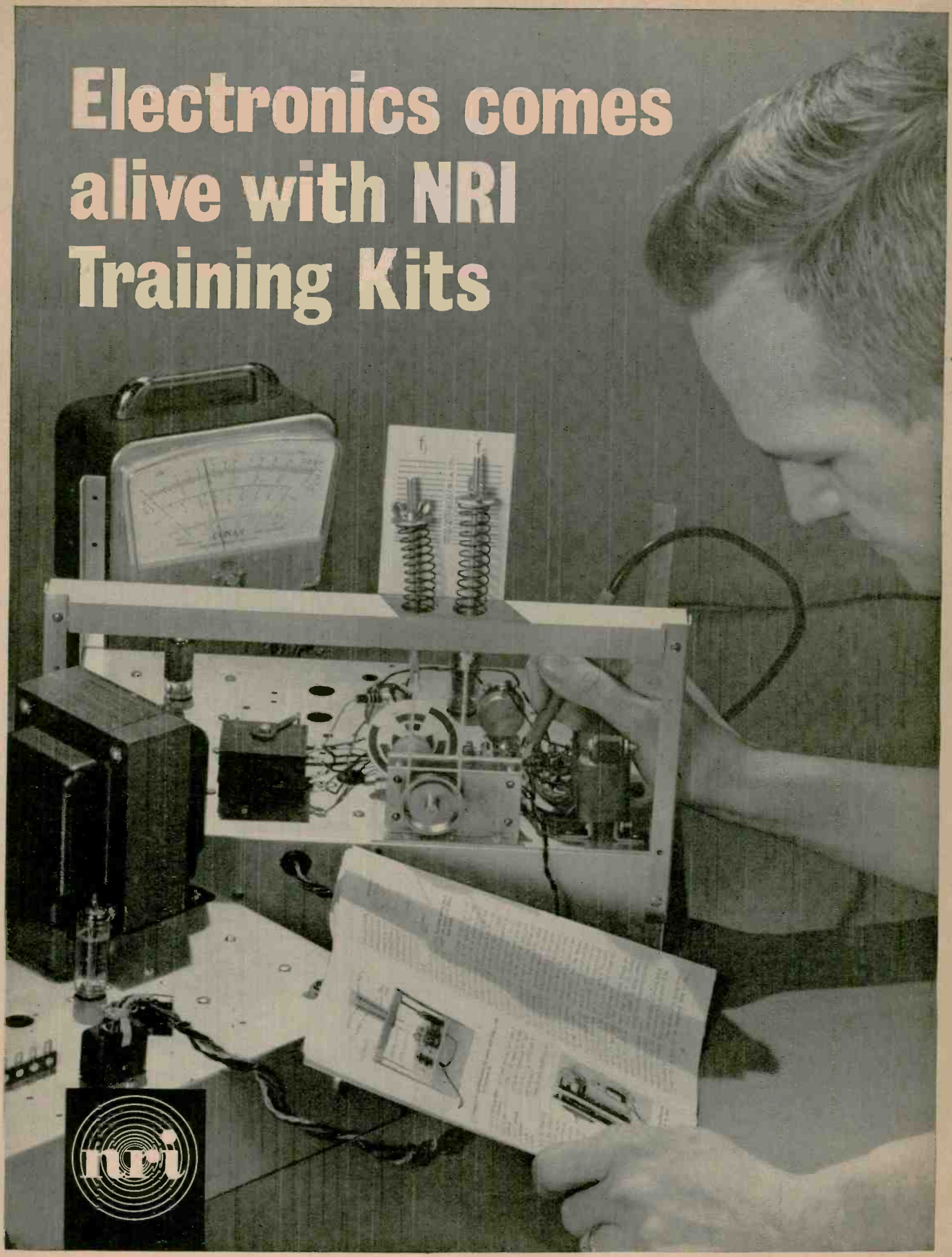

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cle on hyperbolic horns, both bass and high frequency, including nomograms to calculate the necessary parameters since the math is so complicated.

ARTHUR GONTY, M.D.
Menominee, Mich.

SUBMINIATURE INTEGRATED ANTENNA

In News Briefs (July 1967), you mentioned the Subminiature Integrated Antenna developed from the use of high-gain rf transistors, under an Air Force program. Can you provide me with information to build one of these antennas at home?

WILLIAM G. RINGEL
Indianapolis, Ind.

I am very much interested in the Subminiature Integrated Antenna concept, and would like to see more on this subject as it becomes available.

DAVID B. GIBSON
Dade City, Fla.

I would like more detailed information on S.I.A. antennas or possibly a schematic diagram.

ANDREW USIS
Cleveland Heights, Ohio

One article on how to make an S. I. Antenna is scheduled to appear in the February 1968 issue, if we can get the antenna to work.

R-E IN VIETNAM

I want to take this opportunity to thank you for your wonderful Reader's Service. We really appreciate a great magazine like yours over here where it's so hard to get information and literature, so thanks again.

PFC RAYMOND R. SAKSA
3rd Marine Division
Vietnam

REMINDER BETTER ON TAIL LIGHTS

The "Parking Light: Brake Reminder" described in Noteworthy Circuits (April 1967) will work with either parking lights or headlights if the buzzer is connected to the tail lights rather than the parking lights.

WILLIAM R. SPEAKMAN
Reading, Pa.

WANTS FAIRCHILD'S μL914

I would like to build the Audio Tone-Burst Generator (July 1967) described by Dr. De Sa. However, I have not been able to locate the Fair-

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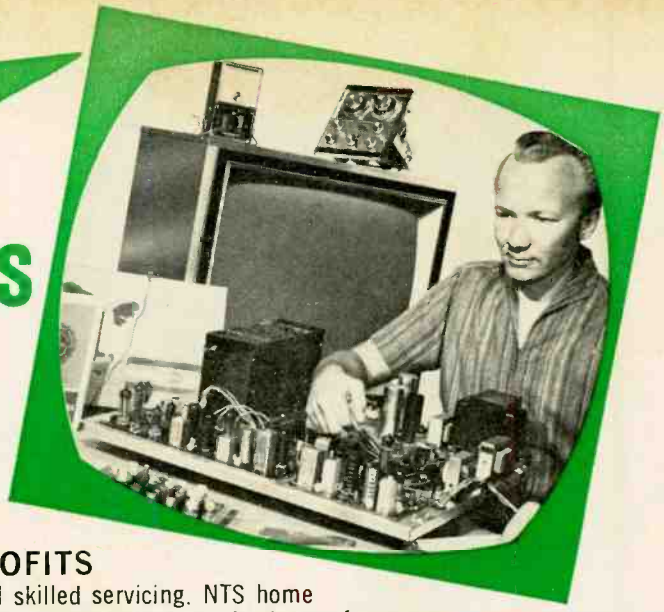

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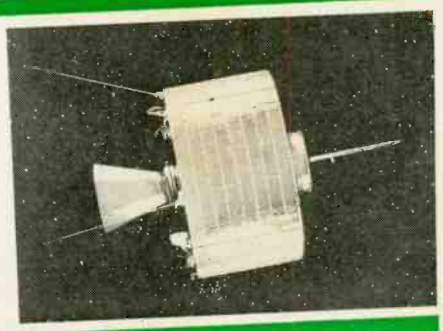

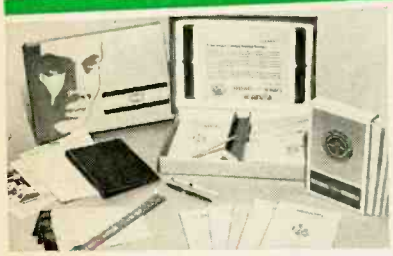

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ACCREDITED SCHOOL — NHSC — NATIONAL HOME STUDY COUNCIL

child μL914 integrated circuit, at the price mentioned (under $1.00). Would you please advise me as to where I may order this part. Incidentally, I enjoy your magazine a great deal, especially the construction articles.

LT. CHARLES D. HAMILTON, USAF
Valdosta, Ga.

Try Powell-Florida, 2049 W. Central Blvd., Orlando, Fla., 32805; Cramer Florida, Inc., 4141 N.E. Sixth Ave., Ft. Lauderdale, Fla., 33308; Hall Mark Electronics, 7233 Lake Ellenor Drive, Orlando, Fla., 32809; Carolina Radio, 221 W. Washington St., Greenville S.C., 29601; or Schweber Electronics, 2109 Clinton Bldg., Huntsville, Ala., 35805. These are 5 stocking distributors nearest you. If you still have a problem, write directly to Fairchild Semiconductor Div., P.O. Box 1058, Mountain View, Calif., 94040. Keep in mind when ordering that many distributors have a minimum charge per order requirement and the less-than $1.00 charge may not be available to you if your order is too small.

MANUFACTURERS AS VILLAINS?

Dear Editor:

I suppose you would not dare to tell about how the manufacturer is the serviceman's worst enemy, since he comes along with different parts just to be different. I mean minor changes not affecting quality. They should not be allowed to introduce new components unless there is at least a 5% increase in quality or performance. The electronic business should be cleaned up.

V. N. EVERT
Moncton, N. B., Canada

If the manufacturer is the serviceman's worst enemy, as you say, he would not make it possible for the serviceman to be in business. At the risk of oversimplification—the formula is simple; no products made and sold, no products to service. Would you believe that a manufacturer does not make a change or add more parts to his inventory than he has to? Each addition or modification costs both time and money and complicates his operation. There is no argument about the need to reduce number of parts to be inventoried, but if things were made simpler, you would have more people competing with you for your servicing business. As it stands, there is a shortage of servicemen. **R-E**

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FINCO MODEL #65-4 Antenna Amplifier $47.95 list VHF-TV Two-transistor Antenna Amplifier for 75 OHM Downlead, and power supply with built-in single or dual 300 ohm outputs. Provides 12 dB gain in the low band and 14 dB gain in the high band.

FINCO MODEL #65-1 Distribution Amplifier $29.95 list 2-tube 4-output VHF-TV or FM Distribution Amplifier for 300 OHM Operation, providing 8 dB gain at each 300 ohm output to feed home or commercial systems.

FINCO MODEL #65-5 Distribution Amplifier $44.95 list VHF-TV 75 OHM Single Outlet Distribution Amplified for deluxe home or commercial use to feed multiple sets through line tap offs or splitters. Delivers 17 dB Low Band and 14 dB High Band.

FINCO MODEL #65-2 Distribution Amplifier $39.95 list 2-tube 4-output VHF-TV or FM Distribution Amplifier for 75 OHM CO-AX Operation, providing 6 dB gain at each 75 ohm output to feed deluxe home or commercial systems.

FINCO MODEL #65-6 Amplifiers $79.95 list. VHF-TV Antenna Mounted two-transistor preamplifier with 75 OHM two-tube Single Output Distribution Post-amplifier up to 30 dB gain for improved reception. Used in home or commercial installations to feed multiple sets.

FINCO MODEL #65-3 Antenna Amplifier $44.95 list New VHF-TV Antenna Amplifier and Power Supply with built in single or dual outputs to improve reception of weak signals in fringe areas. Provides 12 dB gain in the low band and 14 dB gain in the high band.

FINCO MODEL #65-7 FM Signal Amplifier $24.95 list. One-transistor Indoor Behind-the-set FM amplifier with a passive filter input circuit to reject signals outside the FM band which cause interference. Delivers 20 dB Gain.

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Circle 19 on reader's service card

In the Shop . . . With Jack

By JACK DARR

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

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

ONE OF THE WORST PROBLEMS IN A TV is the flyback that runs hot with no apparent cause—no shorts, yoke good, and so on. It just runs hot! The set usually makes a pretty good picture: Voltages are off just enough to be obvious, and the cathode current of the horizontal output amplifier (tube or transistor) will be too high. (The energy's got to come from somewhere, to heat the flyback, and this is it.

All right now—why? Well, let's look at the basic characteristics of all flyback circuits, especially the amplifier itself. It's a pulsed stage. Although the tube or transistor used will have a rating of maybe 15 watts, the actual power dissipated during conduction can run as high as 500 watts!

The reason the stage can get away with this massive overload is simple—it goes on only for a few microseconds. Then, the poor thing cools off for quite a while, comparatively speaking, until the next pulse comes along. You can see that *conduction time* is a key factor in how much power the tube or transistor has to dissipate. Another factor is the output load (the flyback transformer).

Now, we're getting near the key point—the *shape* of the driving pulse voltage. Fig. 1-a shows a normal tube pulse, and Fig. 1-b a transistor drive pulse. Note the difference between "on time" and "off time." This is it.

Pulse shape is determined by the driving circuits and the horizontal oscillator. In transistor circuits, you'll usually find a *driver* stage; its main purpose is to get the required rectangular pulse shape, and to set the on-off time ratio.

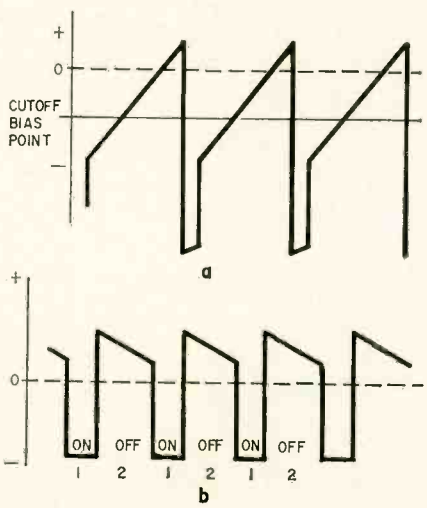


Fig. 1

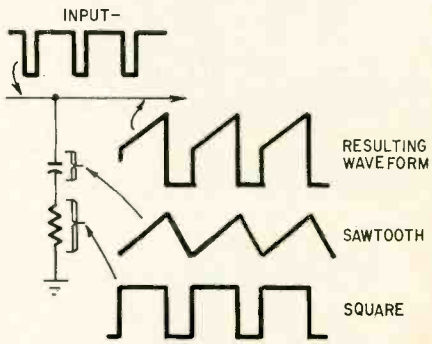


Fig. 2

The basic output of the horizontal oscillator may be a sawtooth, sine wave or even a fair square wave. None of these shapes will do, for driving the output amplifier. Transistor output stages are driven by what looks like a square wave. A close look with a scope shows that it's actually a rectangular wave, with a very precise *ratio* of on-time to off-time, usually about 1:2.

This output wave is shaped by RC networks to make the proper shape. Fig. 2 shows the basic circuit, and what it does. The output waveform is determined by the point of takeoff, *and* by the ratio of part values—resistance to capacitance. The proportions of the drive waveform, with respect to the cutoff point (bias) of the output amplifier, determine the on–off time of the amplifier and its total power consumption.

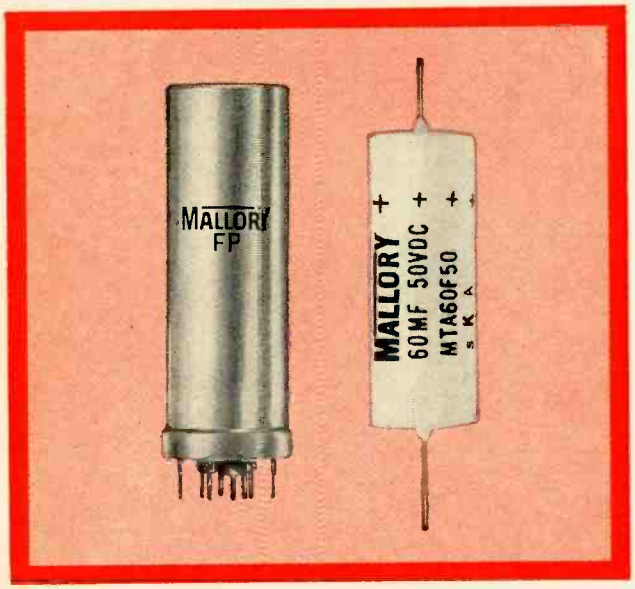
Sounds complicated but it isn't. Use a scope to look at the waveform and compare it to the one shown on the schematic. Then measure its p-p voltage. If there is enough distortion to cause trouble, it'll be pretty obvious. Confirm the diagnosis by taking voltage measurements, current readings and checking the output. Another way: substitute a known good drive waveform from another TV set.

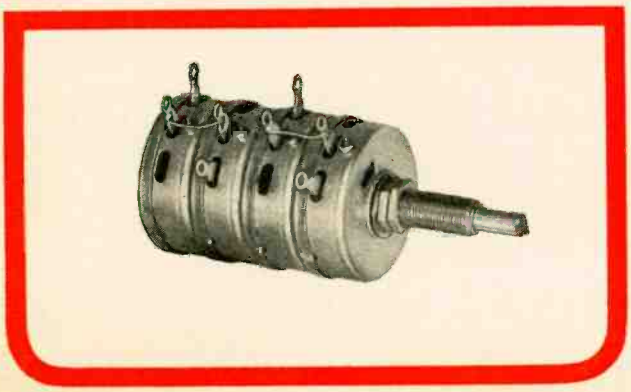
If you "sub" a drive signal from

(continued on page 22)

MALLORY Tips for Technicians

Remember to ask—"What else needs fixing?"





That's the question to ask to add extra profit to every service call. It makes sense. Just about every customer who calls you for TV repair owns other electronic products that are excellent prospects for service. You've already invested your time getting to his home. So why not see what further service you can render?

Does it work? You bet! On a test program sponsored by Electronic Industries Association, in which Mallory is an active member, service men got 6% more profit from business they added just by asking that simple question.

Here are some tips that you can use to cash in on this idea.

Portable radios, for instance. Most homes have at least one. Ask 'em, "How about fresh batteries?" And then sell Mallory Duracell® batteries . . . best buy in long life and fade-free power. And don't forget cameras, flashlights and toys. They need batteries, too, and there's a Duracell type for every job.

Ask to check table radios . . . then listen for hum as the set warms up. Many people put up with hum because they've forgotten how well the radio sounded when new. But hum may be a sign that a filter capacitor is near the end of its life. Replace with a Mallory FP, WP, TC or MTA. Your Mallory Distributor can supply the exact size and rating you need.

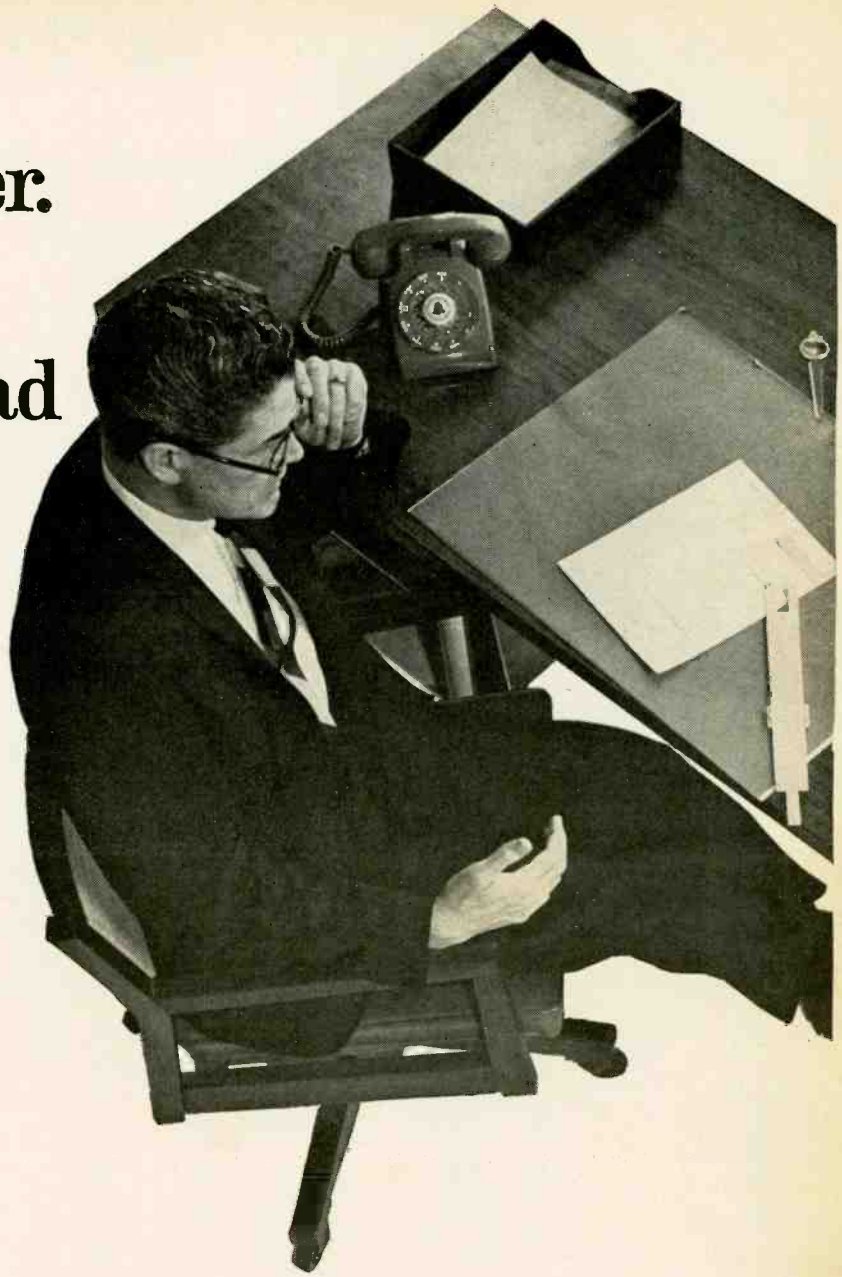
How about hi-fi and stereo? Ask to turn them on, and see if you detect anything that calls for service. You can suggest adding remote speakers for a porch or family room. Be sure to include a Mallory balance control and remote volume controls, to make the installation complete. Record changers and electronic organs are good service opportunities, too.

Try this profit-building "What else needs fixing?" idea on the next calls you make. And for the quality components that make every job sure, see your Mallory Distributor. Mallory Distributor Products Company, a division of P. R. Mallory & Co. Inc., Indianapolis, Indiana 46206.

®Duracell is a registered trademark of P. R. Mallory & Co. Inc.

Circle 21 on reader's service card

"He's a good worker. I'd promote him right now if he had more education in electronics."



Could they be talking about you?

You'll miss a lot of opportunities if you try to get along in the electronics industry without an advanced education. Many doors will be closed to you, and no amount of hard work will open them.

But you can build a rewarding career if you supplement your experience with specialized knowledge of one of the key areas of electronics. As a specialist, you will enjoy security, excellent pay, and the kind of future you want for yourself and your family.

Going back to school isn't easy for a man with a full-time job and family obligations. But CREI Home Study Programs make it possible for you to get the additional education you need without attending classes. You study at home, at your own pace, on your own schedule. You study with the assurance that what you learn can be applied to the job immediately.

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☐ Industrial Electronics for Automation
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(continued from page 16)

a working set, read the cathode current and compare its value to what you had with the original drive. This will tell you what's really going on.

Divide and conquer

In all cases of flyback trouble, you should divide the circuit into two parts: input (or drive) and load (see Fig. 3). The load includes everything fed by the flyback: yoke, damper, HV rectifier (also regulator and focus rectifiers in color sets), and the boost circuits, including the boosted-boost. The drive section includes the horizontal oscillator and driver, afc and all wave-shaping networks in its output.

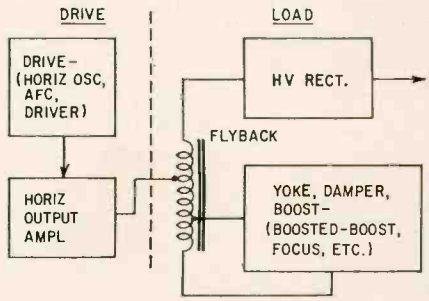


Fig. 3

Load defects are usually pretty easy. They'll affect the output pretty badly—narrow sweep, low HV, etc. If you suspect yoke trouble, substitute the horizontal windings of another yoke, and read the boost voltage. Since the flyback pulse from the yoke is considered as the source of boost, if boost returns to normal, you've confirmed your diagnosis without even seeing a raster!

Input trouble can be harder. A substitute signal can confirm the diagnosis pretty quickly, after a scope check has shown the possibility of trouble—drive signals with excessive flattening of the tops, curvature, too much spiking, and so on; any kind of noticeable deviation from the correct waveform shown on the schematic.

Monitor the cathode current of the output amplifier as a good guide. When you find the real trouble, cathode current will go back down to normal, and the output will come up to normal.

Now, if a sub-signal shows that the set's own oscillator circuit is out of shape somehow, you've got to find out what and why. The cause of this kind of trouble is usually pretty simple (like

(continued on page 26)

Are you eligible for the Bright Guy Awards?

It's easy to get them—and to get all the business they'll bring you. New customers. More sales. More money.

The Bright Guy Awards is the big program Sylvania's running this year to boost your sales.

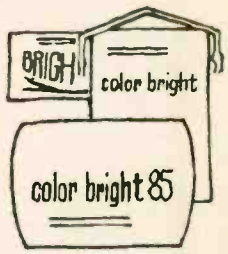
Your Sylvania distributor can put your name and address in TV Guide ads in your area. The ads call you "the brightest serviceman in town"—and tell people in your town why they should call you.

You'll get into the Yellow Pages, too, under the heading "TV Service and Repairs."

Once again this year you'll be eligible for over one hundred valuable, interesting SMB-Bright Guy gifts, just for buying the Sylvania TV replacement parts you normally buy anyway.

And you'll get window displays proclaiming you "the brightest"—the TV serviceman everyone's reading about.

You're eligible for the Bright Guy Awards just by buying Sylvania's famous *color bright 85*® picture tube. And our other picture tubes, and our receiving tubes. So see your Sylvania distributor.



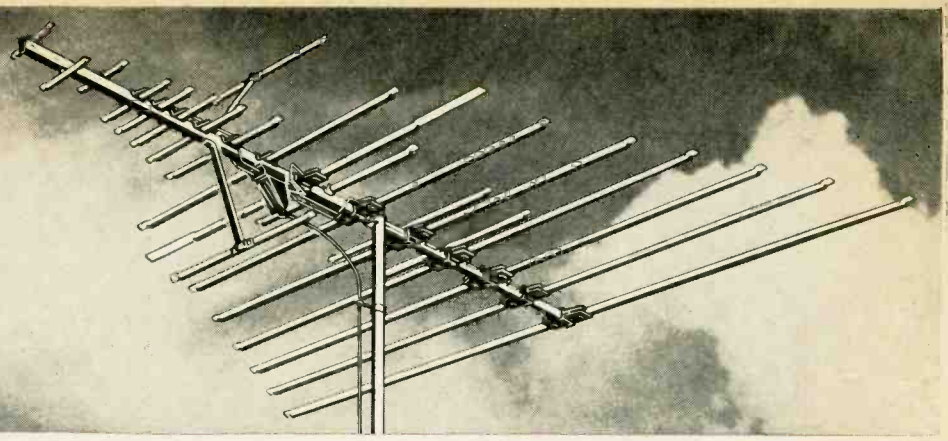
Sylvania Electronic Tube Division, Electronic Components Group, Seneca Falls, New York 13148.

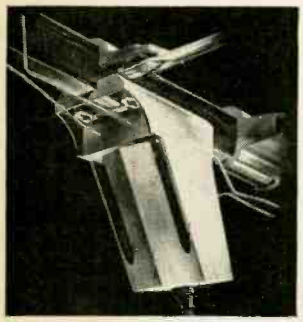
SYLVANIA

A SUBSIDIARY OF GENERAL TELEPHONE & ELECTRONICS

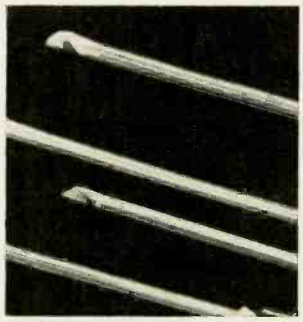
Circle 23 on reader's service card

Winegard put these features in to bring the best color out



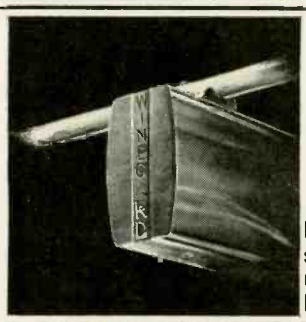


Downlead and Pre-Amplifier Housing—permanent housing is built-into the antenna; provides complete weatherproofing for downlead connector cartridge or pre-amp cartridge.

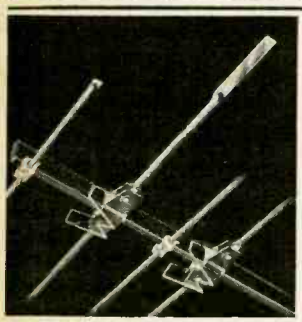


High Tensile Aluminum Elements; with Gold Anodizing—aluminum alloy has PSI rating of 38,000 compared to 27,000 PSI for alloys used in other antennas. More than 49% stronger and 29% more resistant to bend and wind distortion. Elements and boom are gold anodized for the only permanent protection against corrosion and fading.

Solid State Pre-Amplifiers—incorporate revolutionary new silicon overlay transistors, the best performing and most powerful transistors available for antenna use. Drop into pre-amplifier housing at point of signal interception.

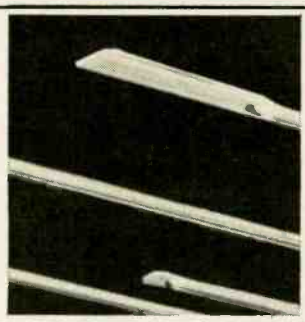


Ellipsoidal Boom—the only aluminum shape engineered especially for antenna use; proved far stronger than any other boom design.



Electro-Lens* Director System—patented system absorbs entire signal and focuses it directly onto driven elements for pinpoint directivity.

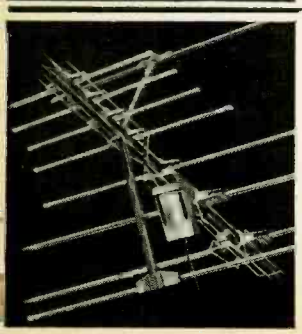
*U. S. Patent No. 2700105
Canada No. 511984



FM Control Element—provide exceptionally high gain on FM bands and provide for the attenuation of FM bands in areas where strong FM signals interfere with tv reception.

Impedance Correlators—patented correlators automatically increase 75 ohm driven elements to 300 ohms to provide 100% signal transfer from antenna to set.

CS-285 Band Separator (with printed circuit)—comes at no additional cost with all 82 channel Super Colortrons to separate UHF and VHF signals. Attaches easily to terminals on back of set.



Vertical Resonant Reflectors—UHF reflectors achieve highest realizable gain on channels 14 to 83 because of exceptionally large vertical capture area; more UHF gain than any other 82-channel design.

2-Year Antenna Replacement Warranty—the only antenna in the industry that gives your customer a 2-year replacement privilege.

No wonder so many dealers are selling so many Winegard Super Colortrons so fast.

You're right, that's a lot of features. A lot more than any other antenna ever designed.

But what's really important is what happens when all those features are sandwiched into one super-performing, super-compact antenna.

And just in case you don't know yet, we'll tell you what happens.

First off, you get an antenna so powerful and with such pinpoint directivity (even without solid state pre-amps) that it eliminates ghosts and snow more effectively than anything you've ever seen before.

And when you drop-in an instant-loading pre-amplifier (there are eight to choose from not counting the color spectrum filter) you've got yourself an antenna that does just about anything you want it to do, just about anywhere—especially when it comes to color tv.

The solid state pre-amplifiers enable you to instantly increase gain on all channels. They let you custom match the Super Colortron to any reception requirement in seconds, using either 75 ohm coax or 300 ohm downlead—and with all connections completely enclosed and protected against the weather.

You can take your choice. There are ultra high gain, low noise 82-channel UHF-VHF-FM pre-amplifiers... VHF-FM pre-amplifiers... UHF pre-amplifiers... and FM pre-amplifiers. And then there's that color spectrum filter. It shuts out electro-magnetic interference... lets only pure TV signals come through for the clearest color pictures ever.

So you see, there's really a lot to talk about when it comes to Super Colortron antennas, all 14 models—with 7 patents and patents pending.

And that's why we're doing a lot of talking in Life and Newsweek and Sunset. 17 ads, between now and Christmas, telling more than 60,000,000 prospects exactly how remarkable the "transistorized" Super Colortron is.

No wonder so many dealers are selling so many Super Colortrons so fast.

So what are you waiting for?

—biggest, most powerful national advertising campaign in the industry.

Winegard
ANTENNA SYSTEMS

WINEGARD COMPANY • 3000 KIRKWOOD STREET • BURLINGTON, IOWA 52601

Circle 24 on reader's service card

(continued from page 22)

all others!): too much leakage in a small capacitor, or a resistor that has drifted off value too far.

A wee bit of leakage in the coupling capacitor from oscillator output to amplifier grid will really shake things up, by upsetting the dc bias level on the grid. (This of course, determines the cutoff point of the amplifier, and the amount of time it is held in conduction, dissipating *power*.)

Normally, this kind of trouble will *not* be in the *frequency-determining* parts of the circuit or in the afc. If it is, you can certainly tell! The most common cause will be a defective "saw-forming network" somewhere between the oscillator and output.

Red hot mystery

Once in a while you'll find a trouble, the cause of which won't be a short or a leak, but an open input capacitor, as in the B+ boost filter circuit shown in Fig. 4.

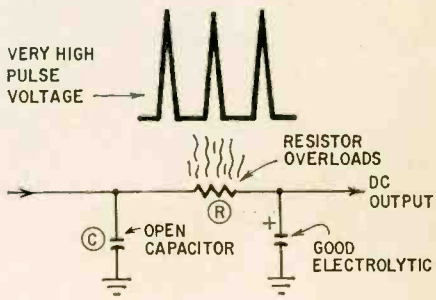


Fig. 4

If the input filter capacitor is open, a greater proportion of the pulses goes through the resistor; some of which are bypassed to ground by the ouput filter capacitor and some of which get into other circuits to cause other troubles.

Under this circumstance you could wind up with a big mystery . . . the resistor would run red hot even though there is nothing abnormal on the load side to draw an excessive amount of current.

To find these things, use the scope again; it's the only thing that'll let you see what's going on. Look for the presence of high pulse voltages in what should be "pure dc" circuits. Hook the scope to the circuit, and then bridge good capacitors across all suspected ones. When you find the open one, the pulse will just about disappear.

Just remember the old adage: "This thing worked, once, with these part values in it. So, if I can get all the parts back to where they were then, it'll work again!" **R-E**

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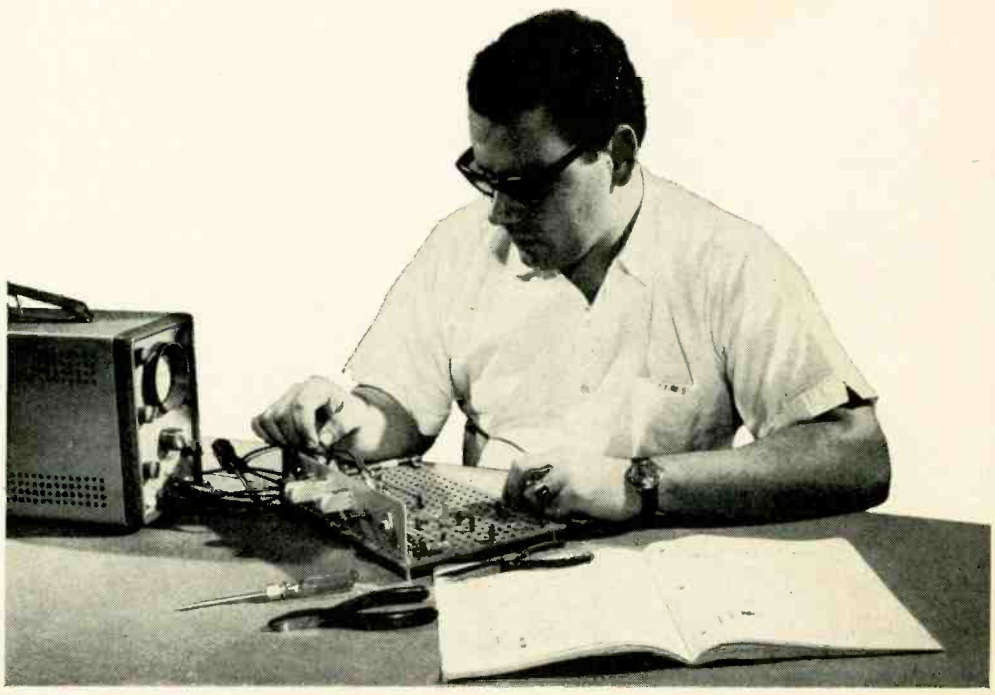

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All during your program of home study, your training is supervised by RCA Institutes experts who become personally involved in your efforts and help you over any "rough spots" that may develop.

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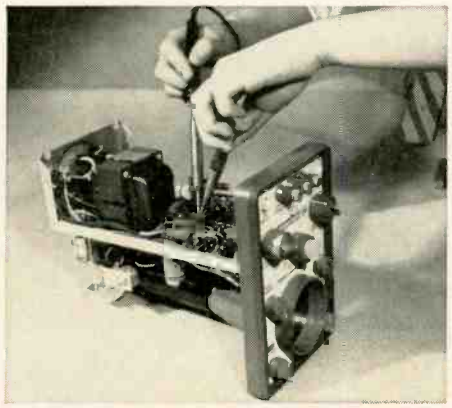
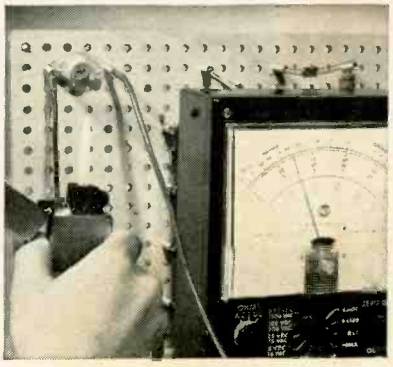


Construction of Oscilloscope.

Temperature experiment with transistors.



COVER STORY

BUILD A SOLID-STATE TAPE/SLIDE SYNCHRONIZER

Easy automatic slide changing with commentary from your tape recorder

By ROBERT S. HAVENHILL

SHOWING COLOR SLIDES is a good way to recreate your vacation for friends. By adding commentary on tape, you're relieved of repeating the same thing, and you can't forget what you said last time. But changing slides is still a nuisance.

The synchonizer changes slides for you automatically. All you need is a stereo tape recorder. You put the voice commentary on one track, and a sync signal on the other. When friends drop in, you simply load the projector and the recorder, turn them on, and the show runs automatically. The recorded sync pulses advance slides as your commentary moves ahead. And there are no relays to chatter or stick.

Theory

The heart of this synchronizer is a bidirectional thyristor, called a Triac. As you know, a silicon controlled rectifier can conduct only on one-half of an applied ac voltage. Why? Because an SCR is simply a diode with a gate. A Triac consists of essentially *two* diodes in reverse parallel, with a gate. It can conduct on both halves of an ac waveform and can be used as a full-wave control and switch. A Triac can also be gated by ac, which is quite useful.

Figure 1 shows the symbol for a Triac and one method of triggering it. When S1 is closed the gate is connected to anode 2 through current-limiting resistor R2. The Triac then conducts and switches on the ac motor. (Some slide changers are operated by a solenoid, but the principle is the same.)

Figure 2 illustrates a second method of triggering: An ac signal is applied to the gate-anode 1 circuit of the Triac through isolation transformer T1. This second method is used in the tape/slide synchronizer on playback. The recorded sync signal on the tape is fed to the primary of T1. The signal then triggers the Triac, which conducts and activates the motor (or solenoid) in the projector. The slide advances.

In the record mode, it's necessary to simultaneously trigger the Triac (to advance the slide) and produce an ac signal (to put sync on the tape). The circuit is shown in Fig. 3. Closing S1

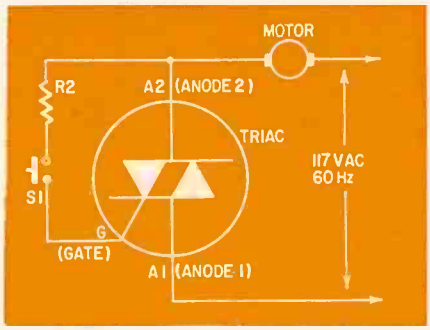


Fig. 1—Triac is turned on with voltage between gate and anode 2. It can conduct on both halves of an applied ac voltage.

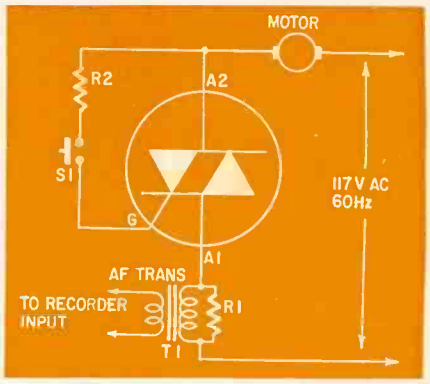


Fig. 3—Drop across R1 is sync signal.

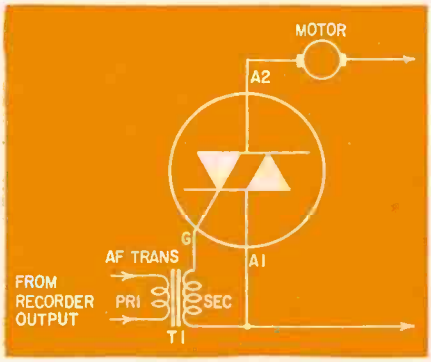


Fig. 2—Either ac or dc will trigger the Triac. Signal can also be applied between gate and anode 1 to turn the device on.

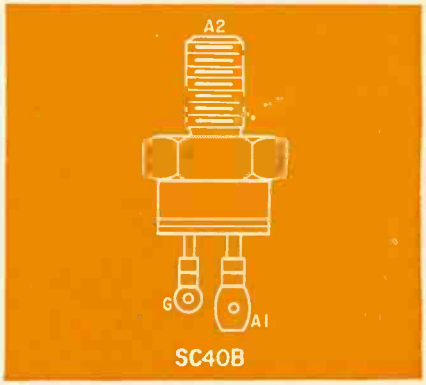


Fig. 4—Typical Triac outline, terminal connections, with mounting stud at top.

triggers the Triac and advances the slide. At the same time the 60-Hz ac to the motor passes through R1, causing a 1-volt drop. This 1-volt signal is passed through T1 to the second tape channel, while voice commentary is going on the first channel. Fig. 4 shows outline and terminal connections of the Triac.

Operation—record

The synchronizer (Fig. 5) is connected to one recording input of the tape recorder through J1, and, to the slide changer through P1. S1 is set to the record function. The tape recorder is then adjusted to record voice from a microphone on the other input channel. The tape is started and when you want to change slides, S2 (or remote switch S3) is pressed. This triggers the Triac into conduction and starts up the slide-changer motor (or solenoid). In a motor-operated changer, when S2 is released the cam switch in the slide changer continues to feed ac to the motor or solenoid until the cycle is complete.

Meanwhile, as S2 is closed, the sync signal is passed through T1, volume control R3 and J1 to the input of the recorder. The level of the sync signal can be set with R3; thus the volume control of the recorder does not need to be changed in going from record to playback.

S3 is an optional remote-control switch. It lets you put sync on tape without having to be near the unit.

Operation—playback

The cable connecting J1 to the recorder microphone input is now used to connect J2 to the external speaker jack of the recorder. (This jack must be on the same channel the sync signals were recorded on.) S1 on the tape/slide synchronizer is set to the playback function, and the recorder controls are set for stereo (or split-channel) playback.

When you play back the tape, you'll hear commentary as usual through the tape speaker. But the sync-channel speaker should be muted, and the sync signal goes into J2 and the primary of T1. The signal is stepped up about 2.5 times by T1 and is then applied to the gate of the thyristor.

Note that closing either S2 or S3 will override all automatic controls and cause a slide change during either recording or playback.

This synchronizer can be used with nearly any slide changer with remote pushbutton operation, and with any stereo or split-channel tape recorder with power amplifiers. It cannot be used with a tape deck since preamp output isn't high enough to trigger the Triac. The SC40B requires 1.5 to 3 volts and 25 to 100 mA for triggering, and will control up to a 6-amp load at 120 volts.

Transformer T1 isolates the power line from the recorder and gives a fair impedance match between recorder output and the Triac gate. In the record function the impedance match to the recorder input is not good, but

continued on page 91

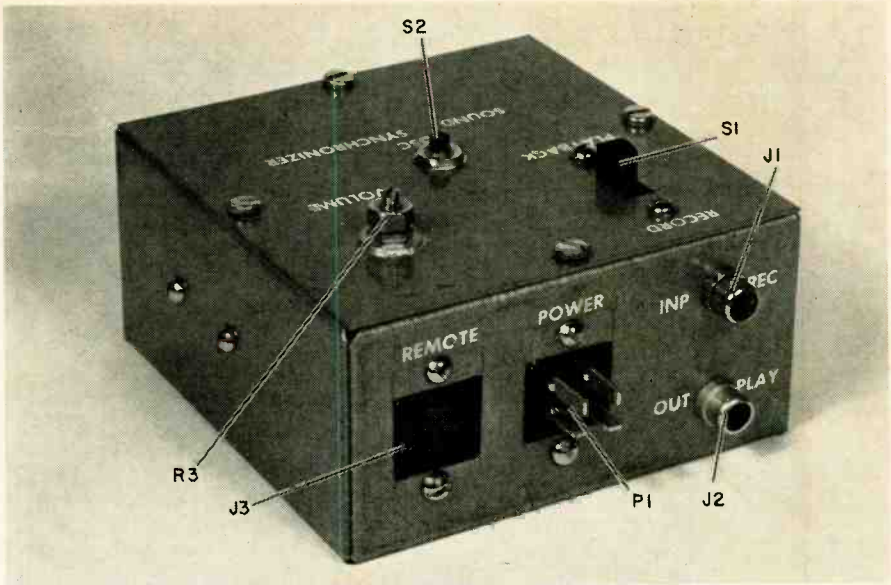


Fig. 6—Remote jack J3 isn't required . . . it is useful for remote operation of S2. Locking control is used for R3 to avoid accidental misadjustment of sync level.

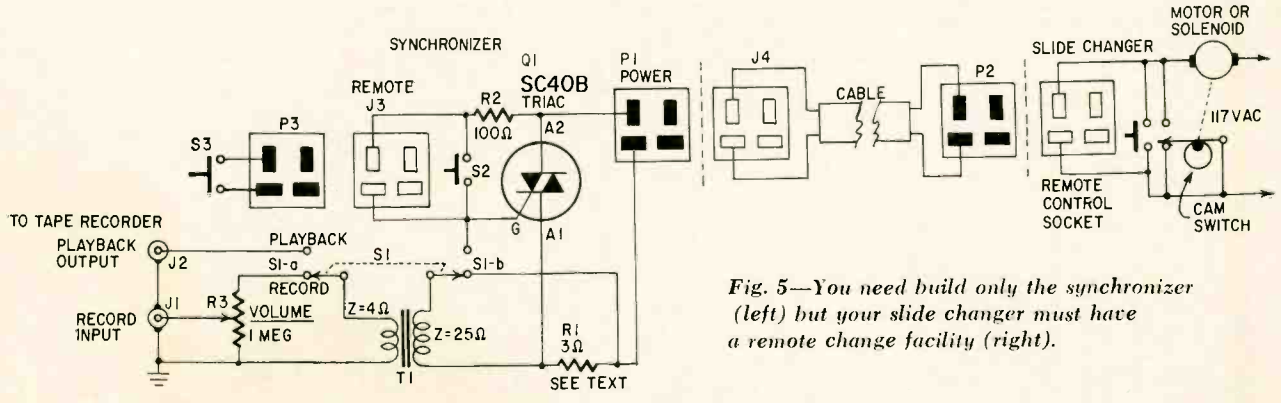


Fig. 5—You need build only the synchronizer (left) but your slide changer must have a remote change facility (right).

Parts List

J1, J2—Phono jacks
J3—4-prong chassis socket (Cinch-Jones S-304-AB or similar)
J4—4-prong cable socket (Cinch-Jones S-304-CCT or similar)
P1—4-prong chassis plug (Cinch-Jones P-304-AB or similar)
P2—Cable plug to match remote-control socket on projector
P3—4-prong cable plug (Cinch-Jones P-304-CCT or similar)
Q1—Triac (G-E type SC40B, Texas Instruments TIC23 or similar)
R1—3-ohm, 5-watt resistor (see text)
R2—100-ohm, 5-watt resistor
R3—1-megohm, audio-taper potentiometer
S1—D.p.d.t. slide switch
S2—S.p.s.t. pushbutton switch, normally open contacts
S3—S.p.s.t. cable-mount pushbutton switch (Switchcraft 913 or similar)
T1—Output transformer, 25 ohms to 4 ohms (Stancor TA-62 or similar)
MISC—Steel utility box 4" x 4" x 2", aluminum plate 1½" x 1½" x ⅛"; 2 insulated threaded ½" spacers or stand-off insulators; cables—one 2-wire power cable to connect unit to slide changer; one or two single-wire shielded cables to connect unit to input and output of recorder (see text)

The Solar-Powered

Self-powered amphibious vehicle will get the

By JOHN HOKE

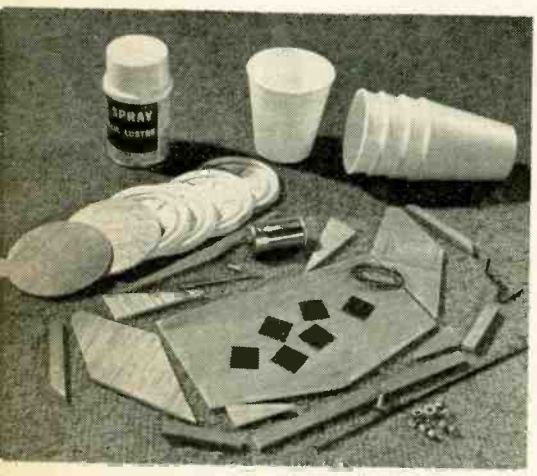


Fig. 1—First lay out the materials you will need to build the solar vehicle.

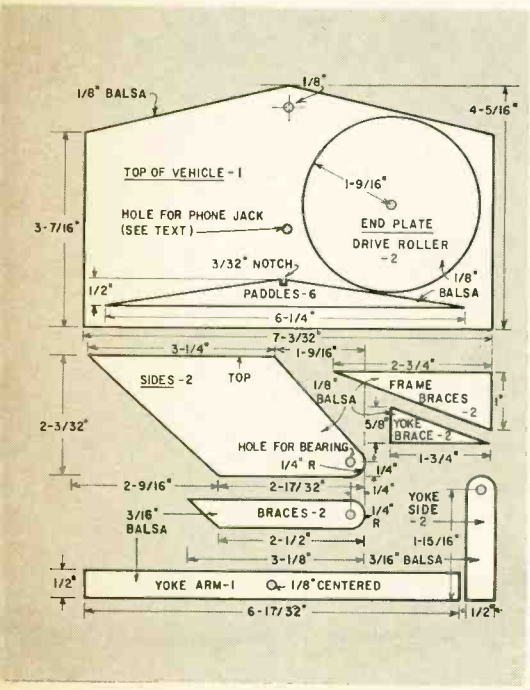


Fig. 2—Unless otherwise marked, sections are cut from two sheets of ⅛" balsa.

A FULL-SCALE GAMMA GOAT IS A MILITARY vehicle designed to operate effectively on any kind of ground. This solar-powered model doesn't look much like the real thing, but it does have similar rough-terrain capabilities. It manages well on land or water, and solely with light power.

You'll find the goat easy to build. It's assembled almost completely from tailored-to-fit parts that can be obtained easily from local sources (see Fig. 1).

The vehicle frame is made from ⅛" balsa wood, with ¼" balsa used for the yoke and for local reinforcement of the thinner wood.

To make later finishing much easier, all surfaces of the balsa should be filled before you cut out the parts. Spread shellac or Elmer's glue smoothly over the wood surface. Lightly sand the treated surface (when it's dry) with about a 320-grit paper before cutting. Use a one-sided razor blade or X-Acto knife to cut the wood. Follow the plans shown in Fig. 2.

Roller construction

Assemble the front roller as shown in Fig. 3. Use acetone or methylene chloride to cement together the lids of two 6-oz Styrofoam cups. Carefully cut a ½" hole through the center of both lids. An eyelet "bearing" must be centered in the bottom of each cup, to receive the axle.

Next, make the balsa yoke for the front roller, following the plans shown in Fig. 2. Assemble the yoke and mount the front roller in it (Fig. 4). Install two eyelets "bearings" in the yoke with collars inward. The axle can be a piece of coat-hanger wire.

The drive roller is the only component that must be constructed to fairly exacting tolerances. The arrangement is a fixed-shaft device in which the whole roller and motor revolve around an axle held stationary to the frame of the vehicle. The roller is made of two more Styrofoam cups glued together bottom to bottom as shown in Fig. 5. Be sure to cut well-centered holes large enough to accommodate the motor. A sharp razor blade, wet with soapy water, makes cutting the Styrofoam much easier. (Make sure all parts are dry before you cement them.)

Using RTV (room-temperature vulcanizing) rubber, cement the motor mount—a discarded core from a roll of cellophane tape—into place against the bottom of one of the two cups. Center it well so that the motor, when put into the mount, also will be properly centered.

Making the wheels

The end plates (Fig. 6) seal the drive roller. They also are the wheels on which the model runs on land. Each is made from a balsa disk and a plastic cup cover. The eyelets "bearings" used to support the drive roller in the frame of the vehicle must be carefully centered. Cement a cup lid to each balsa disc so the grooves into which the lip of the cup fits will remain uncovered. Be careful to center the lids well on the balsa discs. Use Silastic for joining these two pieces.

Six paddles are provided for propelling the model in water. Mark paddle locations on the drive roller as follows: Using a compass, draw a circle on paper—make it a bit larger than the drive roller ends. Then make a six-pointed star pattern with the compass. Transfer the points directly to the rim of one cup, marking them with a pen (see Fig. 5).

The paddles should be sanded smooth, and filled with shellac or Elmer's glue. To keep the paddles from trapping air or picking up water when running in water, cut vent holes (3/32" notches) into the apex of each paddle, as shown in the pattern (Fig. 2).

Next, cement the paddles to the drive roller (Fig. 7).

After the drive-roller end plates and covers have been bonded firmly together, drill out the center holes in which the eyelets will be mounted. Hole size depends upon the size of the eyelets you use. Be sure to strip the eyelets of paint or enamel; they have to carry current from the solar cell to the

Gamma Goat

kids out in the sun this Christmas

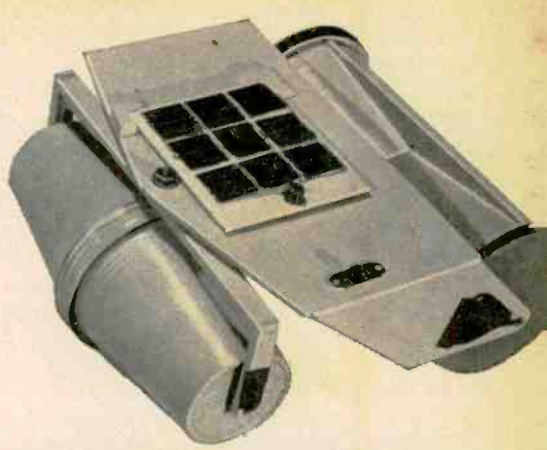


Fig. 3—The front roller assembly: Glue two Styrofoam cup lids together. Then cut ½" hole through each lid center for axle. Finally, push cups into lids as shown.

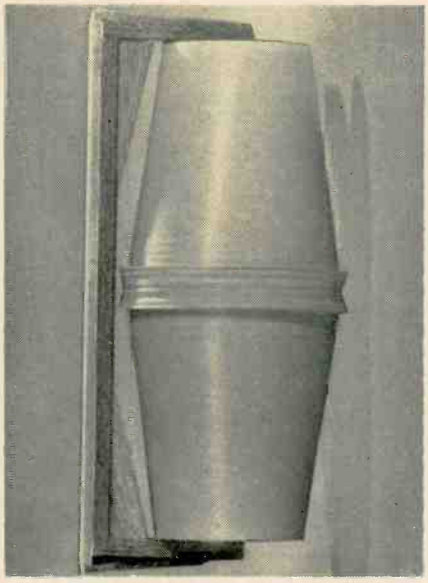


Fig. 4—Front roller is mounted beneath the movable yoke, using two eyelet bearings and a piece of coathanger wire. Unit functions as the steerable roller axle.

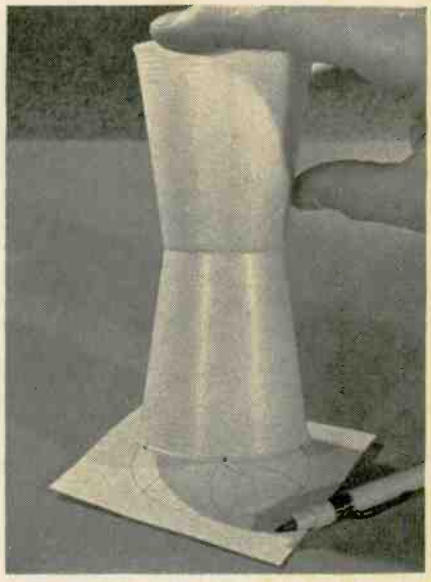


Fig. 5—Cement two additional Styrofoam cups together, bottom to bottom. to form the drive (or motor) roller. Then mark ends for locations of six drive paddles.

Fig. 6—Cement a balsa disc (follow the pattern of Fig. 2) to each Styrofoam cup lid. Then slip each "sandwich" on end of a drive-roller cup. Use two cups and lids.

Fig. 7—Use silastic rubber (or bathtub caulk) to cement paddles to the outside of the drive roller. Be careful not to plug or block the vent holes in paddles.

Materials List

Balsa wood—⅛" x 8" x 2' (vehicle frame) ¼" x ⅜" x ½" x 3' (yoke and supports)
Cups and lids—Styrocups, 6 oz. #67s
Eyelets—Brass, or painted eyelets
Model paint—For painting styrene; Spray Pla by Testor's, and AMT lacquer
Anodized aluminum (or Lucite)—3' x 4" x 3/32"
Shaft coupler—Motor and drive-shaft coupling; Aristo M233:20, Universal couping, two required
Solar cells—Series strings of three cells each; H. & R. No. TM13K490/3; $2.50 per 3-cell module. Minimum of two modules required. Herback & Rademan, 1204 Arch St., Philadelphia, Pa. 19107
Phone plug—Subminiature two-conductor (Switchcraft No. 850)
Phone jack—Subminiature two-conductor (Switchcraft No. TR-2A
Gearhead motor—Dc drive motor, Incabloc No. SR601AO, with reductor of 1, 5, 10, 15, or 20 rpm (select one speed) $8.37 to $9.42 depending on speed (plus shipping). Portescap U.S., 730 Fifth Avenue, New York, N.Y. 10019
Switch—D.p.d.t. toggle switch
Miscellaneous—Dow RTV silicone rubber, bathtub caulk (white-clear), Elmer's glue, spray paints, shellac, epoxy, pins, tape.

motor. As Fig. 8 shows, you'll need four eyelets, each with about 8" of wire attached. Use an enameled wire—No. 26 is a good choice—for this hookup. Make the connection to the outside of the eyelet so the wire won't interfere with the axle. Two eyelets are used in the vehicle frame (Fig. 9) and two more are used in the drive roller (Fig. 10). Wire the drive-roller eyelets to the motor terminals, as shown in Fig. 11.

Instead of eyelet bearings, you can use miniature phone jacks and plugs (transistor radio size) at one end of the drive roller. This is a much easier and more reliable way to apply power to the motor.

Construction of the vehicle frame is straightforward—refer to Figs. 2 and 9. Take care to locate the side panels exactly before you glue them; their leading and trailing edges are not parallel. (Carry the "top" marking onto the pieces, when you cut them.) Use Elmer's glue or a twin-mix epoxy resin for bonding.

Hole drilling

To make things easier later on, drill out the bearing holes as soon as the side members and their braces have been cemented. Drill all other holes, too, so you won't have to juggle the finished frame while you are trying to drill holes in it.

If you plan to use a "plug-in" solar panel (so you can remove the panel to use it for other purposes) drill an opening for the phone jack at this time (Fig. 12). If you also wish to use a forward-reverse switch, do necessary drilling and cutting at this time. In all such drilling operations, use pieces of backup wood so the holes will be neat. Add epoxy cement to the wood around the phone jack hole, for strength.

Before spray-painting the frame, sand it lightly with a fine emery paper. When spraying the model, take care not to get any paint on the unfinished roller assemblies; most spray paints will dissolve Styrofoam. A special paint (see Parts List) must be used to finish the rollers.

Assembly of the drive roller comes next. Use a round pin file or a tube of emery paper to clean out the eyelet bearings thoroughly so they will offer

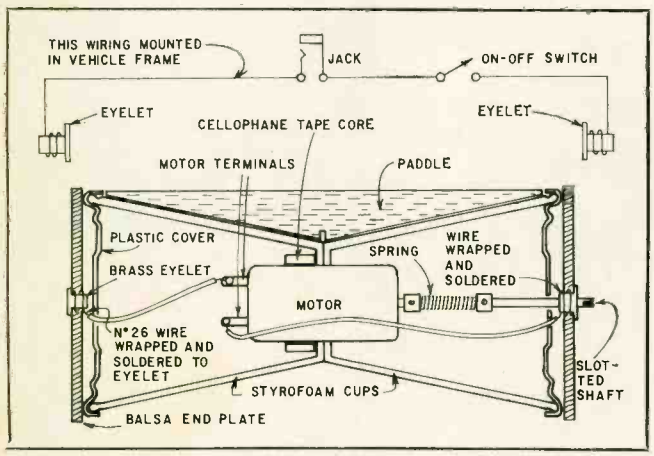


Fig. 8—Cement the motor inside the drive roller with some RTV rubber. Cellophane tape core holds motor securely in place.

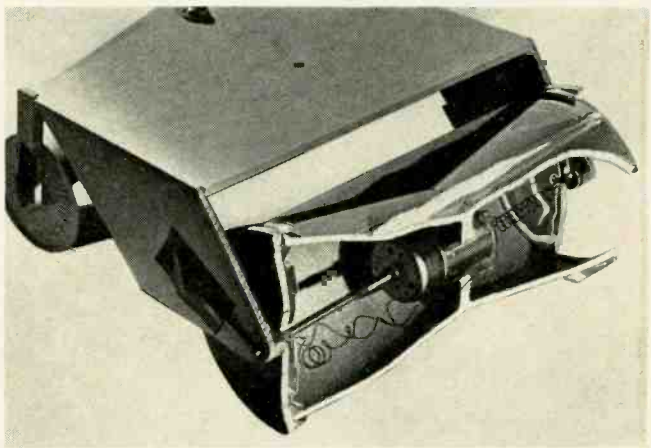


Fig. 9—Motor and drive roller turn when power is applied. Drive shaft is held fixed by cotter pin tied to vehicle frame.

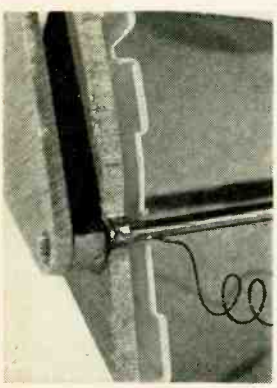


Fig. 10—Solder motor wire to eyelet; mount eyelet in end of drive roller with collar out.

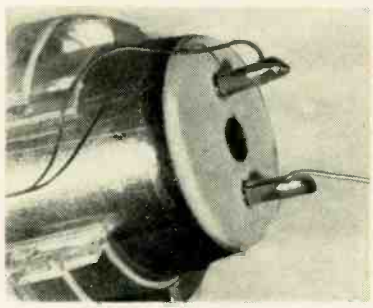


Fig. 11—Solder wires from the drive-roller eyelets to the two motor terminals. Don't overheat.

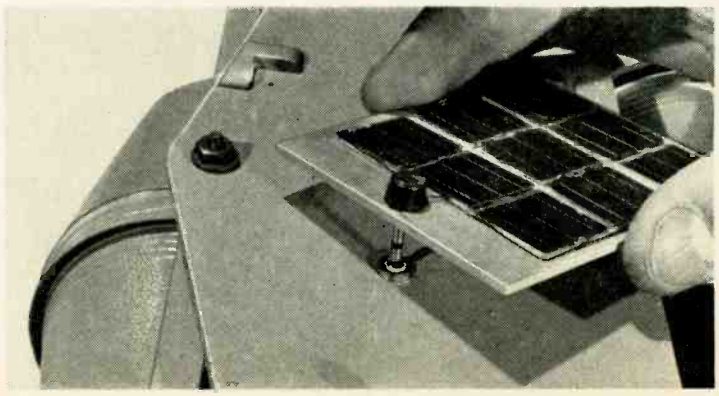


Fig. 12—Cement the solar cells to piece of Lucite or aluminum with a phone plug at one end. Wire cells, plug in series.

good electrical contact. Carefully study Fig. 8 and you will note that one axle is friction-fitted to the motor shaft with a piece of snug-fitting spring. If the vehicle is to be run in only one direction —that in which the spring will "grab" the shafts—this simple hookup is all that will be needed. If, however, you plan to provide a forward/reverse switch, you will need to use a nonslip coupling, such as one with set screws at both ends.

Motor coupling

The drive shaft can be a piece of coat-hanger wire, but a length of ⅛" drill rod is better. Cut the axle long enough to let it extend through both the bearing in the drive-roller end plate and the bearing in the vehicle frame (see Fig. 10). About ⅛" to ¼" of the shaft should extend beyond the frame bearing. As the shaft must be held stationary at this point, it should be slotted with a file. A 1/16" hole drilled through the tip also will provide a means to anchor the shaft.

When the motor and shaft are in place, the two end plates can be put in place, the cup lips tucking into the grooves of the lids.

The drive-roller assembly will need an axle for use in the opposite end of the assembly when it is placed in the frame. A piece of bare coat-hanger will work, but a piece of heavy copper wire is better, since this axle also must conduct electrical current.

This axle is slipped into place through both frame and drive-roller bearings, when the drive roller has been positioned in place. You can bolt the axle in place if you wish, but a simple right-angle key-headed member is all that is needed. Use a piece of Mylar tape, placed over the keyed portion, to hold it in place.

When the drive axle is in place, it must be pinned so that it cannot turn. Use a partially straightened-out paper clip, leaving a "key head" on it over which Mylar tape can be put to hold it to the frame. The end slips through the axle slot to keep it from turning.

Before mounting the drive-roller assembly, spray it with a paint that will not dissolve or damage the Styrofoam cups (see Parts List.) Do *not* use heat to hasten drying; it will permanently damage the Styrofoam.

The yoke of the steering roller is secured to the frame with a small nut and bolt. An eyelet can be potted into the frame to serve as a mount if you wish. Washers should be used to distribute the loading this junction must endure. A flat rubber faucet washer should be sandwiched between the yoke and frame both to separate them and to provide enough friction to hold the yoke in any position.

Fig. 13—A 150-watt flood lamp at 4 feet will run the goat on smooth floor indoors.

Fig. 14—In water, the goat sinks in a bit due to motor weight. But it floats!

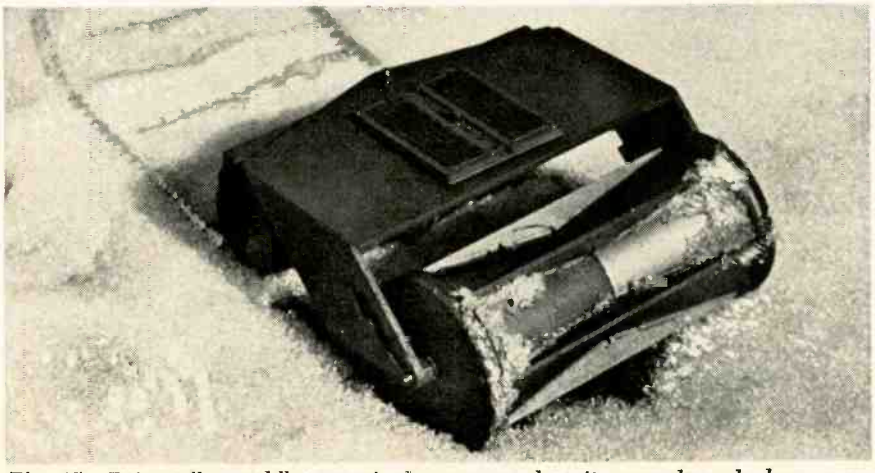


Fig. 15—Drive-roller paddles permit the goat to chop its way through deep snow.

Final assembly

After the yoke is mounted, the roller assembly that fits into the yoke is secured in the yoke bearings. A single, straightened-out piece of coathanger rod extending through all bearings does the job nicely. An L-bend in one end of the wire provides a lever across which to tape the rod in place to one leg of the yoke.

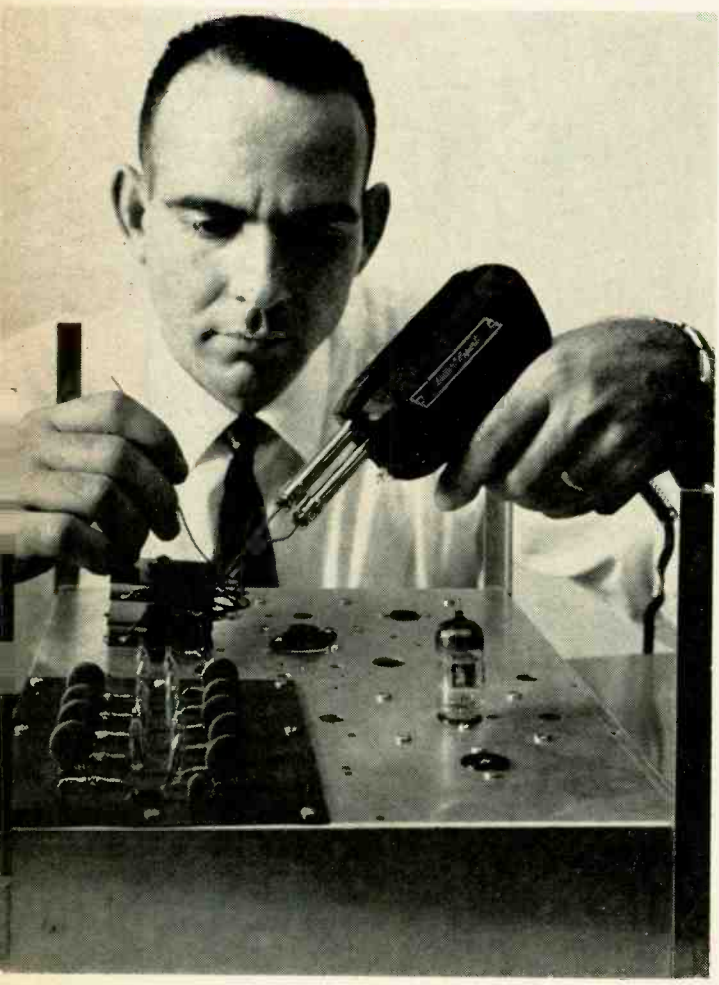
A word about choice of motors: The gear reduction you select from those listed depends on how you plan to use the vehicle. If you use three strings of solar cells, the goat will go over pretty rough ground with a 10 to 15 rpm motor—in sunlight. Even with a 20-rpm motor, it will manage well on dirt or grass.

If you want it to perform well on water, the higher the rpm the better! (Even a 40-rpm unit will run it on water.) The prototype model was made with a 15-rpm motor, which moves over fairly rough ground; it also runs at a reasonable rate on water.

Under a full sun, it is exciting to watch such a device operate, knowing that the energy source is free! But take care: If you tire of watching the goat—or if the sun goes behind a cloud—don't just go away and leave the Gamma Goat untended. You might forget it. Then, when the sun returns, it will wander off! It's a toy and it's in time for Christmas, so have a Merry Christmas.

R-E

YOUR FUTURE IN ELECTRONICS



Exciting, challenging opportunities await you in this fast-growing field

By RAY CLIFTON

Photos courtesy of DeVry Institute of Technology, Grantham School of Electronics, National Radio Institute and RCA Institutes, Inc.

Item: Today at least 50,000 trained electronics technicians are urgently needed to fill well-paying jobs in the U.S.
Item: Additional jobs are being created each year for electronics technicians. The field is expanding rapidly.
Question: Are you an electronics technician?
Question: Would you like to become one—or become a better one?
Statement: Whether you become a (better) technician or not is up to you. Here's how you can.

Job Opportunities

Consumer electronics: Installing and servicing home radio and television receivers, hi-fi and stereo equipment, public-address systems, burglar and fire alarms, and other electronic devices are included in this segment of the industry. Some technicians are self-employed, and some work for others.

With widespread public acceptance of entertainment and other electronic equipment for the home, this field is wide open for skilled technicians.

Industrial electronics: Installation and service of in-plant gear, including computers, servo systems, microwave equipment, burglar and fire alarms, closed-circuit television equipment, intercoms, electronic machine controls, etc. Most technicians work in a plant; some are field-service representatives traveling around the country with expenses paid, and some are self-employed.

These days the wheels of industry are turned electronically, and technicians are in high demand. Wages are good, with periodic raises and promotions, paid vacations and health benefits.

Electronics manufacturing: Quality control, assembly-line inspection and testing, installation and maintenance of in-plant electronic equipment, building prototypes, instrument calibration, etc.

Many technicians in this field are promoted to engineering assistants or associate engineers. They have prestige and a solid future. Salaries are good and employment is steady.

Broadcasting and communications: Includes operation, installation and maintenance of transmitters, studio and associated equipment at AM, FM, TV and shortwave broadcast stations. Installing and servicing commercial two-way mobile radio and fixed stations, and telephone equipment. Operation, installation, maintenance of tape, disc and film equipment for motion-picture and recording studios.

More people use radio communications today than ever before. The number of transmitters in use grows each year. All need qualified technicians to service them.

Hobby electronics: Some persons like electronics for its own sake. They are hi-fi/stereo addicts, ham radio operators, construction builders or CB enthusiasts. They often study electronics because it makes their hobby more fun. A hobby isn't a job, but playing around with a hi-fi amplifier or a ham rig is an easy way to gain valuable practical experience. An electronics hobby can even help you get a better job.

Skills Needed

Regardless of the type of electronics work you would like to do, you must know a certain amount of theory and have some practical experience. The more you know about any equipment, the better and faster you can get it to work; that means money and personal satisfaction.

Consumer electronics: You must know how to use basic test equipment such as a voltmeter, oscilloscope, signal generator, etc. You must be familiar with AM, FM and TV receivers, as well as their antennas, and audio amplifiers and

power supplies. You should understand how transistors, vacuum tubes and semiconductor diodes work, as well as how to handle them.

Industrial electronics: You should be as qualified as the man in the consumer electronics field. In addition you must be familiar with the specialized equipment or systems used in your chosen industrial electronics field. Such things as tachometers, Q-meters, dc choppers, magnetic control amplifiers, polyphase rectifier circuits, telemetering equipment, medical equipment, closed-circuit TV systems, TV cameras, etc., are all part of this exciting industry.

Electronics manufacturing: You need most of the preceding skills, and more. Since your work can be that of an engineering assistant, you must be able to construct equipment from notes, schematics and other plans. You should know how to use laboratory-type test equipment. You may be given an opportunity to supervise and instruct others.

Broadcast and communications: A technician in this field must first have an FCC Commercial Radio Operator license, so he may legally operate, service and maintain radio and TV transmitters. He needs a working knowledge of electronic test instruments and of transmitters. Test equipment includes rf bridges, field-intensity meters, sound-level meters, etc. Other equipment includes TV sync generators and cameras, subcarrier generators and single-sideband equipment.

Acquisition of Skills

There are several ways to become technically qualified for a rewarding career in electronics.

Self-study: You buy a book, read it, work some problems and examples, perhaps build some electronic devices to get to know circuit operation and hardware. This method requires much self-discipline. You have no teacher to guide you or explain things not covered in the book. Many technicians have started this way, but as their thirst for knowledge grew with their experience, many of them found it to their advantage to pursue a more formalized program.

On-the-job training: Quite a few technicians got their start helping out around a radio or TV shop after school. They learned the tools of the trade, the hardware and much of the jargon. However, on-the-job training is only as good as the quality of supervision and programing of activities. Just taking any job in any radio and TV store or factory is not the answer.

But on-the-job training, while it puts you in electronics right away and brings in income, can be a dead end unless you also study theory. Many persons use the self-study method along with work. Some attend manufacturer's seminars and technician association training meetings. Most technicians at one time or another have beefed up their training with a correspondence course.

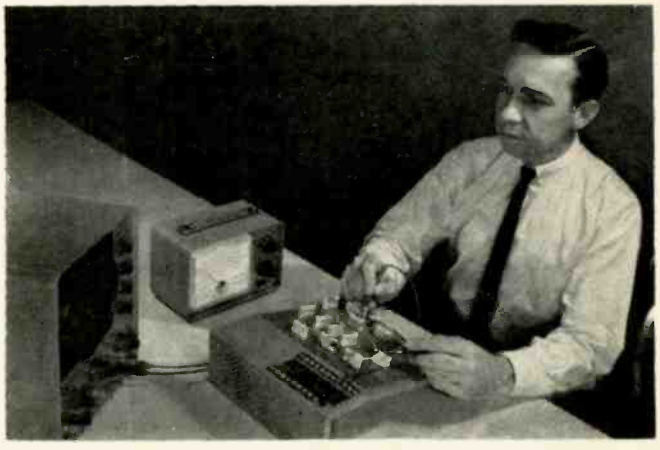
Home study (Correspondence course): You follow formal lesson plans designed by experts to include all needed information. After studying a lesson, you answer questions on the subject; your answers are read and graded by instructors. They will answer any questions you have and give you extra help when necessary. Kits are often used. You begin your program with a course in basic electronics, then pick a more specialized area to work in, such as industrial electronics or consumer electronic servicing.

You can study at home while you are employed full-time. You set your own speed, and you study at your convenience. Costs and time are determined by the complexity and completeness of a course.

Classroom study: For many persons, this is the best way to learn electronics in the shortest time. You attend regular classes, meet your instructor face-to-face at each session, and follow a planned course. You learn not only "book theory" but perform bench experiments and get the feel of the hardware.

Supplementary Reading

You will find many fine electronics books and magazines in your local electronics distributors, bookstores, and newsstands. Some books are short and deal with a specific subject such as how transistors work using a vom, etc. Others are complete texts, and still others are comprehensive reference books. Practically all electronics technicians read such books and magazines from time to time to keep up with the field.



Home-study courses often include useful electronic projects.

With training, you can be a part of the big TV network shows as a video control technician.

Guidance

Many companies will advise you how to go about qualifying for employment with them. Some have complete on-the-job training programs for new employees, and will start you as an apprentice with little or no electronics knowledge at first.

You can also seek guidance from the last school you attended, or from the school you would like to attend. You can write any school and ask them for their catalog and other descriptive material about the courses they offer. The National Council of Technical Schools and the National Home Study Council (see the partial listing of electronic schools for address and more photos on page 40) will also provide you with helpful information. **R-E**

Q. and A. On an Electronics Career

Q: Can a woman study electronics and work in the field?
A: Yes. Sex is no barrier to training or employment. Knowledge, ability and experience are what count.

Q: Is there any age limit for new students?
A: Generally no, but educational prerequisites make it difficult for young children to qualify. Teenagers and persons in their 60's have benefited from electronics training.

Q: What educational requirements are there?
A: For vocational training (such as radio-TV servicing or industrial electronics) at least an 8th-grade education is necessary. For engineering technology (assistant to engineer in manufacturing) a student must often be a high-school graduate. These are general rules; each school has its own requirements.

Q: Does a student *have* to take a basic electronics course first?
A: Not always. If you're already working in electronics and have basic knowledge, you may qualify for an intermediate or advanced course. Most schools have guidance counselors to help you choose the right course for you.

Q: Does an electronics school have contact with major electronics employers to assist graduates to obtain jobs?
A: Yes—most schools maintain placement services for such purposes.

Q: Will a school guarantee a graduate a job?
A: An ethical school won't make such a promise. The final decision on employment is a personal one between graduate and employer.

Q: Do employers recognize diplomas?
A: Yes. Accredited schools must meet standards which require that only students who have made passing grades obtain diplomas. Thus the certificate means you have satisfactorily completed a course or program.

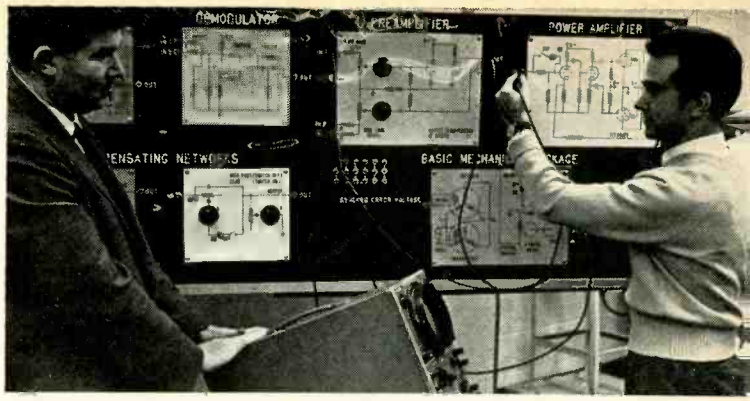
Q: Does a student have to choose his entire program at once?
A: No—you can take each course as you want it. (However, you must take certain subjects before advanced ones.)

Q: Can a student take a home-study course, then transfer to resident school and receive credit?
A: Generally yes, depending on the school(s) involved. It is usually easier to do this at the same school.

Q: Can members of the armed forces on active duty enroll in correspondence courses?
A: Yes. Since lessons are handled by mail, it makes no difference where the student is.

Q: Can veterans attend electronics schools under the GI Bill?
A: Yes. Most schools are approved for veteran training.

Q: Don't training courses become obsolete, with such new devices as FET's and IC's appearing in electronics?
A: Yes—advances in electronics make lessons out-of-date from time to time. Because of this, schools constantly revise and update their courses to include the latest technical material. Some schools even issue regular bulletins to students and graduates, with details of new devices and techniques.



All schools today use training aids and test equipment. You learn the functions, the symbols, and how the circuits work.

Part of your training should be working in the laboratory to develop the feel of tools, test equipment and troubleshooting.

Electronics Schools Directory

Academy Avionics
Reno-Stead Airport
Reno, Nev.

American Institute of Engineering and Technology
1139 W. Fullerton Pkwy.
Chicago, Ill. 60614

American School
Drexel Ave. at 58 St.
Chicago, Ill. 60637

Canadian Institute of Science & Technology
263 Adelaide St., W.
Toronto, Ont., Canada

Capitol Radio Engineering Institute
3224 16 St., N.W.
Washington, D.C. 20010

Central Technical Institute
1644 Wyandotte St.
Kansas City, Mo. 64108

Cleveland Institute of Electronics
1776 E. 17 St.
Cleveland, Ohio 44114

Commercial Trades Institute
1400 W. Greenleaf Ave.
Chicago, Ill. 60626

Cook's Institute of Electronics Engineering
P.O. Box 10634
Jackson, Miss. 39209

Coyne Electronics Institute
1501 W. Congress Pkwy.
Chicago, Ill. 60607

DeVry Institute of Technology
4141 Belmont Ave.
Chicago, Ill. 60641

Elkins Institute
2603 Inwood Rd.
Dallas, Tex. 75235

Grantham School of Electronics
1505 N. Western Ave.
Hollywood, Calif. 90027

Heald College
1215 Van Ness Ave.
San Francisco, Calif. 94109

Hemphill Schools
1584 W. Washington Blvd.
Los Angeles, Calif. 90007

Indiana Home Study Institute
P.O. Box 1189
Panama City, Fla. 32401

International Correspondence Schools
Scranton, Pa. 18515

National Radio Institute
3839 Wisconsin Ave., N.W.
Washington, D.C. 20016

National Technical Schools
4000 So. Figueroa St.
Los Angeles, Calif. 90037

Niles Bryant School
3631 Stockton Blvd.
Sacramento, Calif.

Northrop Institute of Technology
1199 W. Arbor Vitae
Inglewood, Calif.

Philco Technical Institute
219 No. Broad St.
Philadelphia, Pa. 19107

RCA Institutes, Inc.
320 W. 31 St.
New York, N.Y. 10001

Sams Technical Institute, Inc.
1720 E. 38 St.
Indianapolis, Ind. 46218

Technical Training International Inc.
10447 So. Torrence Ave.
Chicago, Ill. 60617

Tri-State College
2487 College Ave.
Angola, Ind. 46703

Valparaiso Technical Institute
Valparaiso, Ind. 46383

Some schools offer correspondence courses, some residence training, some both. This is only a partial listing. For more information about other schools, write:

National Council of Technical Schools
1507 M St., N.W.
Washington, D.C. 20005

National Home Study Council
1601 18 St., N.W.
Washington, D.C. 20009

The FCC License ...and how to get it

Your admission ticket to a career.

By THOMAS R. HASKETT

ONE OF THE MOST COMMON "DIPLOMAS" FOUND IN ELECtronics is the Commercial Radio Operator license issued by the Federal Communications Commission. By act of Congress, most of the nearly 2 million radio and television transmitters used in the US today must be operated—and all must be serviced and maintained—only by persons holding one of the various classes of FCC operator license.

To obtain a "ticket," you must pass a written examination covering, among other things, electronics and radio theory and practice. Thus, possession of an FCC license is generally considered proof of electronics knowledge. Such proof can help you obtain a technical job, even though the position may not legally require a license.

To work as a technician servicing transmitting equipment you must have a ticket, of course. But even if you don't intend to troubleshoot transmitters, a license can be helpful. At nearly half of the 7000 US broadcast stations, for instance, you'll be a more valuable employee if you have a Radiotelephone Third-Class license with a broadcast endorsement. Whether you're an announcer, a typist or a janitor, you can then legally perform routine transmitter operation.

License requirements

To be eligible, you must be a US citizen and capable of transmitting and receiving spoken messages in English. Further requirements depend on the class of license you want. Table I lists the elements of the examination you must pass for each license. Here's what the exam covers:

Element 1—Basic Law: Radio laws, treaties and regulations which every operator must know.

Element 2—Basic Operating Practice: Procedures used when communicating by means of radiotelephone stations.

Element 3—Basic Radiotelephone: Technical, legal and other matters which apply to radiotelephone stations (other than broadcast). Covers general electronics theory.

Element 4—Advanced Radiotelephone: Advanced technical, legal and other matters which apply particularly to AM, FM and TV broadcast stations. Covers advanced electronics theory.

Element 5—Radiotelegraph Operating Practice: Procedures used when communicating by means of radiotelegraph stations.

Element 6—Advanced Radiotelegraph: Technical, legal and other matters which apply to all classes of radiotelegraph stations, and associated matters such as radio navigational aids and message traffic routine. Covers advanced electronics theory.

Element 7—Aircraft Radiotelegraph: Basic theory and practice in the operation of radio communication and navigational systems used on aircraft.

Element 8—Ship Radar Techniques: Specialized theory and practice which applies to installation, servicing and maintenance of ship radar equipment used for marine navigation.

Element 9—Basic Broadcast: Basic regulatory matters which apply to the operation of AM and FM broadcast stations.

Table I—Requirements for FCC Operator Licenses

	Element 1 Basic law	Element 2 Basic Operating Practice	Element 3 Basic Telephone	Element 4 Advanced Telephone	Element 5 Telegraph Operating Practice	Element 6 Advanced Telegraph	Element 7 Aircraft Telegraph	Element 8 Ship Radar	Element 9 Basic Broadcast	Code Speed	Special Requirements
RADIOTELEPHONE											
First-Class License	X	X	X	X				(3)			
Second-Class License	X	X	X					(3)			
Third-Class Permit	X	X							(4)		
Restricted Permit											At least 14 yrs old; declaration only req'd.
RADIOTELEGRAPH										(5)	
First-Class License	X	X			X	X	(1)	(3)		25/20	At least 21 yrs old; 1 year service
Second-Class License	X	X			X	X	(2)	(3)		20/16	
Third-Class Permit	X	X			X					20/16	

1 Aircraft telegraph endorsement required on this license to operate radiotelegraph station on aircraft. (Exception: If license holder has been chief or sole operator in such capacity prior to 2-15-50.)
2 Aircraft telegraph endorsement, 25-wpm code speed, and at least 18 years of age required on this license to operate radiotelegraph station on aircraft.
3 Ship radar endorsement required on these licenses to service and maintain ship radar equipment.
4 Basic broadcast endorsement required on this license to operate certain classes of broadcast transmitters.
5 First figure indicates plain-language words; second figure indicates 5-character code groups; both per minute.

Preparing for the exam

There are two general ways to study: One is to buy (or borrow) a handbook. Several are listed in Table II.

These books contain sample questions similar to those contained in the FCC exam. Each question is followed by the correct answer and the theory behind it. The best way to study is to cover the answer with a piece of paper while you read the question. Then write your answer. If you are correct, check that question off and go on to the next. When you miss a question, study the background material and work a few problems based on the subject. Refer to other books if you like; the object is to become familiar with the theory and practice, not just the answer.

The second way to study for the FCC exam is to enroll in a correspondence or residence school and take a course designed to prepare you on this subject.

To pass the examination for any class of radiotelegraph license, you must be able to transmit and receive International Morse code at the rate specified in Table I.

Code instruction is seldom available at the schools mentioned; they usually prepare you only for radiotelephone exams. Code-practice tapes, records and books are available through electronics distributors.*

Table II—License Study Manuals

Commercial Radio Operator's Question & Answer Guide, by Martin Schwartz. No. 8-01 (Elements 1, 2 and 9) 1964, $0.75; No. 9-01 (Element 3) 1967, $1.95; No. 10-01 (Element 4) 1958, $1.25. Ameco Publishing Corp., Williston Park, N.Y.

First-Class Radiotelephone License Handbook, BON-2, by E. M. Noll. Howard W. Sams & Co., Inc., Indianapolis, Ind., 1966, $5.25.

Radar License Endorsement Handbook, RLH-1, by E. M. Noll. Howard W. Sams & Co., Inc., Indianapolis, Ind., 1964, $2.95.

Radio Operating Questions and Answers, 13th Edition (text), by J. Hornung and A. McKenzie. McGraw-Hill Book Co., Inc., New York, N.Y., 1964, $6.00.

Radio Operator's License Handbook, RON-1, by E. M. Noll. Howard W. Sams & Co., Inc., Indianapolis, Ind., 1965, $3.25. (Covers Third-Class Radiotelephone license with broadcast endorsement.)

Radio Operator's License Q & A Manual, 7th Edition, by Milton Kaufman. Hayden Book Co., Inc., New York, N.Y., 1966, $7.95.

Radiotelephone License Manual, 3rd Edition, by Woodrow Smith. Editors & Engineers, Ltd., New Augusta, Ind., 1962, $5.75.

Second-Class Radiotelephone License Handbook, 3rd Edition, QAN-2, by E. M. Noll. Howard W. Sams & Co., Inc., Indianapolis, Ind., 1966, $4.95.

Successful Preparation for FCC Radio Operator License Examinations, by D. L. Geiger. Prentice-Hall, Inc., Englewood Cliffs, N.J., 1960, $9.95.

Taking the exam

If you live in or near any of the cities listed in Table III, look up the FCC field-office phone number and call them for information. Exams are usually given each week at these offices.†

If you live away from the cities in Table III, your best bet is to write to the nearest listed office. Ask them where your nearest examining point is, and when the next exam will be given. Ask them also to send you one each of FCC Forms 756 and 756-B (the official applications for license). When you plan to take an exam anywhere but an FCC district office (those shown in Table III) you must fill out and mail in the application in advance.

You must pay a fee with your application for a license.

*One useful book is *Learning the Radiotelegraph Code*, American Radio Relay League, Newington, Conn., $0.50.

†Don't apply to a field office for a Restricted Radiotelephone Permit. While there are some exceptions, you should usually write to FCC, Gettysburg, Pa. 17325. Ask for FCC Form 753, which is the application for this class of permit.

Table III—FCC Field Offices

P.O. Box 644	Boston, Mass. 02109
Anchorage, Alaska 99501	Detroit, Mich. 48226
Los Angeles, Calif. 90014	St. Paul, Minn. 55102
San Francisco, Calif. 94126	Kansas City, Mo. 64106
San Pedro, Calif. 90731	Buffalo, N. Y. 14203
Denver, Colo. 80202	New York, N. Y. 10014
Washington, D.C. 20555	Portland, Ore. 97205
P.O. Box 150	Philadelphia, Pa. 19106
Miami, Fla. 33101	P.O. Box 2987
Atlanta, Ga. 30303	San Juan, P. R. 00903
Honolulu, Hawaii 96808	Dallas, Tex. 75202
Chicago, Ill. 60604	Houston, Tex. 77002
New Orleans, La. 70130	Norfolk, Va. 23510
Baltimore, Md. 21202	Seattle, Wash. 98104

Address all communications to "Engineer in Charge, Federal Communications Commission."

If you appear at an FCC district office in person, you may pay cash; otherwise send only check or money order by mail. Cost depends on the class of license or permit: First-Class, $5; Second-Class, $4; Third-Class, $3; Restricted Radiotelephone permit, or renewal of any license, or endorsement of license, or duplicate license, $2.

When you take the exam, you'll be given the code test first if you apply for any class of Radiotelegraph license. You must receive and transcribe consecutive words or code groups for a period of one minute without error at the specified rate of speed. If you fail the code test, you won't be given the written exam.

You will be given a series of printed questions to answer in writing, and (for some elements) you'll be required to draw (or correct) a few schematic diagrams. The minimum passing grade for each element is 75%.

If you fail any element, you are not allowed to go any further in the exam. You will be issued, however, whatever license you have qualified for. For example, suppose you applied for a Radiotelephone First-Class license, passed Elements 1 and 2, but failed Element 3. You would then be issued a Radiotelephone Third-Class permit.

Once you have failed an element, you normally cannot take another commercial exam for two months. (If you have urgent need for the license and are willing to do further study at once, however, you can apply for a waiver of this rule, on FCC Form 757-B.)

License privileges

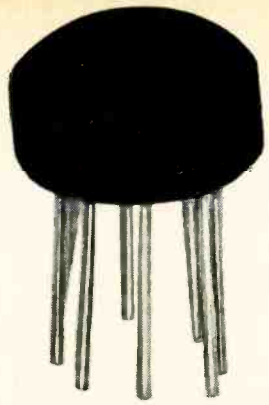
Okay, you passed the exam, you got the license—now what can you do with it? That depends on which license.

The *Restricted Radiotelephone permit* is intended for operators only, and has limited usefulness. You are authorized to operate the following classes of stations: remote-pickup broadcast, land and ship maritime telephone, aviation, public safety (police and fire), industrial, land transportation (taxicab and trucking). You may not perform any servicing or maintenance of transmitters.

The holder of a *Radiotelephone Third-Class permit* may operate all of the preceding stations, plus instructional fixed TV stations, international fixed public stations (common carriers) and—with a broadcast endorsement—AM broadcast stations with power output of 10 kW or less and nondirectional antennas, and FM broadcast stations with power output of 25 kW or less. This permit does not allow any servicing or maintenance of transmitters.

A *Radiotelephone Second-Class license* permits operation of all the preceding (no broadcast endorsement required to operate broadcast stations), plus TV auxiliary and booster stations, and CATV relay stations. This license is also really useful in an electronics sense; it allows you to perform servicing and maintenance at the following types

(continued on page 71)



30 BASIC IC PROJECTS

Part 1 of 2 parts to help you learn how to work with IC components and their related circuits

By R. M. MARSTON

HAVE YOU IGNORED INTEGRATED CIRcuits in your construction projects as "too expensive" or "specialized"? Forget those ideas—cheap, plentiful IC's are here, and you can build many circuits with them.

A real winner is the Fairchild μL914—it costs less than a dollar. For your money you get 4 silicon planar 2N708 transistors and six resistors, all encased in an epoxy block roughly the size of a TO-5 case. The 2N708 transistors have an f_T (gain–bandwidth product) of 450 MHz.

The internal circuit of the μL914 is shown in Fig. 1, and lead connections in Fig. 2. By juggling around the connecting leads and maybe adding a few extra components, you can come up with: a differential amplifier, a multichannel audio mixer, or an audio oscillator, just to name a few examples.

Remember just two basic rules: (1) Do *not* think of an IC as some fantastic new technical device needing new application techniques all its own. (2) *Do* think of the IC as a bunch of perfectly normal transistors and resistors, bonded together in a single block, and requiring perfectly normal transistor-circuit design techniques.

With Rule 2 in mind, take a look at Fig. 1, the internal circuit schematic of the μL914. Unwanted transistors can be effectively cut out of the circuit by shorting them base to emitter.

Cut Q2, Q3 and Q4 out of circuit by shorting pins 2, 3, 4 and 5. Wire a bias resistor from pin 1 to pin 7, and you're left with a perfectly normal common-emitter amplifier, Q1. Short out only Q2 and Q3, and apply bias to Q1 and Q4, and you have two normal common-emitter amplifiers.

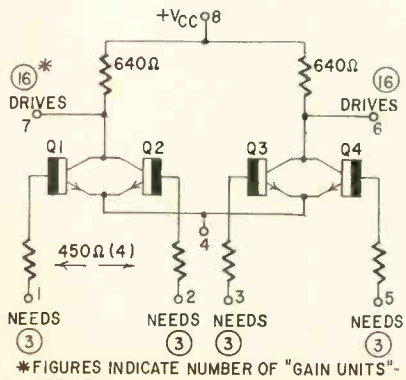
Cut Q3 and Q4 out of circuit, and apply bias to Q1 and Q2. Now you have a two-channel mixer with output at pin 7. Apply bias to all four transistors and short pins 6 and 7, and the IC works as a four-channel mixer.

As you can see, it's easy to wire the μL914 to work in a number of alternative basic modes. Once you've figured out which mode you want, you can get on with circuit design just as if you were using standard transistors.

Want to use the μL914 in pulse or logic applications? A nice feature about this micrologic line of IC's is that you don't have to figure input and output drives in terms of impedance and current. Fairchild specifies input and output needs as so many *units of drive*, as shown circled in the diagrams.

Thus, the μL914 needs 3 units of drive at each input and gives 16 units of drive at each output. Each output can therefore drive as many as five following input stages. This means that, if you want to use a stack of the circuits interconnected, you can easily calculate just how many inputs each output can drive directly, and normally complex circuit layout calculations can be simply made.

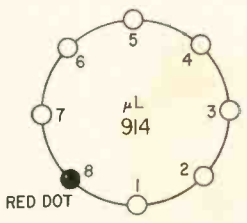
Now let's look at some practical applications.



*FIGURES INDICATE NUMBER OF "GAIN UNITS"-SEE TEXT

INTERNAL CIRCUIT OF μL914

Fig. 1



TOP VIEW

BASE LEAD CONNECTIONS OF μL914

Fig. 2

Waveform generators

When the μL914 is operated as a differential amplifier, one of the two outputs will be in phase with, but of greater amplitude than, the input signal. It follows that if this signal is fed back to the input the circuit will act as an oscillator or waveform generator. The waveform generated will depend on the form of positive feedback connection used in the circuit.

Fig. 3 shows how to connect the IC as a wide-range audio generator to cover 150 Hz to 40 kHz in three ranges. An approximately rectangular waveform is generated, since a simple RC (R6–C2) feedback network is used. R6 acts as the variable frequency control.

Fig. 4 shows the connections for making the circuit act as a 1-kHz Wien bridge sine-wave generator. The frequency-determining components are R1–C3–R6–C2.

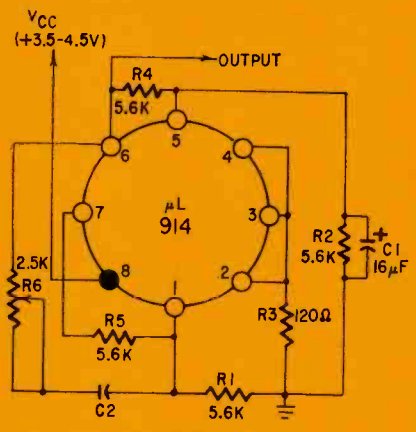
When using this circuit R6 should be adjusted to give a pure sine wave on an oscilloscope. It is possible, using a 4.5-volt supply, to obtain a pure sine-wave output of about 1 volt peak to peak from the circuit. Note that the values used for C2 and C3 are not standard and must be built up by wiring standard components in parallel. The operating frequency can be changed, if required, by changing the values of C2 and C3; an increase in value gives a decrease in frequency.

Dc meter amplifier

The differential amplifier is widely used as the basis of an electronic voltmeter or for increasing the sensitivity of moving-coil current meters. The trouble with normal transistors in these applications is that the circuits are subject to considerable zero drift with small changes in temperature. This is partly due to differences in characteristics of individual transistors. Another reason is that, due to its physical position in the circuit, one transistor may be subjected to larger temperature changes than the other.

When an IC is used as a meter amplifier, however, drift troubles do not exist. IC transistors are etched on a common slab of silicon and must inevitably be held at equal temperatures and have their characteristics closely matched as a result.

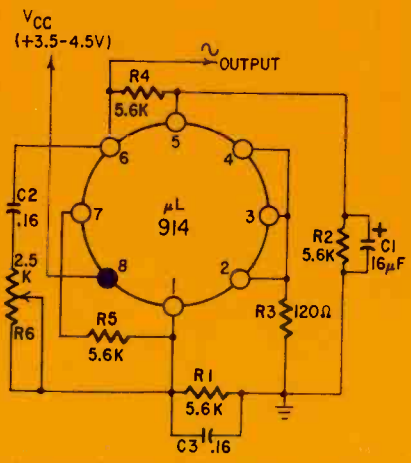
Fig. 5 shows how to wire the μL914 for use as a dc meter amplifier. If a 1-mA meter is used, its sensi-



WIDE-RANGE AUDIO GENERATOR

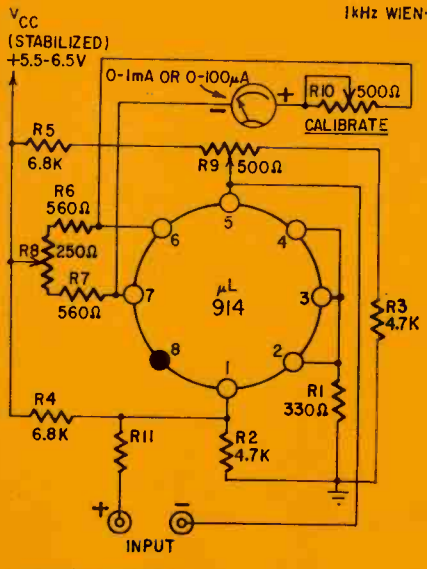
C2 = 1μF, f = 150Hz TO 3kHz
= .1 , f = 3kHz TO 15kHz
.02, f = 12kHz TO 40kHz

Fig. 3



1kHz WIEN-BRIDGE SINEWAVE OSCILLATOR

Fig. 4

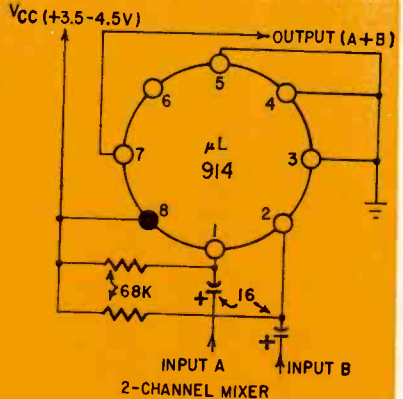


DC METER AMPLIFIER

RII = VOLTMETER RANGE MULTIPLIER
= 20KΩ / VOLT FOR 1mA METER
= 100KΩ / " " 100μA METER

DC METER AMPLIFIER

Fig. 5



2-CHANNEL MIXER

Fig. 6

[The μL914 IC retails for $0.80 at Fairchild distributors. Most of them do not accept mail orders for less than $10.00. Semiconductor Specialists, P.O. Box 8725 O'Hare International Airport, Chicago, Ill. 60666 accepts mail orders of $3.00 or more. If you must purchase by mail-order, we suggest you order four μL914's. They are quite versatile and you can use them in future construction projects.—*Editor*]

tivity will be increased more than 20 times (to 50 μA). A 100-μA meter can be increased more than 10 times (to better than 10 μA).

If a voltage-range multiplier (R11) is wired in series with the input lead as shown, the sensitivity of the resulting electronic voltmeter will be raised to 20,000 ohms/volt using a 1-mA meter, and to 100,000 ohms/volt with a 100-μA meter. Note that this circuit uses a 6-volt stabilized supply which can be obtained from a Zener diode.

Once the meter amplifier has been built, set it up as follows:

(a) Short the input terminals, and set R8 for a zero reading on the meter.

(b) Open the input terminals and set R9 for zero on the meter.

(c) Repeat (a) and (b) until no further zero adjustment is required.

(d) Select the multiplier (R11) for the full-scale voltage required. Example: If a 1-mA meter is used and a full-scale value of 10 volts is required, R11 should be 200,000 ohms.

(e) Apply a known voltage close to the required full-scale value to the input terminals and adjust R10 to indicate this voltage on the meter. The voltmeter is now ready for use.

When using the voltmeter, this series of checks should be repeated occasionally to make sure that calibration is correct. Readjustment will rarely be needed in practice, and R8, R9 and R10 can be preset types tucked away out of sight at the rear of the completed instrument. The unit may be used as a multirange voltmeter by providing switch selection of various R11 values.

Mixer circuits

Since the μL914 contains two pairs of transistors sharing a common collector load, each pair of transistors can be made to operate as a two-channel audio mixer if the transistors are suitably biased.

Fig. 6 shows how to wire the IC as a two-channel mixer using the Q1–Q2 pair of transistors only, and Fig. 7 shows the alternative connection using

the Q3–Q4 pair. Both these circuits give a voltage gain of about 16, between each input and the output.

The μL914 can be made to serve as a four-channel mixer by using both halves of the circuit and shorting all collectors to a common load. Fig. 8 shows the circuit. The voltage gain between each input and the output is about 8 in this mode.

Emitter follower

You can obtain a normal emitter follower by using the connections shown in Fig. 9. Input impedance is about 12,000 ohms; it can be increased by using normal bootstrap techniques, if required. Only one emitter follower can be made from each μL914.

Common-emitter amplifiers

The differential amplifier can be used with advantage to replace conventional common-emitter amplifier stages. The current taken by a C-E stage from the supply line remains virtually constant under operating conditions, and there is thus no great need to incorporate decoupling networks in the supply lines when cascading stages.

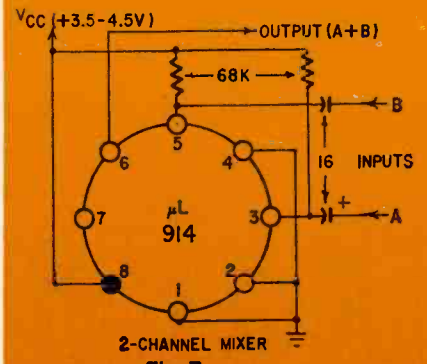
The μL914 can, however, also be used to replace a conventional common-emitter amplifier. Fig. 10 shows one connection using Q1 only, while Fig. 11 shows an alternative connection using Q4. Both these circuits give voltage gains of about 20, and have flat frequency response within 3 dB from 60 Hz to well over 1 MHz.

The μL914 connections can be modified so that the amplifiers of both Figs. 10 and 11 are incorporated in a single circuit, and two independent common-emitter amplifiers are made available. Alternatively, this modification can be made and the two amplifiers cascaded to form a single very-high-gain amplifier. The connections for this mode are shown in Fig. 12.

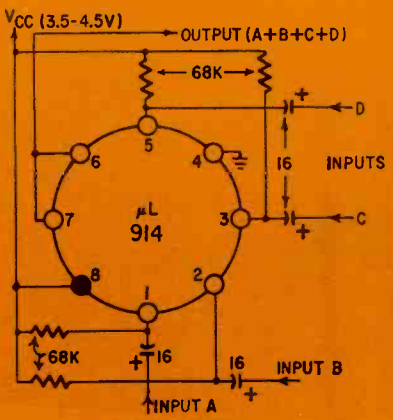
The circuit of Fig. 12 gives a voltage gain of about 400, and has a frequency response that is within 3 dB from 100 Hz to about 200 kHz. The low-frequency end of the spectrum can be extended by increasing the values of C1 and C2. Capacitors C3 and C4 limit the upper end of the frequency response; if they are not used, the circuit will, through internal feedback, act as an oscillator operating at a frequency of several megahertz.

Now that you've seen these first 10 applications of the μL914, you may want to try a couple. Next time we'll show you even more interesting uses for this inexpensive IC.

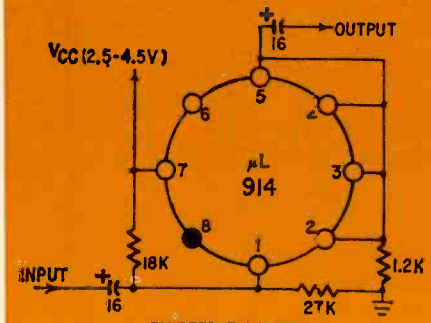
Continued next month



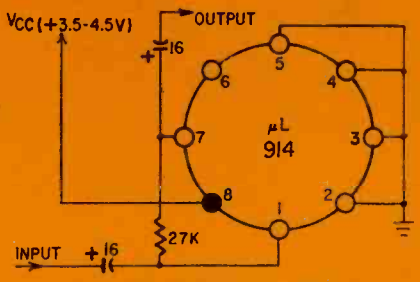
2-CHANNEL MIXER
Fig. 7



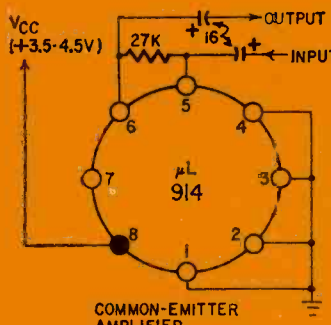
4-CHANNEL MIXER
Fig. 8



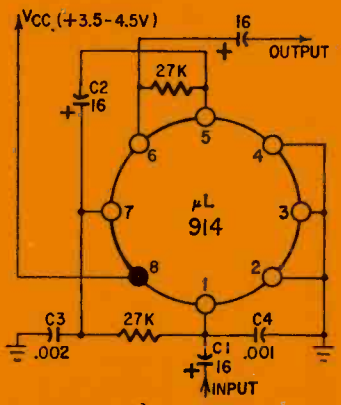
EMITTER FOLLOWER
Fig. 9



COMMON-EMITTER AMPLIFIER
Fig. 10



COMMON-EMITTER AMPLIFIER
Fig. 11



VERY-HIGH-GAIN, COMMON-EMITTER AMPLIFIER
Fig. 12

Rotary Stepping Switches—They're Everywhere

Part 2—Use them for counting, circuit selection and remote control **By TOM JASKI**

PART 1 OF THIS SERIES DESCRIBED HOW rotary switches are used for the selection of as many points as the selecting switch carried, but with only a single sequence of pulses. A telephone dial is a useful control device which produces a maximum of 11 pulses. Thus supplying control pulses with such a dial might make it necessary to dial several times until the correct *total* number of pulses were delivered. Note too that most telephone-type dials will deliver one extra pulse. Thus if 3 is dialed, 4 pulses are actually delivered by an unmodified dial.

Fortunately, it's possible to prevent such action. An electrical modification can be made, by inserting a slow-release relay in the circuit. The relay is then picked up by the first pulse—the relay blocks all line pulses until it *is* picked up. It's also possible to modify the dial mechanism mechanically.

Changing a telephone dial

Fig. 1 shows how to eliminate the extra pulse from a standard older-type telephone dial. Note the "off-normal" contacts. These are operated by a small brass foot attached to the shaft. When the dial is rotated, the normally closed contacts are opened (and the normally open contacts are closed). The pulses are produced by the interrupter as the dial is on the return stroke. By extending the brass foot of the off-normal contacts a little (this can be done by soldering on a small piece of brass) and sending the pulses through one of these contacts, the extra pulse can be eliminated. The last pulse is then blocked by the off-normal contact.

Note too that the dial's mode of forming pulses—making or breaking contacts—can be changed by adjusting the position of the interrupter cam on the geared shaft.

Using the dial for selection leads to a more sophisticated, two-level system. By using a switch of 10 points per level and 10 levels (Automatic Electric type 80, or equivalent), a 2-digit code can select any one of 99 points. Fig. 2 shows the diagram for such a selector system. S1 is a minor switch, operated by the first digit dialed; this action selects the *level* of S2. The next set of pulses then rotates S2 to the desired contact. As arranged here, the pulse line also becomes the control line, and the circuit resets on a single pulse, but only after it has come to rest.

1CR is the relay which translates the pulses so a local power supply can be used. As pulses arrive, motor magnet MM1 steps S1 to the desired level of S2. Slow-release relay 2CR also energizes on the first pulse and remains energized until the pulses stop. When they do, and 2CR releases, relay 3CR is energized through now closed off-normal contacts ONS1 (which are on switch S1) and locks up on the supply. This action removes future pulses from S1 and also sends pulses through contacts 1CR-3 to motor magnet MM2. This second set of pulses causes MM2 to rotate S2.

When this sequence is finished, 2CR again drops out, now connecting 4CR, through 2CR-3, to the line and also to the wipers that make the controlled circuit. A tone arriving over this line does not affect the dc circuit, but a dc pulse *will* energize 4CR, a slow-release relay that will allow MM2 to step home on the interrupter and will energize the release magnet of S1, resetting these switches. Off-normal contact ONS1 on S1 then drops 3CR.

This circuit can deliver any one of 99 points on demand (even 100 by including the code 00). Using the same principles with more switches and relays would make it possible to extend the system indefinitely. Most industrial control or monitoring problems can be handled easily by a system that provides selection of any of 100 points—especially if the system has random access, like this one.

Output pulse polarity

One point about generating pulses with a stepper: The circuit of Fig. 3-a produces negative pulses—i.e., no voltage during steps. Positive pulses—voltage *only during* steps—can be produced with the hookups of Fig. 3-b and c. At (b) the outgoing line is grounded as long as the switch remains on a contact; when the arm moves, a positive voltage goes to the line. The resistor prevents shorting the battery. At (c) a relay inverts the pulses.

The device of Fig. 4 has several functions. First, it counts pulses in decades from a switch-type transducer. By mounting numbered discs or cylinders on the switch shafts this count can be

The Roto-Netic stepping motor from Heinemann Electric Co. converts pulses into rotary motion consisting of 10 precise steps. The device (see photo) consists of a linear solenoid, a spring-loaded, plunger-type armature, and a ratchet-and-pawl actuator on the end of the plunger that turns the output shaft.

When the solenoid is energized by a pulse, the plunger is drawn into the coil against spring tension. After the pulse, the solenoid is de-energized, and the spring forces the plunger back to "rest" position. This drives the actuator against a 10-tooth starwheel and produces 36° of shaft rotation (one step).

The actuator prevents the starwheel from rotating more than 36°, and a pawl prevents reverse rotation. This means there's no possibility of overshoot, and overshoot compensation isn't necessary. Each step is precisely the same as the last, and since the power stroke occurs upon de-energization, even the last stroke is recorded in case of power failure.

Speed is nominally 600 steps per minute and operates on either 12 volts dc or 115 volts ac with a bridge rectifier.

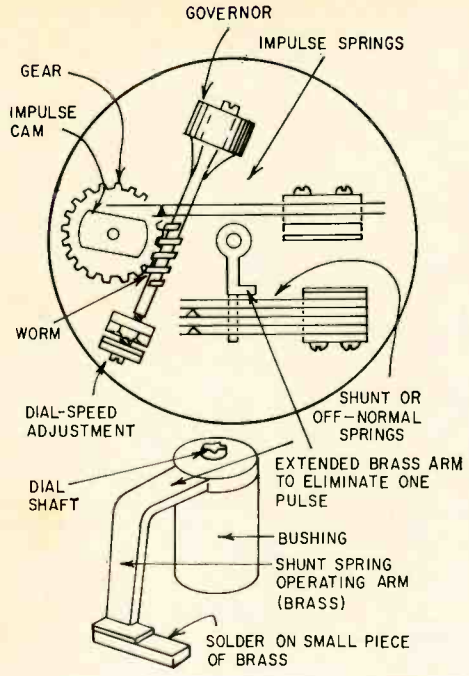


Fig. 1—How a telephone dial's shunt-spring operating arm is modified to eliminate the extra pulse that it normally generates.

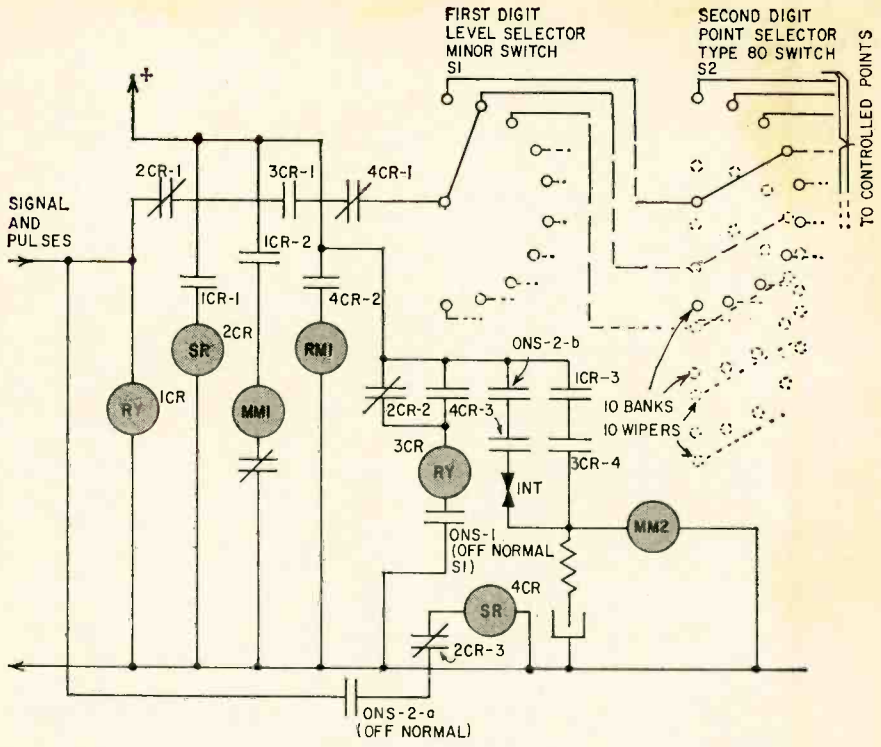


Fig. 2—A two-level selector can select any one of 99 points by actuating S1, then S2.

read directly. By supplying different tones for each switch, characteristic signals can be sent out over a single line, to identify units, tens and hundreds. (Of course, three separate lines can be brought out for this purpose.)

Circuit operation is simple: Incoming pulses operate relay 1CR, which is present for the usual reason (to keep from loading the pulse line). It causes S1 to step, and on the tenth pulse to S1 causes a wiper contact to connect MM2 to the positive dc line. This starts S2 on its first step. This same wiper contact energizes relay 2CR, which resets S1. The next two steps operate similarly, and just one pushbutton resets the whole circuit.

Again it's possible to say that this circuit can be expanded to include "thousands," "ten thousands" and so on. For practical purposes a count of 999 is quite large. The circuit shown was used for registering gallons pumped by gas pumps in a service station. A remote register totaled all the data from the pumps, using a storage or "memory"

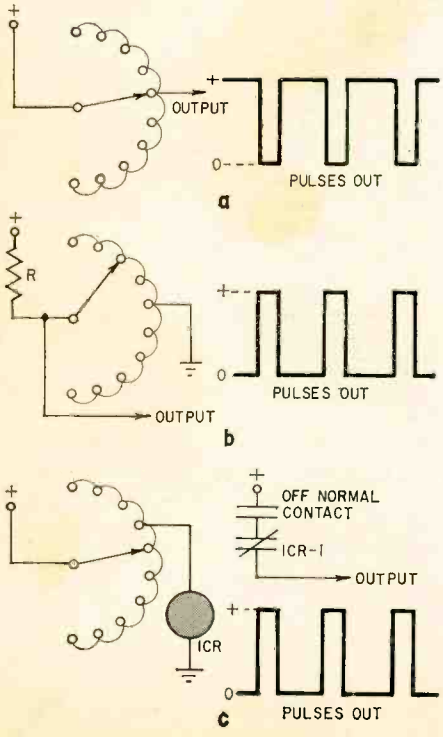


Fig. 3—How stepper generates pulses. a—Negative (zero-voltage) pulse output when arm is between contacts. b—Positive-pulse generator. c—Relay 1CR inverts pulses.

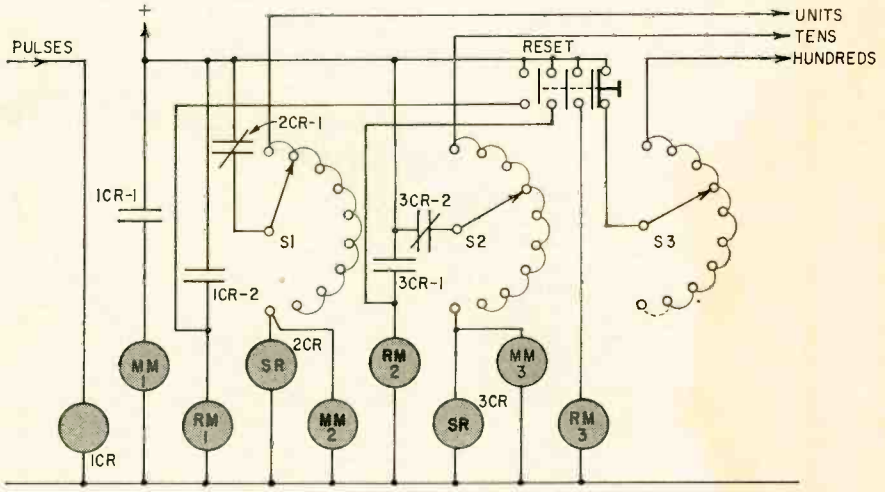


Fig. 4—(above)—Decade counting circuit. Separate lines send units, tens and hundreds pulses to readouts. Distinctive tone codes can be sent out over a single line.

circuit if several pumps were used simultaneously.

These circuits have been designed for direct-operated switches. For accurate timing it may make a difference whether switches are operated direct or indirect. An indirectly operated switch acts on the *cessation* of a pulse, rather than on the starting of one. In the circuits shown, that makes little difference. Also, all levels of contacts have been shown for nonbridging wipers. Bridging wipers running across contacts would not generate pulses.

Another point: A switch steps home much faster than it steps out, and pulses are produced by it much faster than dial pulses occur. (The latter run from 10 to 20 per second.) A switch stepping home on interrupters can be slowed down, as was described in Part I. But the homing speed of a minor switch can be regulated only by adjusting mechanical friction or spring tension. The speed can be slowed down some but not much.

Storing numbers

The circuit of Fig. 4 can be used to store three digits (and more by extension). A simple readout can be built to show the final setting of the three switches. Such a readout arrangement is shown in Fig. 5. The banks at right of the diagram are one level each from the three minor switches of Fig. 4. The stepping switch used for readout must be adjusted to make 30 contacts in sequence (on two levels), by properly setting the wipers. Each set of 10 is connected to the minor-switch contact banks. The switch will step through the first contacts (after starting, and this switch steps slowly) and will energize 4CR when a "ground" is encountered on the minor-switch bank. 4CR then stops further pulses (up to 10) from appearing on the output line.

When point 10 is reached, 4CR is reset by 2CR-3, and the switch then scans the bank of the second minor switch, and so on. The result is a series of three sets of pulses which will signal in order the units, tens and hundreds count of the three minor switches. If a pause is needed between sets of pulses, 2CR and 3CR can be used also to energize slow-operating relay 5CR. For the duration of its on–off cycle, 5CR prevents 1CR from stepping the switch. This function is indicated by dotted lines. The START button can be any momentary-contact type—even a relay contact.

For example, with several storage registers, a sensing circuit could be used to hold off one register until another has been "read." Any relay can be used as such a sensor by either the absence or presence of a voltage on its coil.

[In Fig. 5, the stepping switch is shown with two sets of 30 contacts arranged in circles. Each set of 30 contacts has 3 wipers. The method of presentation is used for simplicity. Actually, each set of 10 contacts is on a separate level and the wipers are 120° apart. Thus, contacts 1 through 10 are on one level, 11 through 20 on the next, and so on. This switch—Automatic Electric type 44 or equivalent—accommodates up to six 10-point bank levels. It is driven by a 33-tooth ratchet providing 10 "on-the-bank" positions followed by an "off-the-bank" position for each one-third revolution.—*Editor*]

Relay code selection

The individual code selector is a useful device. It can select one, and only one of several circuits, by means of one line or radio channel. While such selectors are made by various manufacturers (there are even electronics selectors with no moving parts), it's possible to build this kind of selector by using stepping switches and relays. Fig. 6 shows one circuit, which uses a type 44 switch, again arranged for 30 points.

Incoming pulses operate the slow-release relay and the motor magnet (the usual pulse relay has been left off). This switch, as shown has been arranged for the code 4–5–9. (Up to 0–9–9 can be used with the 44 switch.) If the switch wiper lands on any point connected to relay 2CR, the switch will immediately step home. Only by *successively* landing on the code-specified contacts will the

(continued on page 70)

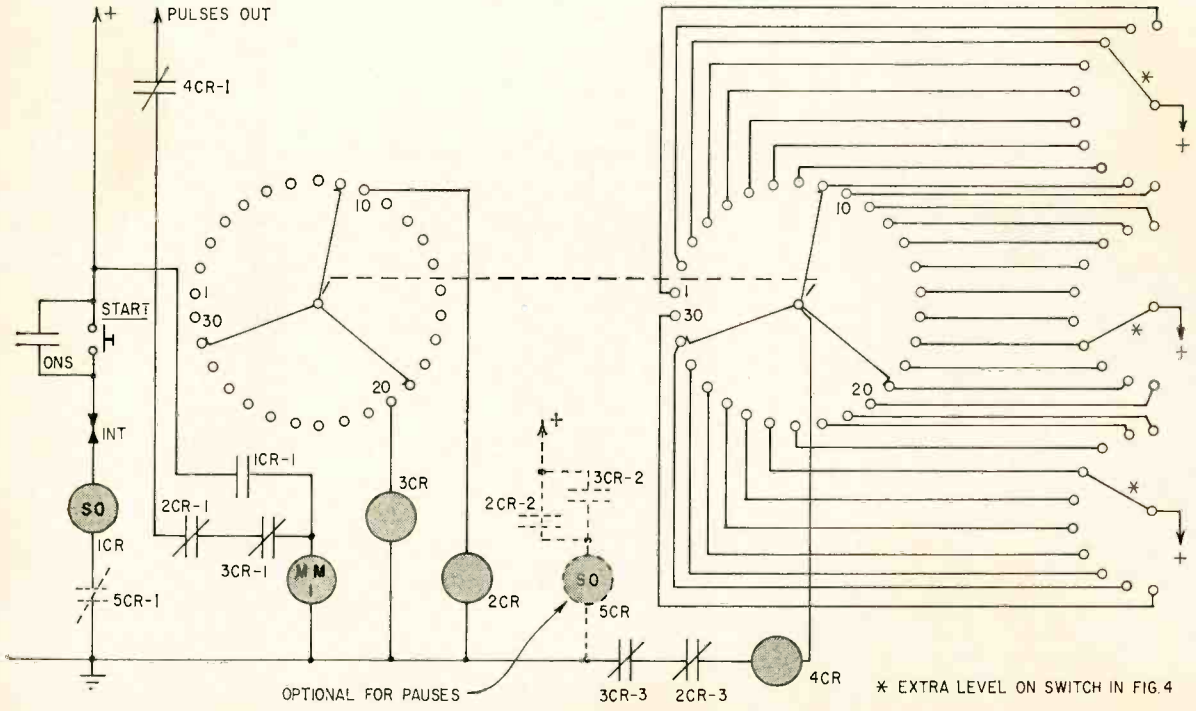
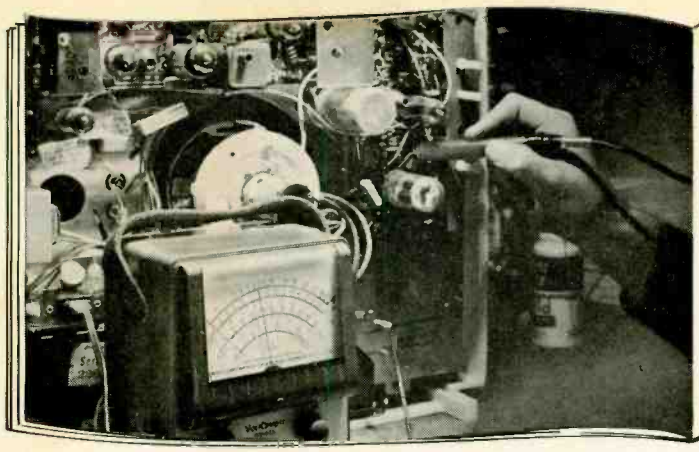


Fig. 5—Readout to indicate settings of switches in Fig. 4. An extra relay on contact 30 can replace the reset (START) switch.



VERTICAL SWEEP MANUAL

Learn vertical sweep servicing as an expert analyzes typical problems.

By HOMER L. DAVIDSON

VERTICAL SWEEP TROUBLES ARE EASY to spot. They appear on the screen as if to tell you exactly where to find them. If you know the functions of the vertical oscillator and output sections the visual symptoms can become most significant to you.

No vertical sweep shows up as a picture completely collapsed into a thin horizontal bright line. The line is usually bright because the energy of the electron beam that would normally be displaced over the full height of the screen is all concentrated in the line. Insufficient sweep shows up as a partially shrunken picture on top, bottom, or both. Nonlinear vertical sweep can cause heads to stretch or become flat-topped and feet to appear to be too long or too short . . . in severe cases the top and bottom of the picture folds over on itself.

Picture rolling can be caused by improper vertical oscillator frequency or loss of sync due to a weak signal, old age, poor video separation and other troubles in the video signal handling circuits.

Vertical deflection circuits

There are three types of vertical-deflection systems, but only two are widely used. The oldest is the simplest to repair. It has a *blocking oscillator* and a vertical output stage as shown in Fig. 1. An integrating network keeps all pulses except vertical sync out of the vertical oscillator.

Take care when checking the voltage at the plate of the vertical output tube. The high-amplitude spikes can damage the meter. The best bet is to use a scope with an appropriate probe. If the waveshape is good and the amplitude correct, you can assume that the plate voltage is okay. Start at the vertical oscillator and proceed to the output stage.

Another method is to connect two pieces of flexible hookup wire to the leads of a 0.05-μF, 600-volt capacitor. Solder alligator clips to the free ends of the wires. You can check the vertical-deflection voltage by clipping an alligator clip to the center terminal of the volume control. Touch the other clip to the input and output of each stage in the vertical section. You will hear a 60-cycle buzz that will get louder as you progress toward the yoke. If the buzz drops off, you have located a trouble spot.

If you do not have a negative voltage on the blocking oscillator grid, the stage is not oscillating. Check the blocking-oscillator transformer windings with an ohmmeter. Many times the secondary is open. If it's okay, check the plate voltage and resistances. The vertical-output transformer's resistance should also be checked against the manufacturer's data. Also check to see that none of the transformer windings are shorted to the transformer core.

In many older TV receivers that come in for repair, the vertical hold control will move the picture only one way. The quickest [but not necessarily the best—*Editor*] repair here is just to change the vertical hold circuit. Simply tie a couple of clip leads to a 2.5-meg pot. Clip one to the vertical oscillator grid and the other to the top terminal of the hold control. Set the hold control in the center of its range and adjust the clipped-on pot until the picture rolls both ways when you turn the set's hold control. Now disconnect the pot and measure it. Solder in a 1-watt resistor of the closest 10% value.

The second kind of vertical-deflection system uses a *multivibrator*, and a vertical output stage. The third system is just like the second, only the vertical-output stage is part of the multivibrator. This third system is used quite extensively in newer TV receivers; in many, only one two-section tube is used, such

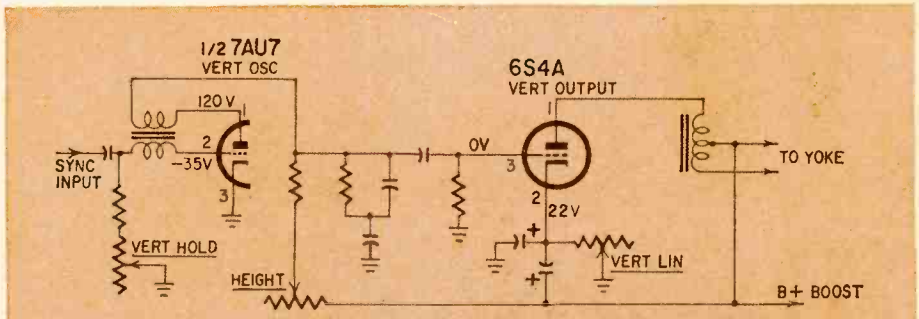


Fig. 1—A typical blocking-tube type vertical oscillator and output stage.

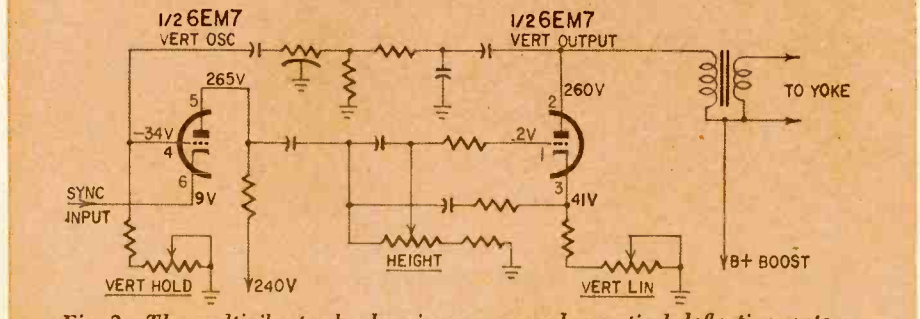


Fig. 2—The multivibrator hookup is a very popular vertical deflection system.

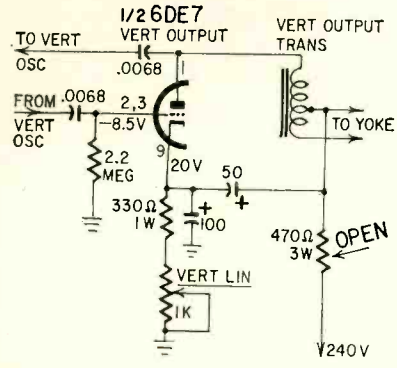


Fig. 3—The 470-ohm resistor opened, causing total loss of vertical sweep.

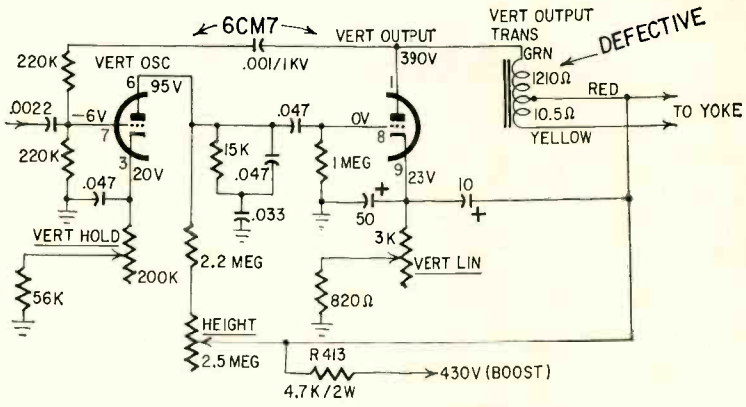


Fig. 4—Increase in transformer resistance cut pix height to 2 inches.

as a 6EM7. Fig. 2 shows a typical modern vertical-deflection system.

A multivibrator is a two-stage amplifier with the output of each stage fed to the input of the other. This positive feedback causes the circuit to oscillate. If any stage or a part of the feedback circuit becomes defective, the circuit will not oscillate.

Actual troubles

Let's take the case of only a horizontal line on the TV screen—let's say this is an Admiral 20US6 (Fig. 3). The brightness control should be turned down so the line is just visible. Otherwise you can burn a line across the tube.

The 6DE7 tube was checked and found okay. The trouble was an open 470-ohm, 3-watt B+ dropping resistor.

This same trouble can also be caused by a feedback coupling capacitor at the plate of the output stage. There is a high peak voltage at this point and even the 1,000-volt capacitors usually used there can short or start to leak. A small Admiral portable, chassis 15UA2, came in with this trouble. The feedback capacitor had shorted, leaving only a white line on the screen. Replace such capacitors with 1,600-volt types (the kind used as buffer capacitors in vibrator power supplies).

Another insufficient-height trouble was in an Admiral 14UY30 chassis (Fig. 4). There was only 2 inches of raster. Turning up the height control didn't help a bit. The output plate voltage was 200, and the grid voltage zero. The cathode voltage was only 11.5; it should have been around 23.

Most of the voltage, it turned out, was being dropped across the vertical-output transformer primary. A resistance check here showed that the winding had increased from 1,210 ohms to 1,580. The transformer was replaced, and we were in business. On this same chassis, I have found that R413 increases in resistance and causes the same trouble. Increased resistance in the height control or plate dropping resistor will cause the same symptoms.

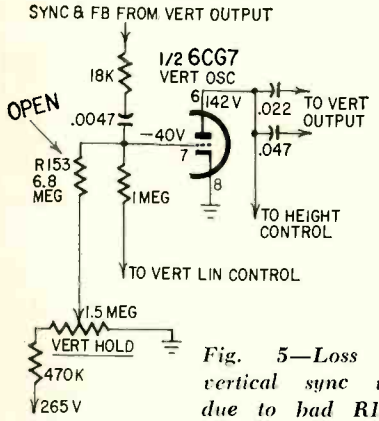


Fig. 5—Loss of vertical sync was due to bad R153.

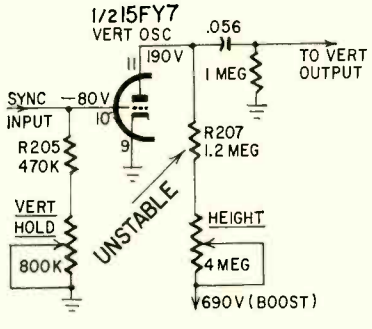


Fig. 6—R207 shifted with changes in temperature. This caused the picture to roll intermittently.

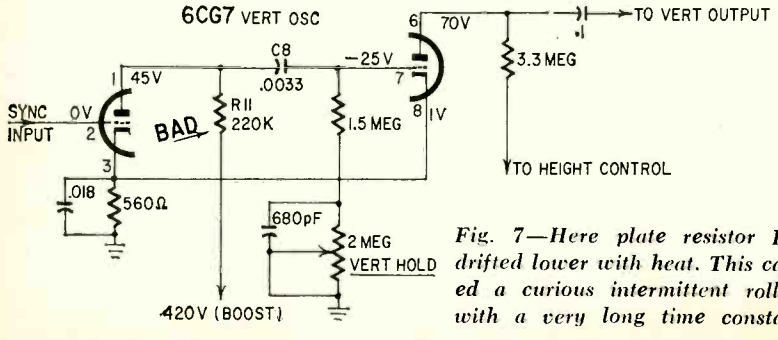


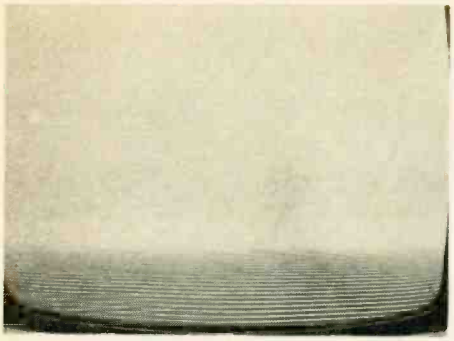
Fig. 7—Here plate resistor R11 drifted lower with heat. This caused a curious intermittent rolling with a very long time constant.

Rolling picture

Many things can cause the picture to roll: insufficient sync, a defective integrator circuit, too-high resistance, leaky capacitors or some variety of intermittent. Let's take a look at a RCA KCS97D chassis (Fig. 5).

The vertical hold control had no effect on the rolling picture. This control didn't even seem to be in the circuit. Control open? Checked it. Nope. Wrong again. Voltages on the vertical-oscillator tube were quite close to what they should be. I just *knew* the trouble was in the vertical hold circuit. R153 checked 5.5 meg. It should have been 6.8, but that didn't seem to be too serious a difference.

The original complaint was intermittent vertical rolling. Now the set just rolled, period! Back to R153. I cut one end of the resistor loose and checked the resistance. Here was the trouble. The resistor was wide, wide open.



A case of severe nonlinearity at bottom of the screen. The cause is shown in Fig. 9.

(Sometimes it just pays to work a hunch.) The 5.5-meg reading? Shunt paths elsewhere in the circuit.

Now let's check some intermittent vertical-roll troubles. I had a G-E QX chassis (Fig. 6) that would be okay for about 2 minutes and then roll. I would set the vertical hold for a stable picture and within 5 minutes it was rolling again. That told me resistance values were changing or perhaps a capacitor was leaking.

When a picture rolls intermittently, the trouble is usually in the grid or plate circuit of the vertical-oscillator stage. Sometimes the trouble is in the cathode circuit, but usually the cathodes are grounded.

I measured the grid resistor, R205. It was off by a bit, so I replaced it, but to no avail. Finally I came to R207, a 1.2-meg resistor. As the set warmed up, its resistance changed. Replacing it solved the problem.

You will find that many intermittent vertical-roll troubles can be traced to the oscillator plate resistor. If you have any doubts, replace it. A change of resistance in the vertical hold control or the height control can cause vertical rolling.

The main trouble from height controls is a burned spot. When you try to increase the height, the raster collapses to a few inches. Always remember: the height control affects the bottom of the picture most, while the linearity control has its main effect at the picture top.

Another rolling trouble, in a Philco model 91.60U (Fig. 7). Here more time elapsed between rolls. This set wouldn't roll until after it was on for 1½ hours. I could reset the vertical hold control and again the picture would sit still for an hour or two. Great! To top it, when the back was removed the set wouldn't roll at all!

I pulled the chassis, set it on the bench and checked all the tubes. They were okay. Heat seemed to figure in the trouble. I tried a new 6CG7 vertical tube, just in case. I put the set back in its box. Sure enough, in about 2 hours the same trouble appeared. Capacitor C8 was replaced because it was a little leaky. Still the set rolled after a couple of hours.

R11 seemed quite warm. It measured 220K. The next time the set started to roll, I jerked the line plug out and clipped out one end of R11. It now read 150K. R11 was changing with heat. I should have followed my own advice: "Replace the plate load when in doubt."

Odd vertical troubles

After this Silvertone model 45-528.51680 receiver was on a few seconds, the raster was only about 3 inches high and quite jittery. It bounced. Of course the vertical tube was the first thing checked. It was okay. The grid voltage was off a little and the plate voltage on pin 5 was only 50 (Fig. 8). According to the service data, I should have had 90. The height control and the 1-meg series resistor were checked; they were good. Something was leaking and pulling that voltage down.

I pulled the vertical tube and checked its plate voltage. (You have to do this very rapidly in a series-heater receiver, because of course the other tubes go out when one is pulled.) Here I found only the same 50 volts; I should have been getting the full voltage at the height control.

I checked C30 for leakage; it was good. C29 showed some leakage. When I cut one end, I measured 100K across it. Replacing the capacitor restored the full raster.

In many sets, a jumping raster is caused by a defective vertical-output transformer. This is especially true in old, long-used sets.

This next case looked like vertical linearity trouble. The bottom of the picture had wider scanning than the top line did. This is shown in photo at left.

It was an Admiral model UP9808 (Fig. 9). Someone else had attempted to repair the set, for the thermal relay had been shorted out. Sometimes the picture looked like it was suffering from vertical bunching, but this proved not to be the case. All voltages in the vertical circuit were checked, and they all seemed fine.

After searching the vertical section for trouble, I traced the B+ wires back to the power-supply filter. I found after a little browsing that the silicon rectifier had been replaced. Something didn't add up. The B+ line that fed the vertical and horizontal circuits came directly off the rectifier. It should have gone first through the filter choke.

The B+ wire to the horizontal and vertical circuits had been removed and hadn't been resoldered to the correct point. This goes to show that the poor helpless television receiver may have, not only its own troubles, but a few extras put in. **R-E**

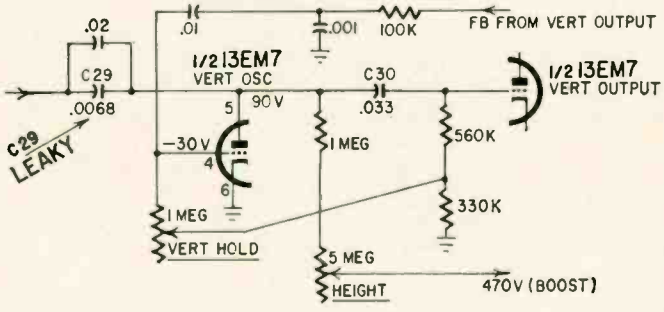


Fig. 8—Leakage in C29 upset the normal operation of the vertical multivibrator and produced a bouncing 3-inch high raster.

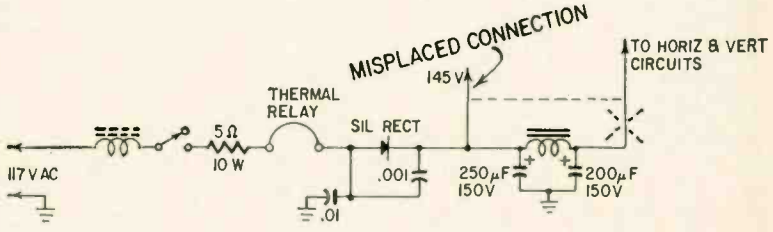
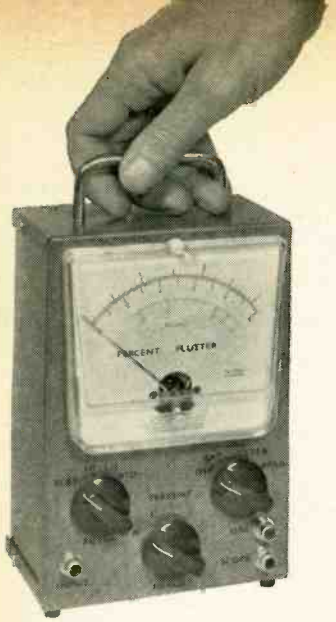


Fig. 9—Nonlinearity developed after a careless technician inadvertently bypassed the pi-network filter after replacing the silicon rectifier.



A Compact, High-Performance Flutter Meter

Useful in servicing tape recorders, this meter can measure tape-travel inaccuracy of less than 0.1%

By EARL T. HANSEN

IS YOUR TAPE RECORDER AS GOOD AS IT was when new? As mechanical parts wear, slight speed variations can cause a degradation of recorded tapes; the fault becomes progressively worse as tapes are copied. This meter will let you make easy, periodic measurements of such signal degradation, to help you avoid poor recordings.

This meter uses the latest solid-state components, including an integrated circuit and an FET. Battery operation keeps the cost down, provides portability, and—most important—eliminates 60-Hz hum pickup from the ac line.

Alignment and calibration require only a vtvm and an audio oscillator, though a scope and an ac voltmeter will assure greater accuracy.

Flutter consists of undesirable and relatively rapid changes in pitch of recorded and reproduced sound. It is caused by irregular mechanical motion during recording or playback of tape, disc or film. Per cent flutter is defined as the rms deviation from the average frequency as a percent of that average frequency.

Flutter meters normally detect flutter rates from 0.5 Hz to 120 Hz; some even go up to 200 Hz, if intended for measurements of motion-picture equipment.

(Undesirable but relatively slow changes in pitch are known as *wow;* frequency variation is typically 0.5 Hz to 5 Hz. Wow occurs principally in disc recording and playback, so we aren't concerned with it here.)

How it works

The basic idea for most flutter meters is to use some kind of FM discriminator or detector. Proper limiting to remove amplitude modulation is important—just as in an FM receiver. The signal from the discriminator is filtered to remove the audio carrier frequency and to limit the range of flutter rates. The rms value of the signal is then measured by a high-sensitivity ac vtvm with extended low-frequency response.

A commonly used frequency for flutter tests is 3 kHz; the frequency was chosen many years ago for motion-picture use, when sound-system response barely reached 5 kHz. This meter uses 5 kHz as a test frequency for several reasons. The discriminator could be more easily designed around readily available components. The higher carrier frequency allows measurement of higher flutter rates and simplifies the required filter.

In this meter (Fig. 1) an inexpensive integrated circuit makes an ideal amplifier and limiter. The IC contains 10 transistors, a voltage regulator, and those resistors necessary to complete a three-stage amplifier. Because of the internal regulator, changes in battery voltage have minimum effect on the limited output amplitude (a 5-kHz square wave) which drives the discriminator coils. The IC has very high gain and will saturate with 30 mV at input jack J1.

Minimum input level should be 0.1 volt, to lessen the effect of tape dropouts. Diode D1 protects the IC against possible damage by an external voltage overload.

A 5-kHz signal is fed to input jack J1 and then through limiter IC1. Output from this stage is a square wave, which goes through isolating resistors R6 and R7 to the discriminator. The discriminator consists of tuned circuits L1–C5 and L2–C6, and associated components. One circuit is tuned to 4 kHz, the other to 6 kHz. Each drives a voltage-doubling rectifier (or peak-to-peak detector). Diodes D2 through D5 are polarized so as to have opposite dc polarity at the output; positive from the L1 side, and negative from the L2 half.

When the voltages induced in the coils are equal (at approximately 5 kHz) the dc outputs will be equal and opposite in polarity; thus they cancel to zero at the junction of R8 and R9. When the input frequency changes toward either 4 kHz or 6 kHz, the ratio of the voltages in the two halves of the discriminator will not be equal and the dc at the junction will change. Fig. 2 shows the frequency-vs-output curve for the discriminator, as measured at the source of Q2.

Note that the voltage is 2.85 rather than zero at the middle frequency. This is a result of two voltages which are added to the discriminator output. One is the difference in potential across FET Q2 (gate to source). The other is the result of the discriminator return being connected to pin 3 of IC1. This is a convenient source of approximately 2 volts forward bias on the FET (which acts as a source follower); the bias sets the correct operating point on the FET transfer curve for handling larger voltage swings.

A three-section RC filter between the discriminator and Q2 removes any remaining 5-kHz carrier, and deter-

Two RADIO-ELECTRONICS editors used this flutter meter to check out a medium-quality tape deck. Following the author's instructions, we recorded the 5-kHz test signal at 7½ ips. Then we played back the tape and read flutter on the meter. Our average for several measurements was about 0.1%, within specifications for the tape deck. At 3¾ ips, the machine had about 0.15% flutter. By rapidly jabbing a finger against the tape or the capstan during playback, we could artificially increase flutter to over 1% as read on the meter.

A reader using the author's calibration tape should *not* rewind it in the normal manner, as this might stretch the tape and alter its calibration. Instead, reverse reels and run it back at "play" speed.

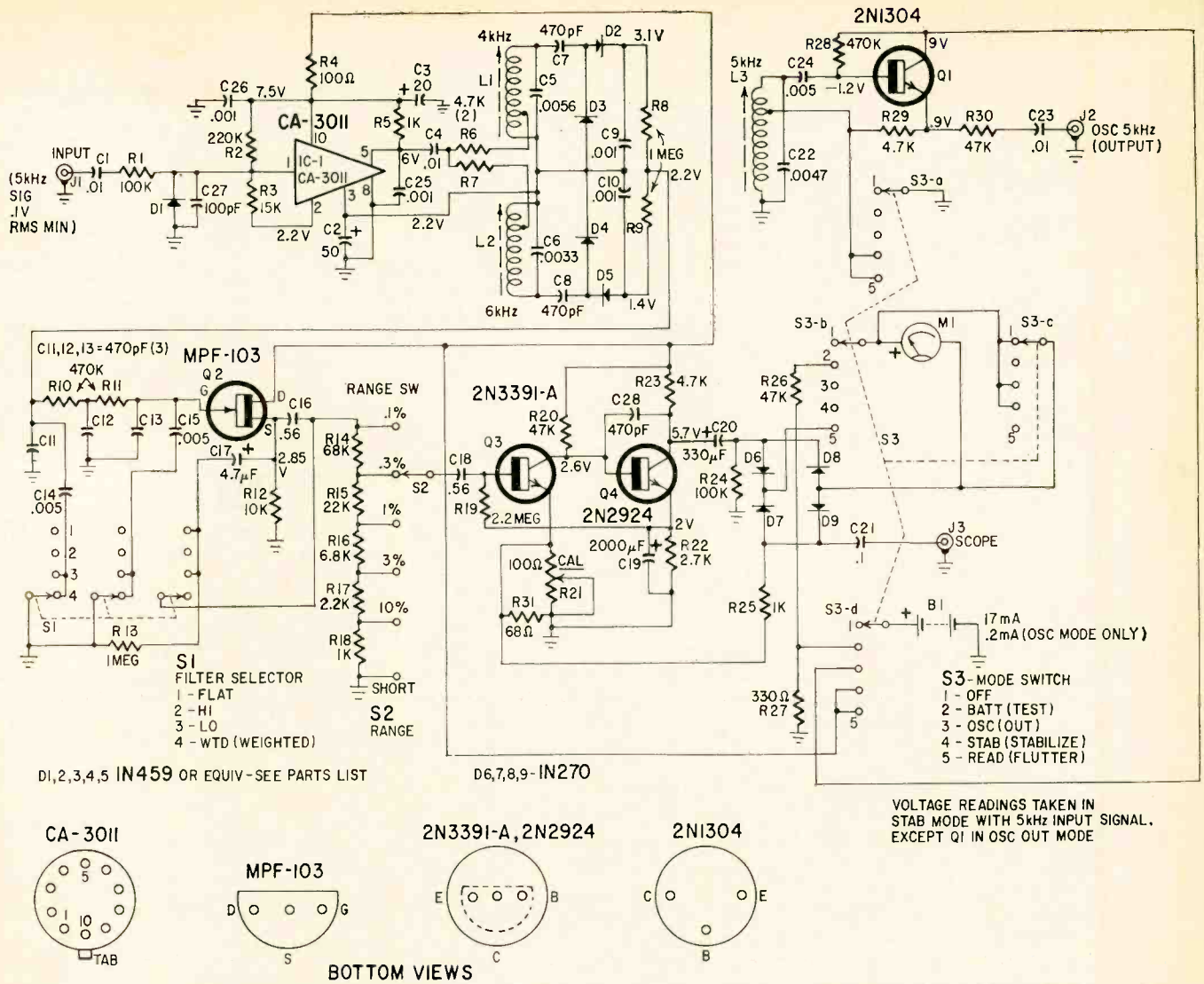


Fig. 1—Sine-wave input signal is fed to IC1, which produces square-wave output. Discriminator (L1-C5, L2-C6) furnishes error voltage to amplifier Q2. Voltmeter section (Q3-Q4) reads this error as flutter produced by the tape recorder tested.

Flutter Meter Specifications

Ranges: 0.1%, 0.3%, 1%, 3%, 10% full scale rms

Input level: 0.1 volt rms minimum for good limiter saturation

Input frequency: 5kHz, ±5%

Battery: 9 volts, NEDA 1602

Battery drain: 0.2 mA in OSC mode, 17 mA in all other modes

Internal OSC output: 5kHz, 4 volts rms unloaded, with less than 5% distortion

Internal noise: The residual reading due to the combined effects of internal oscillator FM variations and random noise is less than 0.001% flutter

Stabilization time: 30 seconds after power on, or 5 seconds after applying signal input

Flutter rate bandwidth: FLAT (filter switch position), 0.6 to 200 Hz, ±3 dB

HI, low-frequency rolloff, down 6 dB at 1.5Hz

LO, high-frequency rolloff, down 6 dB at 35 Hz

WTD (weighted filter position) combines the rolloff of the HI and LO filters

Parts List

R1, R24—100,000-ohm resistor
R2—220,000-ohm resistor
R3—15,000-ohm resistor
R4—100-ohm resistor
R5, R25—1000-ohm resistor
R6, R7, R23, R29—47000-ohm resistor
R8, R9, R13—1-megohm resistor
R10, R11, R28—470,000-ohm resistor
R12—10,000-ohm resistor
R14—68,000-ohm, 5% resistor
R15—22,000-ohm, 5% resistor
R16—6800-ohm, 5% resistor
R17—2200-ohm, 5% resistor
R18—1000-ohm, 5% resistor
R19—2.2-megohm resistor
R20, R30—47,000-ohm resistor
R21—100-ohm miniature potentiometer (Mallory MTC or similar)
R22—2700-ohm resistor
R26—47,000-ohm, 5% resistor
R27—330-ohm resistor
R31—68-ohm resistor
All resistors ¼-watt or more, 10%, unless otherwise noted
C1, C4, C23—0.01-μF paper or ceramic capacitor
C2—50-μF, 6-volt electrolytic capacitor
C3—20-μF, 10-volt electrolytic capacitor
C5—0.0056-μF mica capacitor
C6—0.0033-μF mica capacitor
C7, C8, C11, C12, C13, C28—470-pF ceramic capacitor
C9, C10, C25, C26—0.001-μF ceramic capacitor
C14, C15, C24—0.005-μF ceramic capacitor
C16, C18—0.56-μF tantalum capacitor (Kemet C series or similar)
C17—4.7-μF, 10-volt, tantalum capacitor (Kemet C series or similar)
C19—2000-μF, 10-volt, electrolytic capacitor
C20—330-μF, 10-volt, tantalum capacitor
C21—0.1-μF paper or ceramic capacitor
C22—0.0047-μF mica capacitor
C27—100-pF ceramic capacitor
All capacitors 20 volts, or more, unless otherwise noted
IC1—Integrated circuit amplifier, RCA CA3011
Q1—Germanium npn transistor, 2N1304
Q2—N-channel junction field-effect transistor (Motorola MPF-103 or similar)
Q3—Silicon planar npn transistor (G-E 2N3391A or similar)
Q4—Silicon planar npn transistor (G-E 2N2924 or similar)
D1, D2, D3, D4, D5—Small-signal silicon diode, 1N-459 or similar
D6, D7, D8, D9—Germanium diode, 1N270
J1, J2, J3—Phono jack
S1—3-pole, 4-position, shorting rotary switch (Centralab 1012 or similar)
S2—1-pole, 6-position shorting rotary switch (Centralab 1000 or similar)
S3—4-pole, 5-position shorting rotary switch (Centralab 1012 or similar)
L1, L2, L3—78-240-mH tapped inductor (Miller 9018 or similar)
B1—9-volt battery (NEDA 1602 or 1605; see text)
M1—200-μA meter, scales 0-3 and 0-10 (Heathkit 407-85 or similar. Available from Heath Co., $10.40 plus postage)
Misc.—3" x 5" x 7" metal box (Bud CU-2108A or similar); perforated board, push-in terminals, handle, knobs, wire, and small hardware
Note:—A 3" reel of calibration tape is available for $2.40 postpaid, from E. T. Hansen, 3361 Millcreek Rd., Salt Lake City, Utah 84109. Instructions are included.

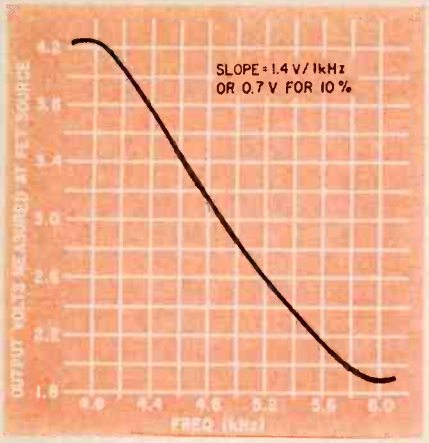


Fig. 2—Discriminator output curve. Circuit converts frequency shift to dc.

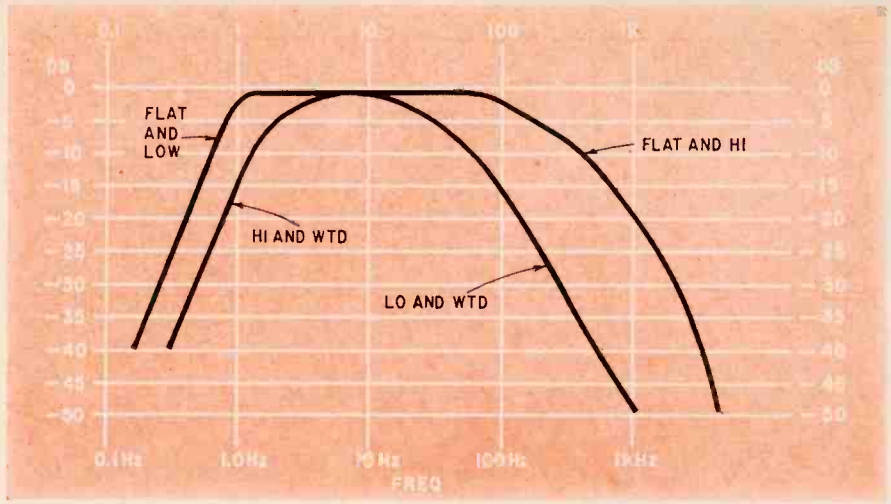


Fig. 3—Filter output curves for the four positions of filter selector switch S1.

mines the desired curve for the flutter-rate frequency response. Figure 3 shows the curves for the four settings of filter switch S1. As a source follower with a gain of less than one, Q2 matches the very high impedance of the discriminator and filter to Q3.

Transistors Q3, Q4 and associated components constitute a feedback-stabilized ac voltmeter. Large coupling and bypass capacitors—C20 and C19—extend the low-frequency response to the required range. Feedback ratio (and therefore gain) is adjusted by the calibration control, R21. Resistor R25 develops a voltage proportional to meter current, which allows the actual flutter waveform to be observed on an external oscilloscope via J3. Approximately 0.5 volt peak to peak appears at J3 with full-scale meter deflection.

Construction

I would suggest a slightly larger metal box than the one I used, unless you are concerned about size. Assembly will be easier if things are not so crowded. Many small components can be mounted on the switches; mount the others on a perforated board with push-through terminals (see Figs. 4, 5 and 6). Coils L1 and L2 should be separated by at least 1½" to avoid interaction; location of L3 is not so critical though, since it is shorted out during the READ mode. Leads on the ceramic capacitors which bypass pins 1, 5 and 10 of IC1 to ground should be kept as short as possible. Otherwise the IC may oscillate at some rf rate.

The tap location on the coils is important. On L1 and L2 the taps are nearest the ends which go to pin 3 of IC1. On L3 the tap is farthest from ground. The unused pins (4, 6, 7 and 9) on IC1 may be snipped off to minimize congestion. If you do use a larger case I would suggest the next size larger battery (NEDA 1605). It has a longer life at about the same cost.

In case you want to substitute, component types are not critical except as follows: Q1 must have at least a 10-volt emitter–base rating. Switches should be the shorting type to avoid transients. Q3 and Q4 must be high-gain, low-leakage silicon-planar types. Q3 should be a low-noise type.

Test and calibration

Connect a milliammeter in series with the battery and make sure that the current is not excessive. It should be zero in the OFF position, about 0.2 mA in the OSC position, and about 17 mA in the other positions. The test current in the BATT position depends on the value of R27.

Apply a 1-volt, 5-kHz signal from a sine-wave audio generator to the input, J1, and set S3 to the STAB position. There should be a square wave on pin 5 of IC1. The waveform should be about 2.4 volts peak to peak and will be tilted. Set the generator to 4.0 kHz. Connect the hot lead of a dc vtvm to the junction of D2 and C9, with the common lead to ground. Adjust L1 for maximum reading on the vtvm. Next set the generator to 6.0 kHz and adjust L2 for *minimum* positive voltage at the junction of D5 and C10. Set S3 to the OSC mode and monitor the output at J2 with a scope or audio amplifier. Set the generator to 5.0 kHz and compare the frequencies, audibly, or preferably with the scope. Adjust L3 so the output at J2 is 5 kHz.

Measure the dc voltages on Q3 and Q4. The collector voltage on Q4 should be between 4.5 and 7. If it is not, the value of R20 should be changed slightly. Increasing R20 will increase the Q4 collector voltage and vice versa. If it is necessary to go above 100,000 ohms for R20, Q3 has low gain and should be changed. This completes everything except the actual calibration adjustment (R21).

As a start, adjust R21 for a reading of 38 ohms from Q3's emitter to ground—with the flutter meter turned off, of course. At this point the meter will be accurate enough for most home comparison-type measurements. This includes correction for the 0.707 factor described below in the section on using the meter.

For a more accurate calibration proceed as follows: The end accuracy will depend on the accuracy of your equipment, the audio generator, the dc vtvm and the ac voltmeter. Connect the dc vtvm to the Q2 source (junction of R12 and C16). Set the audio generator to 4.5 kHz, 1 volt out, connected to J1, and set S3 to STAB. Read the voltage with both 4.5-kHz and 5.5-kHz inputs (one at a time). Note the difference between the two readings; it will be 1.4 volts typically. This difference is equivalent to a peak-to-peak frequency swing of 20%, or half the difference is equal to the peak frequency swing of 10%. Therefore an rms voltage equal to the difference would be equivalent to 10% rms swing (or flutter).

Set the generator to 20 Hz. Connect the generator output to the top of the range switch (junction of R14 and C16). Then set the range switch to 10% and set S3 to READ. Measure the audio amplitude from the generator with the ac voltmeter and adjust it to an rms value equal to half the dc difference voltage noted above. As an example, if the difference measured above is 1.46, set the generator output to 0.73 volt rms.

Adjust R21 until the flutter meter reads full scale (10%), *if* you desire a true flutter reading, or do as I did and adjust R21 until the meter reads 7.07%. This will let you make measurements without factoring when re-

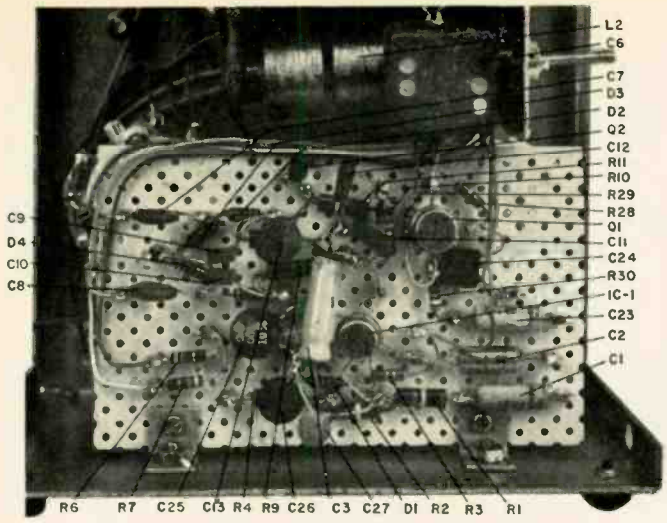


Fig. 4—Limiter-discriminator layout is easily done on board.

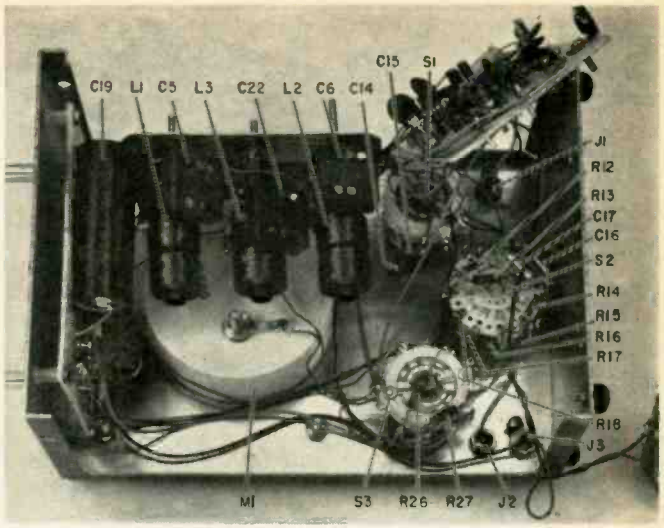


Fig. 5—Coils are mounted on a bracket beside meter movement.

cording and playing back. Otherwise factoring is necessary to compensate for the flutter created by both the recording and the playback of a tape.

The cover on the metal box must be in place before using high-sensitivity positions of the range switch, to avoid stray pickup.

An alternate and more accurate method of calibration is to obtain a calibration tape. See the parts list.

Using the meter

The mode switch has four active positions. BATT measures the battery voltage with a resistive load equal to the normal meter drain. OSC operates only the internal 5-kHz oscillator, which is available at J2 for recording onto a tape. The recorded 5-kHz signal is then played back into the flutter meter to obtain a reading. STAB is the stabilize position, used prior to taking a reading. In this position the meter is shorted out until the long time constants in the ac voltmeter circuit become stabilized; otherwise the meter would bang the peg a time or two. The READ position gives a meter reading of the flutter amplitude.

Battery voltage has a negligible effect on accuracy until it drops below 7.5. The battery should be changed when it drops to 8 volts, as indicated on the meter in BATT position. Useful life of the NEDA 1602 battery is about 40 hours of intermittent use, except for the OSC mode, which is very much longer.

There are two methods of measuring flutter in sound equipment. One (known as the standard method) uses a standard recorded reference, that is a tone (carrier) recorded on a tape (or disc or film) with a flutter content very much less than that of the equipment to be tested. By this method the flutter content can be obtained directly from the meter without factoring, or rerunning to get an average. The flutter meter described here can be used for this method. However, standard tapes with low flutter content are very expensive.

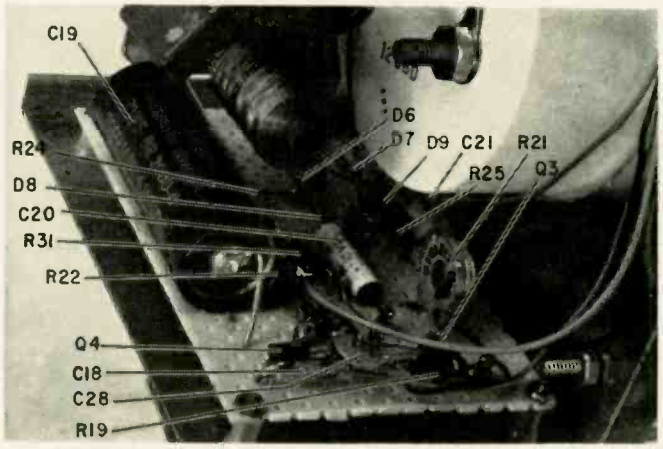


Fig. 6—Voltmeter circuit is also mounted on perforated board.

The second (or nonstandard) method is to record a tape from a very stable source (such as the oscillator built into this meter) and play it back through the meter. This method has one drawback: the recorder adds flutter to the tape during recording and again during playback. The two flutter conditions will add vectorially, and readings can vary considerably, depending on the phase and regularity of the two sources. Generally the resultant will be greater than either of the two sources alone. The generally accepted practice is to take the average of several readings and multiply it by 0.707 to obtain a true flutter measurement. The 0.707 factor has been included in the calibration of this meter and need not be considered when making measurements.

It is good practice to average several readings. Rewind the tape slightly between each reading to change the recorded flutter to machine flutter/phase relationship. Fig. 7 shows typical flutter viewed on a scope.

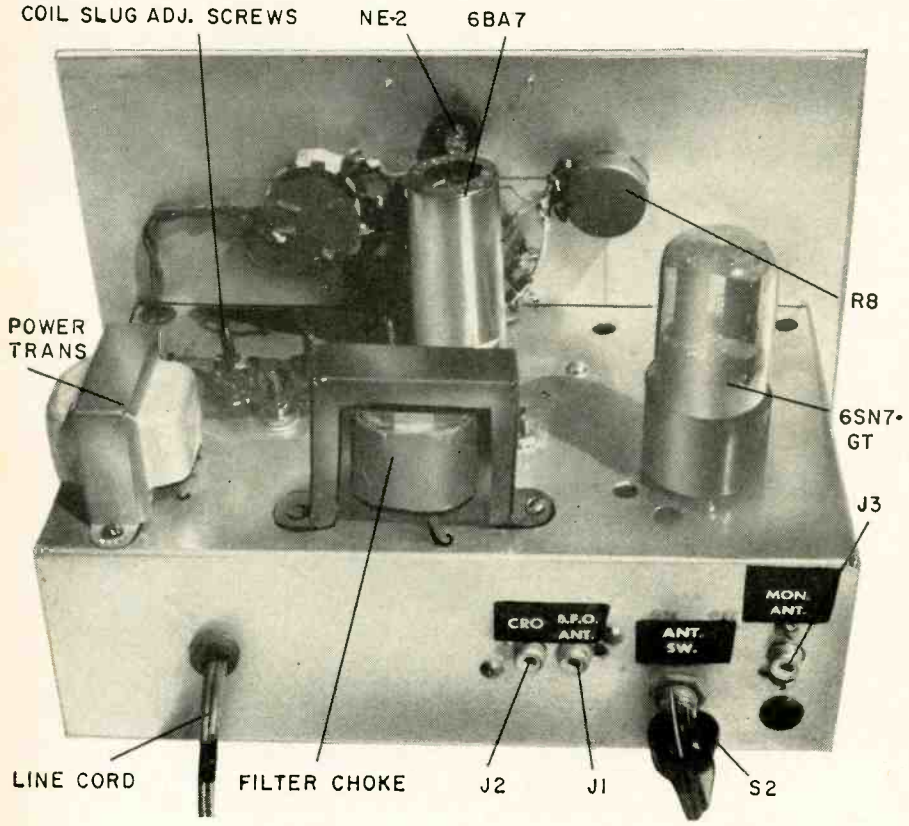
When recording the carrier (5 kHz) on a tape, use the maximum record level. The amount of distortion will have no effect on the flutter content. Record several minutes of the carrier so there will be plenty of time for meter stabilization and multiple readings.

The filter switch gives a choice of flutter-rate response characteristics. The FLAT position has maximum bandwidth and reads flutter at its worst. The HI position removes very low flutter rates—as might be caused by an off-center reel—and therefore helps to isolate the source and type of speed variation. The LO position removes the higher frequencies—which might origi-

(continued on page 60)

BUILD
A Professional Quality Transmitter Monitor

Solid-state and vacuum-tube versions of a handy rf watchdog for hams, CB'ers and commercial operators



By J. P. NEIL

ANYONE WHO OPERATES A RADIO STATION—amateur, CB or commercial two-way—will find an rf monitor useful. It enables you to keep tabs on the transmitter while operating. The ones described here don't require any physical connection to the transmitter itself. Here's what each does:

1. Permits continuous visual and aural carrier on–off monitoring: has relay contacts to operate external alarm (solid-state version only).
2. Acts as CW keying monitor. (*Note*: Does not warn of key clicks or CW hum.)
3. Demodulates an AM signal for quality check of audio.
4. Supplies rf output to drive an oscilloscope. You can then observe either trapezoid or envelope waveforms to check percentage of modulation.

General description

Block diagram, Fig. 1, illustrates monitor function. Rf is fed through a beat oscillator and mixer and a low-pass filter. The filter output (below 1 MHz) is split, appearing on terminals for scope display, and being fed to the carrier-alarm circuit (solid-state version only). The carrier-alarm circuit triggers a relay, the contacts of which may be used to operate an external alarm.

Rf is also fed to a detector, a bfo and an audio amplifier. These circuits provide monitoring and quality checks of CW keying and AM modulation.

Circuit details

Figure 2 is the schematic of the solid-state version, which operates as follows: if a pickup antenna is used at J3, closing S4 will usually produce enough rf drive to operate the alarm circuit. If this is not the case, a separate antenna may be connected to J1. Whichever jack is used, rf travels through RF GAIN pot R1 and C4, then to the base of Q1. This transistor works as both an oscillator and a mixer, its frequency being determined by the particular LC tank selected by S1. All oscillator coils are slug-tuned to about 355 kHz above or below the transmitting frequency in the selected band. C6 is a panel adjustment for trimming the beat frequency.

In the alarm circuit, L2 and C9 resonate at about 355 kHz, so C6 is adjusted for maximum signal at the base of Q2. Depending on the relay used, Q2 will operate with about 10 or 15 mA. It should be heat-sinked if the monitor will be used continuously in the carrier-on mode.

The keying- and modulation-monitor section uses diode D to rectify incoming rf. For CW monitoring, Q3—a tone generator—acts as a bfo which is switched on and off by transmitter keying. For AM modulation monitoring, demodulated rf from D is fed through S5 to Q4 and Q5. These stages are direct-coupled, npn to pnp. J4 is a closed-circuit jack; normally the speaker is used

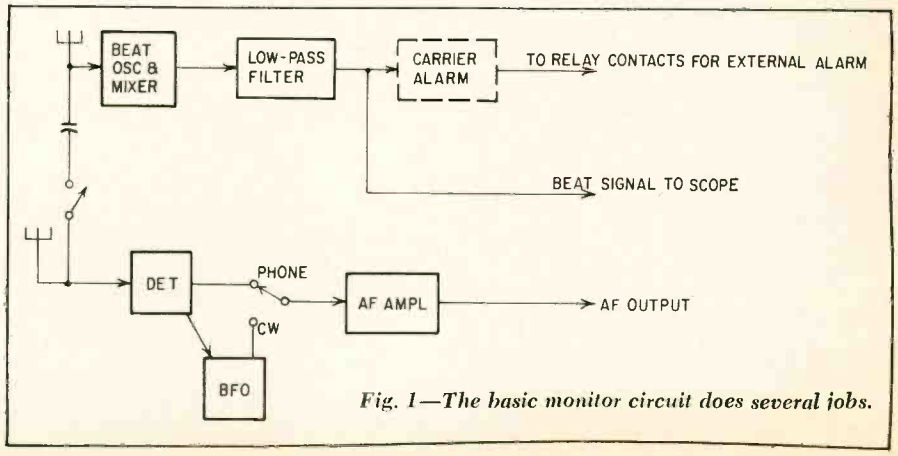


Fig. 1—The basic monitor circuit does several jobs.

Parts list for solid-state model

R1—1000-ohm potentiometer (including S3—s.p.s.t. switch)
R2—15,000-ohm resistor
R3, R9—10,000-ohm resistor
R4—1800-ohm resistor
R5—20,000-ohm potentiometer
R6, R10—100-ohm resistor
R7—50,000-ohm potentiometer
R8—91,000-ohm resistor
R8—470-ohm resistor
C1, C2—(See coil table)
C3—5-pF capacitor
C4, C5, C7, C11, C13, C15, C19—0.01-μF capacitor
C6—25-pF variable capacitor
C8, C9—20-pF, silver mica capacitor
C10—470-pF capacitor
C12—0.22-μF capacitor
C14, C16, C17—25-μF, 25-volt, electrolytic capacitor
C18—0.02-μF capacitor
C19—100-μF, 25-volt, electrolytic capacitor
C20—0.05-μF capacitor
C21—0.5-μF capacitor
J1, J2, J3—Phono jacks
J4—Closed circuit phone jack
L1—1-mH rf choke (J. W. Miller 4652-E)
L2—10-mH rf choke (J. W. Miller 4672-E)
L3—2.4-mH rf choke (J. W. Miller 4666-E)
D—1N4009 diode
Q1, Q4—2N2924 transistor
Q2—2N696 or 2N169 transistor
Q3—2N1617, 2N2160 or 2N2646 transistor
Q5—2N1415 transistor
S1—2-pole 6-position rotary switch
S2, S4, S6—S.p.s.t. toggle or slide switch
S3—(See R1)
S5—D.p.d.t. toggle switch
SPKR—2" or 3" speaker, 4-ohm coil
T—Output transformer: 500-ohm primary, 4-ohm secondary
RY—Relay: 50–500-ohm coil resistance, 10–15-mA operating current. Contacts N.O. or N.C., as desired.
BATT 1—battery, 12 volts
BATT 2—battery, 9 volts

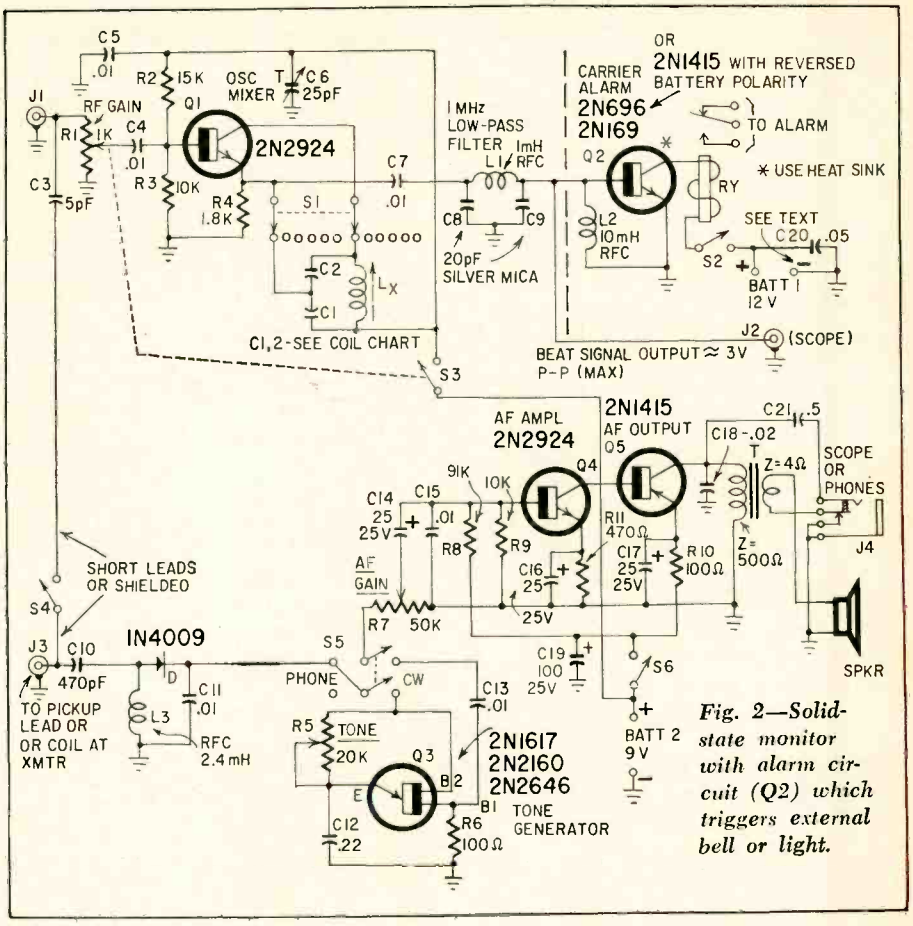


Fig. 2—Solid-state monitor with alarm circuit (Q2) which triggers external bell or light.

Parts list for vacuum-tube model

R1—1000-ohm potentiometer (including S3—s.p.s.t. switch)
R2, R6—10,000-ohm resistor
R3, R5, R14—27,000-ohm resistor
R4—150-ohm resistor
R7—1500-ohm resistor
R8—1-megohm potentiometer
R9, R11—1-megohm resistor
R10—47-ohm resistor
R12—47,000-ohm resistor
R13—2-megohm potentiometer
R15—100,000-ohm, 1-watt resistor
C1—5-pF capacitor
C2, C14, C17—220-pF capacitor
C3—50-pF capacitor
C4, C15—0.005-μF capacitor
C5, C9, C10, C12, C13, C18—0.01-μF capacitor
C6—25-pF variable capacitor
C7, C8—20-pF capacitor
C11—10μF, 50-volt, electrolytic
C16—0.002-μF capacitor
C_X—See Table 1
All capacitors 400v unless noted
J1, J2, J3—Phono jacks
J4—Phone jack
S1—2-pole 6-position rotary selector switch
S2, S5—S.p.s.t. toggle or slide switch
S3—(See R1)
S4—D.p.d.t. toggle switch
D—1N4009 diode
T—Output transformer: 10,000-ohm primary to 4-ohm secondary
L1—1mH rf choke (J. W. Miller 4652-E)
L2—2.4-mH rf choke (J. W. Miller 4666-E)
L_X—See Table 1
V1—6BA7 tube
V2—12AU7, 6SN7-GT or similar tube
PL—6.3-volt pilot lamp
NE—NE-2 neon lamp

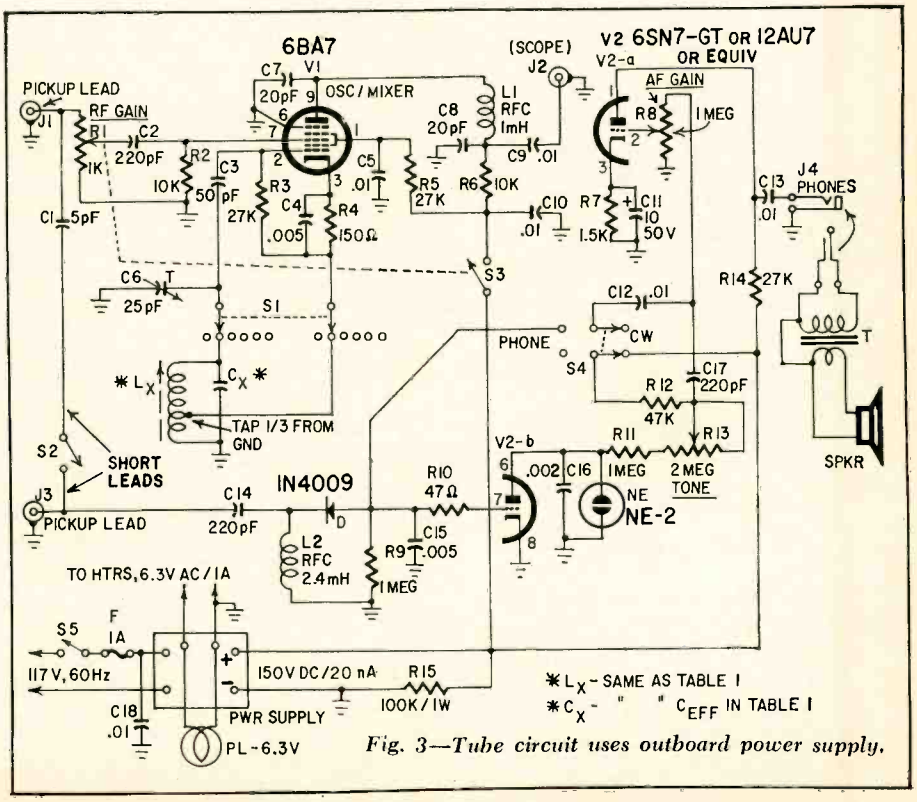


Fig. 3—Tube circuit uses outboard power supply.

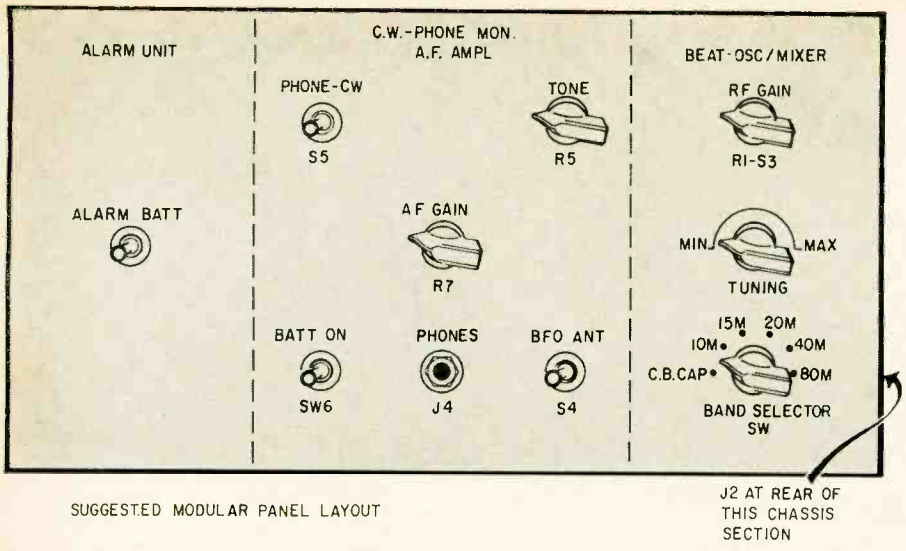


Fig. 4—Panel layout is not critical . . . position parts to fit without crowding.

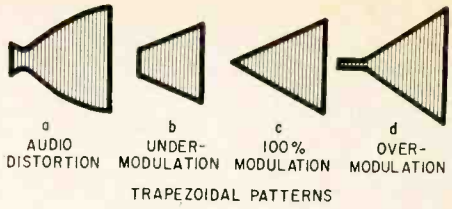


Fig. 5—Trapezoid waveforms you'll see on your scope when checking AM transmitters.

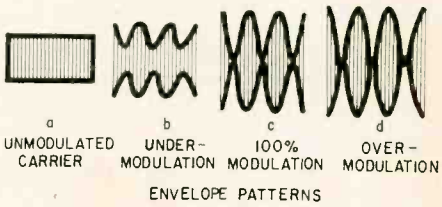


Fig. 6—Envelope modulation patterns.

Build a Professional Quality Transmitter Monitor

for CW monitoring while only the phones are used on AM. Thus the speaker is killed and feedback is avoided, where the monitor is used near the transmitter microphone.

Note that Q3 requires no power supply: it operates from incoming rf. Q5 takes most current from the battery, but it operates class AB. Hence the total drain of Q4 and Q5 will be from only 2.9 to 5.2 mA, depending on audio level.

The vacuum-tube model operates the same as the solid-state model. There is no carrier-alarm circuit, but it would not be difficult to build one using a thyratron and a plate relay. As before, C6 must be adjusted to resonance, and the easiest way is by tuning to peak the waveform observed on a scope at J2. There is also no power supply, but requirements are small: 6.3 Vac at 1 amp and 150 Vdc at 20 mA. Note that the 6BA7 should be shielded.

Assembly and setup

It's up to the user whether to build the monitor on a conventional chassis or a printed-circuit board. The solid-state version is easily constructed on a perforated board, while the vacuum-tube unit goes best on a standard chassis. A suggested panel layout is shown in Fig. 4 and the photo.

Values listed in the coil table cover the bands listed, all tunable with C6. Use the coil slugs to set operating frequencies, and trim with C6.

To adjust the carrier alarm in the solid-state version, first couple rf into the monitor by a pickup antenna connected to J3 or J1. Adjust R1 and C6 for maximum current through the relay coil. Don't overdrive the transistor. Monitor the current with a vom and if Q2's rating is exceed, you may have to drop the battery voltage with a divider.

In the monitor section, R5 adjusts the keying-monitor tone, and R7 sets AM-monitor gain.

To check the percentage of modulation of a transmitter with a scope you must modulate the rig with a single-frequency tone, preferably from a good-quality audio generator. To obtain a trapezoid pattern: Connect the scope vertical input to J2. Set horizontal gain at minimum. On the monitor, set R1 at maximum and adjust C6 for maximum vertical trace on the scope. Set the scope vertical gain to fill about one-third of the screen, and connect the horizontal input to J4, switching the horizontal input selector to the EXTERNAL position. Adjust horizontal gain to about one-third or one-half full. Set S5 to PHONE position and adjust audio gain with R7 until horizontal sweep just about fills the screen.

You'll find one of the traces shown in Fig. 5 on the scope screen. If there's distortion, it may be occurring due to overload in the monitor or the scope. Reset R1, R7 and the scope vertical gain control to see if this eliminates the distortion. If it doesn't, the transmitter is probably at fault.

It's simpler to obtain the envelope patterns of Fig. 6. You need only take the output from J2, feeding it to the scope vertical input. If the transmitter is modulated with a 1,000-Hz tone, adjust the scope horizontal sweep rate to 250 Hz and you'll see four cycles on the screen. If the peaks of the modulated envelope are flattened, there's distortion somewhere.

Low-priced scopes generally have limited frequency response, and won't show much of a trace of rf above 1 MHz. The monitor circuits described here beat the transmitter frequency down to below 1 MHz, where it can be easily displayed by nearly all scopes. **R-E**

Coil table

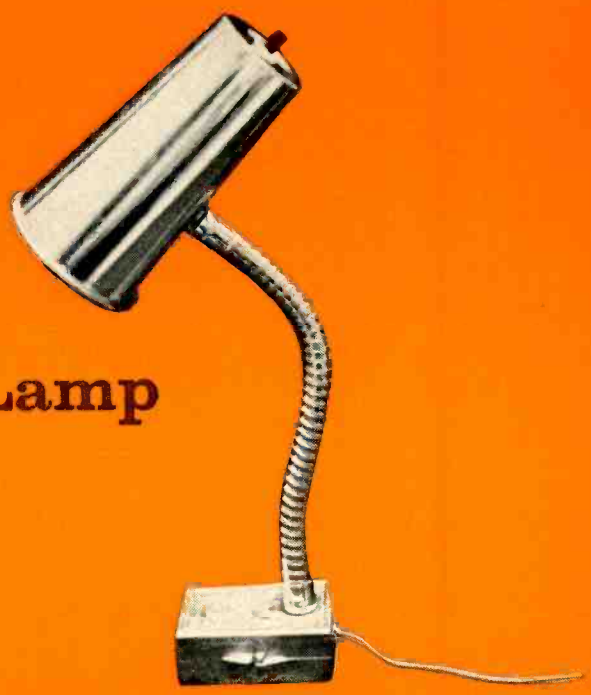
Band	Freq. (MHz)	L_X (μH)	C_{eff} (pF)	C1 (pF)	C2 (pF)	L_X (turns)	Wire Size
80 m	4.05	8	200	600	300	26	N. 24 dcc
40 m	7.35	5.4	100	300	150	20	"
20 m	14.355	2.5	50	150	75	10*	"
15 m	21.455	2.0	50	150	75	7½*	N. 18 enam.
CB/CAP	27.3	0.7	50	150	75	6*	"
10 m	29.5	0.6	50	150	75	5*	"

* Equally spaced turns

Coils are wound on ⅜" diameter forms with ¾" winding length. Slug core material for 1–30-MHz service. (J. W. Miller type 21A000RB1, Cambridge Thermionic LS3 series or similar.)

BUILD

A Two-Way, Two-Way Lamp



Let there be more light this Christmas

By BYRON G. WELS

DOUBLE TALK? NOT REALLY. THIS lamp does double duty in two ways. For one thing, it's a high-intensity lamp with a "two-speed" control. In the first switch position, the lamp is off. In the second position it is about half bright: in the third position, the lamp is fully bright—and don't get the idea that you need an automobile lamp to get high intensity, either!

It's also two-way because this lamp can mount either on its base like any other lamp or (because the base is filled with small magnets) you can mount it on any ferrous metal surface.

As the diagram shows, a three-position switch is used. This gives you OFF (no current to lamp), HI (full current) and LO (half current). In the LO position, a silicon rectifier conducts only on every other half-cycle of the ac voltage, thus reducing current drain (and lamp brightness).

While you can purchase all the materials new, you may wish to modify an old lamp or salvage some parts from your scrap box to keep the costs down.

Construction tips

I mounted the switch on the base of an aluminum tumbler, and cemented the lamp socket to the switch. You'll want to use a s.p.d.t. pin switch with wire leads. Start by mounting the back of the switch on the base of the lamp socket. Use RTV cement to hold it in place, and allow it to set overnight.

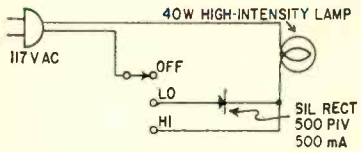
Next align the magnets so they aid rather than repel each other, and place them in the bottom of the plastic or nonmagnetic metal box used as a base. You can use RTV cement generously to hold the magnets in the box. A double layer of magnets will give the base added gripping power.

Locate the center of the bottom of the drinking cup or tumbler and drill a ⅜" hole for the switch. Make another ⅜" hole on one side to support the gooseneck. Placing the gooseneck closer to the open lip of the cup will not only make for a more artsy-craftsy look, it will also make the nut on the end of the gooseneck easier to tighten and give you more working room inside.

Make a final ⅜" hole in the top of the plastic or metal box to mount the other end of the gooseneck. Now snake the line cord up through the box and gooseneck; pull out plenty of slack from the front of the cup, which is now your lampshade.

Following the wiring diagram, connect the switch, lamp socket and line cord. Carefully wrap all exposed leads with plastic electrical tape (or shrinkable tubing). Now insert the switch through the hole in the back of the shade, and fasten it in place with its nut. The switch is now supporting the socket as well. Pull the excess wire back through the bottom of the box and, with your soldering gun, make a small indentation in the plastic to allow the line cord to pass. If you use a metal box you'll have to drill a hole for the wire.

Try the lamp . . . if it works paint it gold or any other color to go with your room decor. **R-E**



Silicon rectifier reduces lamp intensity by allowing current to flow only 50% of the time. Its polarity is not important.

Materials List

1—High-intensity lamp, 117 volts, 40 watts (G-E 40 S11N/1 or similar)

1—Socket to fit lamp

1—S.p.d.t. pin switch, 117 volts (two on positions, one off position) with leads

1—Silicon rectifier diode, 500 piv, 0.5 amperes

1—Ac line cord and plug

1—Anodized aluminum cup or tumbler

1—Flexible gooseneck, about 10" long by about ¾" diameter

1—Plastic or nonferrous metal box, about 3" x 2" x 1"

1—Tube of Dow Corning RTV 732 Silastic cement or similar

Several small, strong magnets (old speaker magnets will do)

Note: You can obtain the diode, the ac line cord and plug, the plastic or metal box, and possibly the magnets, at an electronic parts house. You'll probably have to get the lamp, socket, switch and gooseneck at an electrical supply house or hardware store, where you can also obtain the Silastic cement. Magnets are also available from Edmund Scientific Co., Barrington, N. J. 08007.

HIGH PERFORMANCE METER

(continued from page 55)

nate with motor torque variations—and again helps to isolate a problem.

The WTD position gives a weighted measurement. The term "weighting" applies to noise filters designed to pass noise frequencies in proportion to their degree of objection. Weighting filters are used for audio and video noise measurements as well. In the WTD position the flutter reading is more of an indication of just how objectionable or noticeable a speed variation will be to the ear. As an example, a flutter rate at 100 Hz of a given amplitude will not be so noticeable or objectionable as one at 10 Hz at the same amplitude. The ear is most sensitive to rates between 2 and 10 Hz.

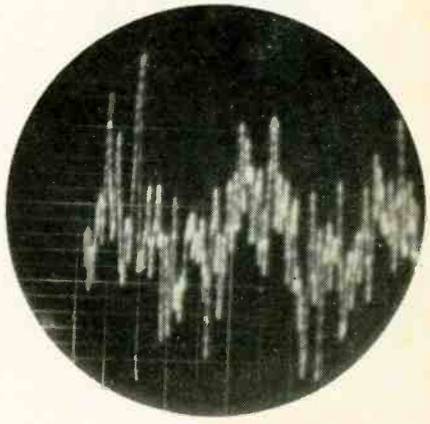
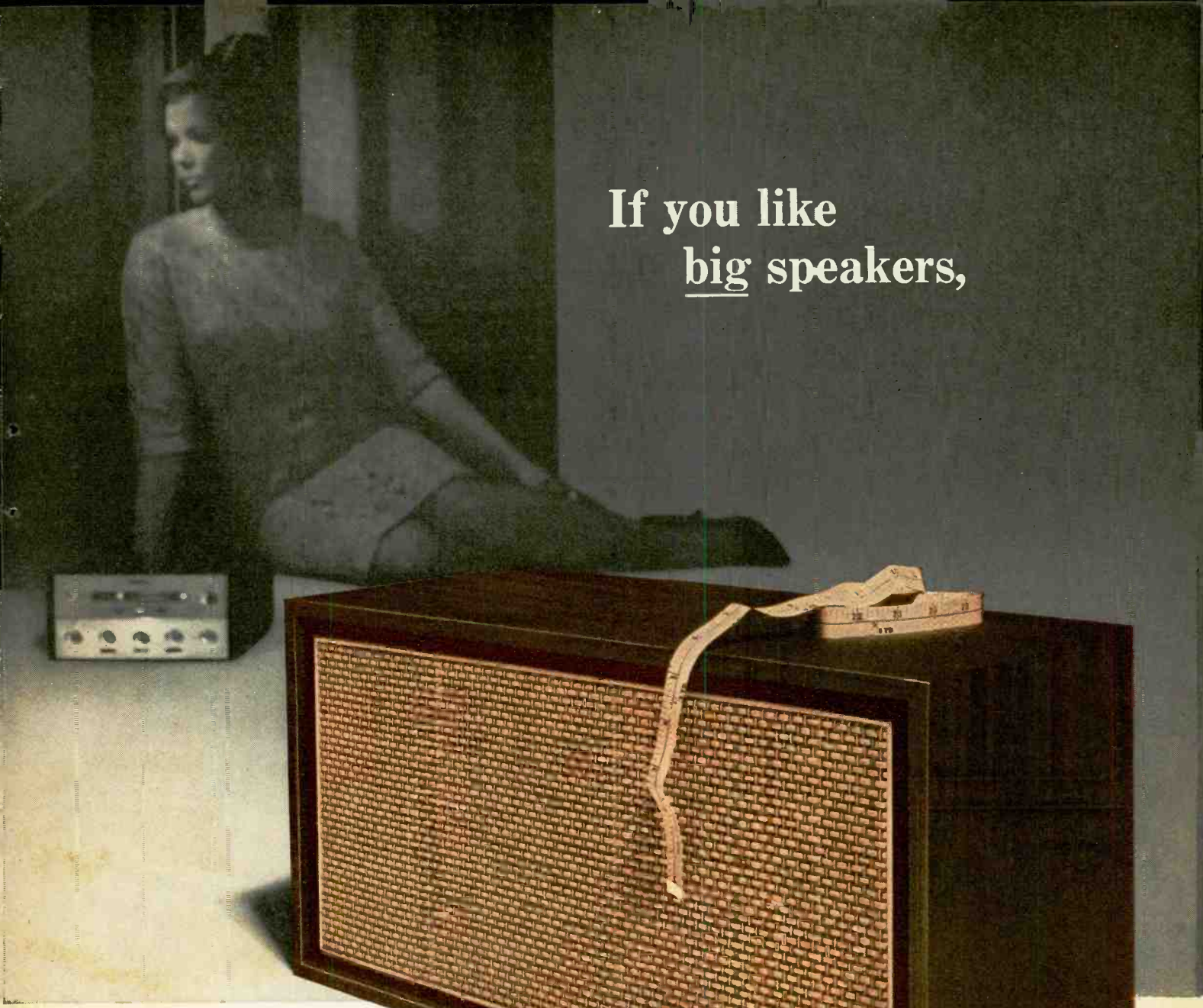


Fig. 7—Typical scope trace of flutter in tape playback. Sweep rate is 0.2 second and vertical sensitivity is 0.5 volt peak to peak. Note random characteristic of flutter in the signal.

To summarize using the flutter meter, set the mode switch to OSC and record several minutes of the 5-kHz signal on a tape, at the tape speed you wish to check. Set the mode switch to STAB for at least 30 seconds or until the tape is rewound. Play the tape back into the flutter-meter input and set the mode switch to READ. Then set the range switch as required, and read the average flutter. Since flutter is usually a random thing, the meter pointer will not be steady; take an average pointer reading. Rewind the tape slightly each time and take at least four more readings. The average of the five readings will give a good indication of the tape equipment quality and condition. Well-built tape machines will average less than 0.1% flutter at 7½ ips. For checking turntables, use a frequency-test record with a 5-kHz test band on it. **R-E**



If you like big speakers,

listen to the mammoth little E-V SEVEN!

The E-V SEVEN is the small speaker for people who don't really want a small speaker. Built in the shadow of one of the biggest speakers of them all (the vast Patrician 800) the E-V SEVEN refuses to sound as small as it is.

But why does an E-V SEVEN grow up when it's turned on? Our engineers point to years of painstaking exploration in the byways of sound. They'll patiently explain the virtues of our low resonance 8″ woofer and 3½″ cone tweeter with symmetrical damping (an E-V exclusive). They may even mention—with quiet pride—the unusual treble balance RC network that adjusts E-V SEVEN response more smoothly than any conventional switch or volume control.

But when it comes to describing the sound, our engineers prefer to let the E-V SEVEN speak for itself. And while they'd be the last to suggest that the E-V SEVEN sounds just like speakers many times larger (and costing much more) they treasure the pleased look of surprise most people exhibit when they hear an E-V SEVEN for the first time.

If you have just 19″ of shelf space, 10″ high and 9″ deep... and have $66.50 to invest in a speaker, by all means listen carefully to the E-V SEVEN. It might well be the biggest thing to happen to your compact high fidelity system!

high fidelity systems and speakers • tuners, amplifiers, receivers • public address loudspeakers • microphones • phonograph needles and cartridges • organs • space and defense electronics

ELECTRO-VOICE, INC., Dept. 1274E, 613 Cecil Street, Buchanan, Michigan 49107

Electro-Voice®

EQUIPMENT REPORT

Ampex 985 Music Center

Circle 43 on reader's service card

WITH THE GROWING popularity of three-piece modular stereo music systems, it was only natural that Ampex should introduce a *music center*. Their device is built around a tape recorder (naturally), rather than the more common record changer/receiver concept. Housed in an attractive walnut cabinet, the music center is a three-speed ¼-track stereo and mono audio tape recorder complete with AM, FM and FM-stereo receiver. The tape transport uses bidirectional playback which eliminates reel turnover; it has a push-to-reset digital tape counter and a fingertip control panel. There are two separate electronic control panels: one for the recorder and one for the radio.

The recorder control panel has a recording mode selector (STEREO or MONO), and a record safety button, which prevents accidental erasure of recorded programs. There are individual channel record-level meters, a five-position source and playback selector switch and dual record-level controls.

The radio control panel contains a flywheel tuning control; a mode selector for choosing FM, AM or FM-stereo reception; dual ganged bass and treble controls; individual channel loudness controls; a tuning meter effective on both FM and AM, and an FM-stereo beacon indicator.

As expected, the recorder was a joy to operate. Reel threading is as simplified as this operation can be made; after some experimenting I was able to make some creditable recordings using both microphones supplied.

An interesting innovation is the automatic reverse feature, which allows playback of both tape sides without reel turnover. This mechanism is activated by a 20-Hz signal (inaudible) recorded on the tape. The reversing signal can be dubbed onto any tapes you may presently own (prerecorded or otherwise).

The overall frequency response of the recorder is listed by the manufacturer as 50 to 15,000 Hz ±4 dB at the 7½-ips speed. This was actually bet-

tered by the unit I tested, using a standard-frequency test tape. Signal-to-noise ratio at 7½ ips was measured at 45 dB (as opposed to the 46 dB listed by the manufacturer). That's well within the classification of "excellent" for home recorders and better than some of the so-called "professional" recorders I've seen. More important, what little residual noise there was consisted of inobtrusive background hiss, or white noise, rather than the more annoying hum components so often prevalent in high-gain devices such as tape recorders.

While the amplifier section boasts a modest 7.5 watts per channel (15 watts combined music power), the model 830 speakers supplied with the unit I tested supplied plenty of sound —even for the concert-hall-level listener. This illustrates a seldom noted advantage of "modular component purchasing."

Since the manufacturer has control of speakers and amplifier selection, he will make sure to supply speakers which are efficient enough to operate properly with his own amplifier, regardless of its *electrical* power rating. It is, after all, *acoustic* power that counts: A 10%-efficient speaker fed by 2 watts of power will sound as loud as a 1%-efficient speaker fed by 20 watts of electrical power!

Obviously emphasizing recorder performance in the descriptive literature, Ampex failed to mention any FM or FM-stereo performance specifications, so I decided to measure them. They shouldn't have been ashamed to publish specs. IHF measured sensitivity was 5 μV, not the best there is, but certainly adequate. This was borne out by my ability to receive satisfactorily FM-stereo stations 20 miles away with full limiting action, using just the built-in dipole. Full limiting occurred with 8 μV of signal. The stereo beacon lit at 3 μV input, though reception at this level was quite noisy.

Separation for FM-stereo, with a 100-μV signal was 25 dB at 1,000 Hz on one channel, 22 dB on the other. At 10 kHz separation was still in excess of 15 dB, not bad at all for a multiplex section with only three transistors!

AM reception was quite adequate; the circuitry is conventional.

All electronics in the 985 are fully transisorized, employing a total of 42 transistors.

If tape recording is your special interest, and if the compactness of modular component approach to stereo sound has appeal, you would do well to check into the model 985 Ampex music center. —*Leonard Feldman*

Price: $599.95

"King of the hill"

Keep on top of your solid-state replacements...with RCA "Top-Of-The-Line" SK-Series. They make up just a handful of types—17 transistors, 2 rectifiers, and 2 integrated circuits. Together these 21 RCA SK-Series types can keep you ahead of 9,000 solid-state replacements in entertainment-type equipment. Designed especially for this purpose, you'll find these devices useful in line-operated and battery-operated radios, phonographs, tape recorders, TV receivers, AF amplifiers, and automobile radios.

RCA SK-Series transistors and rectifiers and the 9,000 types they replace are cross-referenced in the RCA Solid-State Replacement Guide. It's a handy booklet listing comparably-rated types including industry standard EIA types, foreign types, and those identified only by device manufacturers' or equipment manufacturers' parts numbers.

Check with your RCA Distributor. He stocks the complete line in either cartons or see-through display packs. Also, pick-up your copy of the RCA Replacement Guide SFD-202-D available through your RCA Distributor.

RCA Electronic Components and Devices, Harrison, N.J. 07029

The Most Trusted Name in Electronics

Amphenol 870
Millivolt Commander

Circle 44 on reader's service card

Manufacturer's Specifications

Dc Voltmeter
Ranges: 100 mV to 100 volts full scale
Accuracy: ±2% of full scale
Input resistance: 10.6 megohms

Ac Voltmeter
Ranges: 10 mV to 300 volts rms full scale
Accuracy: ±3% of full scale
Input impedance: 10 megohms, 50 pF

Decibels
Ranges: —40 to +50 dBm
Accuracy: ±3% full scale, 50 Hz–50 kHz

Ohmmeter
Ranges: 10 ohms to 10 megohms center scale
Accuracy: ±3° of arc

Size: 9¼" x 5¾" x 6⅜"
Weight: 5 lb
Price: $99.95

FOR MANY YEARS, most of us have struggled with non-portable vtvm's which had to be plugged into an ac line and warmed up every time we moved 'em. If you needed high input impedance to avoid circuit loading, you babied that vtvm, 'cause a vom wouldn't do the job.

Amphenol's Millivolt Commander, model 870, *will* do the job. Input impedance is 10 megohms on all ranges, and the instrument has full-scale deflecion of 100 mV on dc and 10 mV on ac. These features are obtained by using an FET input stage. The entire voltmeter is solid-state and battery-operated, for complete portability and stability.

There's still another advantage—you aren't tied to the ac line, so you can hang the meter across nearly any kind of circuit with no regard for where the ground is.

You'll find the model 870 can measure almost any voltage or resistance you run into in electronic servicing—with the possible exception of TV high voltage. Accuracy is good (see below) and the instrument is stable. In the dc mode, there is 60 dB of ac rejection at the 60-Hz line frequency.

The heart of this voltmeter is a dc amplifier which has good temperature stability. To eliminate drift, this amplifier is supplied with a constant bias voltage; the cells supplying this voltage are loaded with a constant current. Drain is minimal, and the cells should last two years in normal service.

Actually, there are three separate battery supplies: One is used for the ohms supply, one for the zero reference, and one for the amplifier supply. All batteries are AA size. Zinc-carbon cells are cheapest, but for best and longest performance, you might want to try alkaline cells.

One thing I noticed was the appreciable effect of the ohms battery on the accuracy of the Rx1 scale. I put a 15-ohm, 1% resistor across the test leads on the Rx1 scale of the 870 as supplied by Amphenol. The reading was 9 ohms. Then I replaced the ohms battery with a fresh cell and read 13 ohms (which is within specifications).

Good mechanical design is evident in the model 870. The meter movement has been designed to operate satisfactorily in both the horizontal and the vertical plane, so you can set up the voltmeter any way you want. A brace in back permits you to tilt the meter up at a 45° angle when reading it.

The circuit is shielded by a metal interior case (to avoid stray pickup) with a leatherette exterior case and front-panel cover (for portability).

You can do a lot with the Millivolt Commander. You can check microphones and phono cartridges for output level and balance, you can measure transistor bias voltages, and you can evaluate the performance of small-signal equipment. All in all, this is a most handy instrument.

—*Ray Clifton* **R-E**

Circle 32 on reader's service card

14 KIT-GIVING IDEAS FROM HEATH . . .

For The Whole Family . . .
New Deluxe "227" Color TV

Exclusive Heathkit Self-Servicing Features. Like the famous Heathkit "295" and "180" color TV's, the new Heathkit "227" features a built-in dot generator plus full color photos and simple instructions so *you* can set-up, converge and maintain the best color pictures at all times. Add to this the detailed trouble-shooting charts in the manual, and you put an end to costly TV service calls for periodic picture convergence and minor repairs. No other brand of color TV has this money-saving self-servicing feature.

Advanced Features. Boasts new RCA Perma-Chrome picture tube for 38% brighter pictures . . . 227 sq. in. rectangular viewing area . . . 24,000 v. regulated picture power . . . improved phosphors for brilliant, livelier colors . . . new improved low voltage power supply with boosted B+ for best operation . . . automatic degaussing . . . exclusive Heath Magna-Shield to protect against stray magnetic fields and maintain color purity . . . ACC and AGC to reduce color fade and insure steady, flutter-free pictures under all conditions . . . preassembled & aligned IF with 3 stages instead of the usual 2 . . . preassembled & aligned 2-speed transistor UHF tuner . . . deluxe VHF turret tuner with "memory" fine tuning . . . 300 & 75 ohm VHF antenna inputs . . . two hi-fi sound outputs . . . 4" x 6" 8 ohm speaker . . . choice of installation — wall, custom or optional Heath factory assembled cabinets. Build in 25 hours.

Kit GR-227, (everything except cabinet). . . $42 dn., as low as $25 mo. . . . 114 lbs. **$419.95**
GRA-227-1, Walnut cabinet. . . no money dn., $6 mo. **$59.95**
GRA-227-2, Mediterranean Oak cabinet (shown above) . . . no money dn., $10 mo. **$94.50**

Kit GR-227
$419.95 (less cabinet) $25 mo.

Kit GRA-27
$19.95

New Remote Control For Heathkit Color TV

Now change channels and turn your Heathkit color TV off and on from the comfort of your armchair with this new remote control kit. Use with Heathkit GR-227, GR-295 and GR-180 color TV's. Includes 20' cable.

Kit GR-295
$479.95
(less cabinet)
$42 mo.

Deluxe Heathkit "295" Color TV

Color TV's largest picture . . . 295 sq. in. viewing area. Same features and built-in servicing facilities as new GR-227. Universal main control panel for versatile in-wall installation. 6" x 9" speaker.

Kit GR-295, (everything except cabinet), 131 lbs. . . . $48 dn., $42 mo. **$479.95**
GRA-295-1, Walnut cabinet (shown above), 35 lbs. . . . no money dn., $7 mo. **$62.95**
Other cabinets from $94.50

Kit GR-180
$349.95
(less cabinet & cart)
$30 mo.

Deluxe Heathkit "180" Color TV

Same high performance features and exclusive self-servicing facilities as new GR-227 (above) except for 180 sq. in. viewing area.

Kit GR-180, (everything except cabinet), 102 lbs. . . $35 dn., $30 mo. **$349.95**
GRS-180-5, table model cabinet & mobile cart (shown above), 57 lbs. . . .no money dn., $5 mo. **$39.95**
Other cabinets from $24.95

FREE... 40-Lesson Record Course With Either Heathkit/Thomas Organ! A $50 Value! Includes four 33⅓ rpm records, music book & leatherette album.

Kit TO-67
$995
(including bench)
$200 dn.,
as low as $29 mo.

Heathkit®/Thomas "Paramount" Theatre Organ

Save Up To $500! Build in 80-100 hours. All Thomas factory-made parts . . . 15 manual, 4 pedal voices; instant-play Color-Glo; all-transistor circuit; 200 watts peak power; 2-speed rotating Leslie plus main speaker system with two 12" speakers; 44-note keyboards; horseshoe console with stop tablets; 28-note chimes; 13-note bass pedals; repeat & attack percussion; reverb; headset outlet; assembled walnut finish hardwood cabinet & bench; and more. 265 lbs. 7", 33⅓ rpm demonstration record 50c.

America's Lowest Cost Solid-State Organ

Kit GD-325B
$394.90
$40 dn., $34 mo.

Save Up To $205! Instant-play Color-Glo; 10 voices; 13-note bass pedals; repeat percussion; 37-note keyboards; 75-watt peak power; vibrato; assembled walnut cabinet & bench. 172 lbs. 7", 33⅓ rpm demonstration record 50c.

Exclusive Band Box Percussion

Automatically or manually adds 10 percussion voices to any Heathkit/Thomas organ. Build & install in 12 hours.
Kit TOA-67-1, no money dn., $14 mo. **$145.00**

Exclusive Playmate Rhythm Maker

Adds 15 fascinating rhythms to any Heathkit/Thomas Organ. Requires Band Box percussion (above) for operation.
Kit TOA-67-5, no money dn., $18 mo. **$189.90**

USE COUPON BELOW TO ORDER NOW

NEW! VOX "Jaguar" Transistor Combo Organ By Heathkit

Kit TO-68
$349.95
$35 dn., $30 mo.

Save Up To $150 on the world's most popular combo organ with this new Heathkit version. Features the most distinctive sound of any combo organ. Has a special bass output that gives a brilliant stereo bass effect when played through a separate or multi-channel amplifier, 4 complete octaves, vibrato, percussive effects and reversible bass keys. Includes hand crafted orange and black cabinet, fully plated heavy-duty stand, expression pedal and waterproof carrying cover and case for stand. Requires a bass or combo amplifier like Heathkit TA-17 (opposite page).

Kit TO-68, 80 lbs. . . . $35 dn., $30 mo. **$349.95**

NEW! Deluxe Solid-State Combo Amplifier & Speaker System . . . Choose Kit Or Factory Assembled

Amplifier Kit TA-17
$175
$17 mo.
(Assembled TAW-17 $275)

Speaker System Kit TA-17-1
$120
$11 mo.
(Assembled TAW-17-1 $150)

Special Combination Offer
Amplifier & Two Speaker Systems Save $20
Kit TAS-17-2
$395
$40 dn.
$34 mo.
(Assembled TAW-17-2 $545)

All the "big sound" features every combo wants . . . tremolo, built-in "fuzz", brightness, reverb, separate bass and treble boost and more. Delivers a shattering 120 watts EIA music power (240 watts peak power) through two TA-17-1 speakers . . . or 90 watts through one TA-17-1 speaker. Features 3 independent input channels, each with two inputs. Handles lead or bass guitars, combo organ, accordion, singer's mike, or even a record changer. All front panel controls keep you in full command of all the action.

Speaker system features two 12" woofers, special horn driver and matching black vinyl-covered wood cabinet with casters & handles for easy mobility.

NEW! Lowest Cost Solid-State Stereo Receiver

Kit AR-17
$72.95
(less cabinet)
$8 mo.

Features wide 18-60,000 Hz response @ ±1 db at full 5 watts RMS power per channel . . . 14 watts music power . . . inputs for phono and auxiliary . . . automatic stereo indicator . . . outputs for 4 thru 16 ohm speakers . . . adjustable phase for best stereo . . . flywheel tuning . . . and compact 9¾" D. x 2⅞" H. x 11¼" W. size. 12 lbs. Optional factory assembled cabinets (walnut $7.95, beige metal $3.50).

Kit AR-17, (less cab.) 12 lbs. . . . no money dn., $8 mo. . . **$72.95**
Kit AR-27, 7-Watt FM Mono Only Receiver (less cab.) 9 lbs. . . . no money dn., $5 mo. **$49.95**

Kit AR-15
$329.95
(less cabinet)
$28 mo.

Assembled ARW-15 $499.50
(less cabinet) $43 mo.

World's Most Advanced Stereo Receiver

Acclaimed by owners & experts for features like integrated circuits & crystal filters in IF amplifier; FET FM tuner; 150 watts music power; AM/FM and FM stereo; positive circuit protection; all-silicion transistors; "black magic" panel lighting; and more. Wrap-around walnut cabinet $19.95

Kit AR-15 (less cab.), 34 lbs. . . . $33 dn., $28 mo. **$329.95**
Assembled ARW-15, (less cab.), 34 lbs. . . . $50 dn., $43 mo. **$499.50**

Professional 10-Band Shortwave Receiver

Kit SB-310
$249
$23 mo.

Covers 49, 41, 31, 25, 19 & 16 meter shortwave . . . 80, 40 & 20 meter ham . . . 11 mete· CB Includes 5 kHz crystal filter for AM, SSB and CW listening. Features selectivity that slices stations down to last kHz; 11-tube circuit; crystal-controlled front-end and more. 20 lbs. SB-600 8 ohm 6" x 9" speaker in matching cabinet $18.95.

NEW! Solid-State Portable Volt-Ohm-Meter

So Handy, So Low Cost we call it "every man's" meter. Just right for homeowners, hobbyists, boatowners, CBer's, hams . . . it's even sophisticated enough for radio & TV servicing! Features 12 ranges . . . 4 AC & 4 DC volt ranges, 4 ohm ranges; 11 megohm input on DC, 1 megohm input on AC; 4½" 200 uA meter; battery power; rugged polypropylene case and more. Easy 3 or 4 hour kit assembly. Ideal gift for any man! 4 lbs.

Kit IM-17
$19.95

NEW
FREE 1968 CATALOG!

Now with more kits, more color. Fully describes these along with over 300 kits for stereo/hi-fi, color TV, electronic organs, electric guitar & amplifier, amateur radio, marine, educational, CB, home & hobby. Mail coupon or write Heath Company, Benton Harbor, Michigan 49022.

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☐ Enclosed is $_____, including shipping.
Please send model (s)_____
☐ Please send FREE Heathkit Catalog.
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Name_____
Address_____
City_____ State_____ Zip_____

Prices & specifications subject to change without notice. CL-310

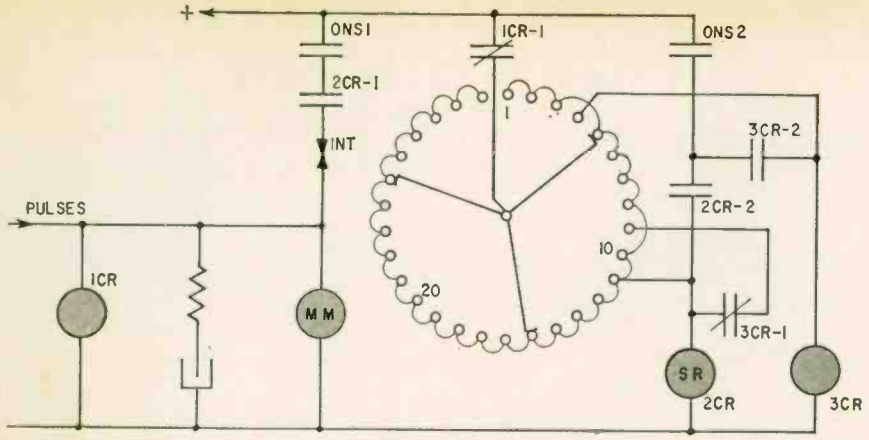

Fig. 6—A 3-digit selector using type 44 switch. Can be reset with a single pulse.

Rotary Stepping Switches

(continued from page 48)

switch stay in the last position it reaches.

For example, with the circuit shown, we can dial circuit 9 only by dialing first 4 and then 5. Any other sequence causes the stepping switch to home. 1CR-1 opens at the beginning of the first series of pulses, disconnecting the battery from the wiper and prevents false triggering. At the end of the pulse 1CR-1 closes and connects the battery to the wiper. If the correct number (4) had been dialed, 3CR is energized and locked in through 3CR-2 and ONS2. The next series of 5 pulses steps the switch to position 9.

If the code is misdialed or 9 is dialed directly, 2CR is energized and the stepping switch homes through 2CR-1 and off-normal contacts ONS1.

For low digits an additional relay may be needed, to prevent landing on the third digit position. It would be necessary to use a second code of pulses to ensure that the switch comes to rest successively on all three points or not at all. Line connection is made through a second level of contacts (not shown in the diagram). Any additional pulse after the three-digit code will of course have the same effect as too many pulses—it will send the switch home.

Where only a few selectors are to be used on a line, relay RY1 can be eliminated simply by making the first digit 0 (tenth contact) and the second digit 9 or 0. This makes it unlikely that accidental connection could take place, yet allows for the use of 9 selectors. With that many pulses needed it is also unlikely that accidental connection could take place, yet the circuit allows for the use of 9 selectors. It is equally unlikely that random pulse noise might connect a selector.

The circuit of Fig. 6 has many applications. It can be used to read voltages or currents of a remotely located transmitter (or any other electronic device, for that matter). A suitable meter would be used at the dial (pulse-originating) location, while series and shunt connections would be made at the stepper (pulse-receiving) location.

Another use would be to switch microphone circuits remotely into a single amplifier and line.

Rotary stepping switches have been used for many years in telephone, communications and industrial electronics. Today's models are highly sophisticated and capable of complex functions. In spite of the hundreds of thousands of steppers in daily use, many persons interested in electronics have little knowledge of stepping-switch function. These switches aren't really so complicated, however, as this series has shown. **R-E**

The FCC License

(continued from page 2)

of stations: experimental, auxiliary, booster, translator, and instructional fixed TV; developmental and remote-pickup broadcast; noncommercial educational FM broadcast with power output not more than 1 kW; CATV relay; land, maritime, aviation, public safety, industrial, land transportation, and domestic public. You may perform maintenance at a ship radar station only with a ship radar endorsement.

If you get a *Radiotelephone First-Class license* you have the most privileges (and the most qualifications) in this group. You may operate all the preceding, plus AM broadcast stations with power output over 10 kW or with directional antennas, FM stations with power output over 25 kW, TV stations and shortwave broadcast stations.

You may also perform servicing and maintenance at those stations so listed under Radiotelephone Second-Class, plus AM broadcast, commercial FM, TV, shortwave broadcast, and noncommercial educational FM stations with power output over 1 kW. You may perform maintenance at a ship radar station only with a ship radar endorsement.

The *Radiotelegraph Third-Class permit* holder is quite limited in permissible duties, and may operate only land maritime telegraph and telephone stations, ship maritime telephone, public-safety telegraph and telephone, industrial telephone and telegraph, land transportation telephone and telegraph, domestic public telegraph, and international fixed public stations. He may not perform any servicing or maintenance.

A *Radiotelegraph Second-Class license* allows you to operate all the preceding, plus AM broadcast stations with both power output of 10 kW or less and nondirectional antennas, FM stations with power output of 25 kW or less, and remote-pickup broadcast stations. You may also operate aircraft telegraph stations but *only* if you are at least 18 years of age and have an aircraft telegraph endorsement, and have passed a code test of 25 wpm.

This license, like its radiotelephone counterpart, is for the technician. With it, you may perform maintenance at noncommercial educational FM stations with not more than 10 watts power, land and ship maritime telegraph, aircraft telegraph, public-safety telegraph and telephone, industrial telegraph and telephone, land transportation telegraph and telephone, and domestic public telegraph stations. You may perform maintenance at a ship radar station only with a ship radar endorsement.

The *Radiotelegraph First-Class license* is the most difficult ticket to get, and it really means something. To insure the safety of life at sea, the holder of this license may not only operate all the preceding, but *only he* may act as chief or sole operator on a cargo vessel (other than a vessel operated exclusively on the Great Lakes) which is required by treaty or statute to be equipped with a radiotelegraph installation, and only after he has completed 6 months' service as a radio operator aboard a US ship.

With this license, you may perform maintenance at those stations listed under Radiotelegraph Second-Class. You may also operate aircraft telegraph stations, but only with an aircraft telegraph endorsement. You may perform maintenance duties at a ship radar station only with a ship radar endorsement.

An FCC operator license can mean a lot in your electronics future. Make it easy on yourself—try for a Third, or maybe a Second. Study one element at a time. With a second phone you can do CB, two-way business radio and trucking company servicing. Then get that first phone. Or, if you'd like to go to sea, study code and try for a second telegraph. But get that ticket. You may find it's your meal ticket—and you may find yourself eating steak. **R-E**

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   Include zip code! Manufacturers will not guarantee to fill your requests unless your zip code is on the reader service card!

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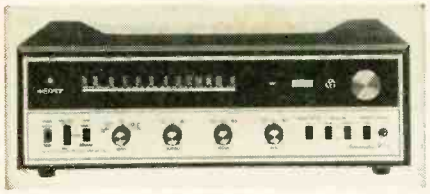
NEW AUDIO EQUIPMENT

More new product information is available free from the manufacturers of items identified by a Reader's Service number. Turn to the Reader's Service Card facing page 72 and circle the numbers of the new products on which you would like information. Detach and mail the postage-paid card.

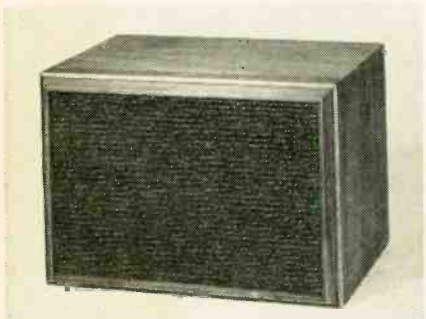
65-WATT STEREO RECEIVERS, FM stereo *342B*, and AM/FM stereo *382B*. Both feature **Scott FET** circuitry, which eliminates all cross modulation and drift in both AM and FM. Driver and output transformers are eliminated from the design of the two models. Output is direct coupled, each model has dual speaker switches for main, remote, both speakers, or all-speakers-off for headphone listen-



ing; noise filter; front panel headphone jack; separate bass, treble, and volume controls for each channel. Both receivers achieve 2.2 μV sensitivity with 80 dB cross-modulation rejection. Separation is 36 dB. *382B* features automatic variable bandwidth and automatic gain control. *342B* features integrated circuit i.f. *342B* is $299.95 and *382B* is $339.95.—**H. H. Scott, Inc.**

Circle 46 on reader's service card

FOUR SPEAKER SYSTEMS. The *Maximus 22* is a 2-way system (shown) and *Maximus 55* is a 3-way system. Both may be used horizontally on bookshelves or in a vertical position, free standing. The *Maximus 33* and *Maximus 44*, along with the other models, offer an integrated line of speakers. All units employ the acoustic suspension principle with a



higher efficiency because of the magnetic design, permitting use of amplifiers of relatively low power. They all have removable grilles to permit use of custom grille fabrics to blend with room decor, and make cleaning easy. All speakers have hand-rubbed, oiled walnut cabinets. *Maximus* series *22*, *55*, *33*, and *44* are $39.95, $99.50, $56.00, and $76.00 respectively.—**UTC Sound, Div. of TRW.**

Circle 47 on reader's service card

CASSETTE CARTRIDGE TAPE RECORDER, The *M8320* is operated on four "C" batteries. Play, record, rewind and stop functions are controlled by a slide switch. This unit features a remote control microphone with pouch, a detachable carry strap, a neon recording-level

indicator, capstan drive for constant tape speed and a cassette guard which prevents accidental tape erasure. Optional accessories are an ac converter, a patch cord and an earphone. 60 or 120 minute blank or pre-recorded music cassettes may be used. $49.95—**General Electric**

Circle 48 on reader's service card

3-SPEED TAPE RECORDER, *Model 1040*. Detachable speakers are this unit's feature. It uses 4-track stereo and mono at 7½, 3¾ and 1⅞ ips. Instant stopping permits editing as you go. The same single control is used for rewind, stop, play and fast forward operations. Novice and expert operators will find the digital counter and the two VU meters useful.

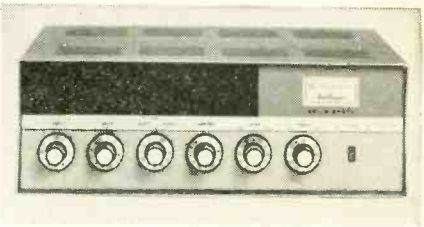
The solid-state amplifier (10-watt peak) has a fold-down panel which conceals recording controls, record interlock and inputs. The recorder and speaker fold into a compact portable case. Shutoff is automatic. Response: 30–18,000 Hz at 7½ ips; flutter and wow: less than 0.15% at 7½ ips. $169.95 price includes two speakers, 2 microphones, 7" take-up reel and patch cords.—**Allied Radio Corp.**

Circle 49 on reader's service card

New Audio Equipment

continued from page 75

SOLID-STATE P.A. AMPLIFIERS, *Challenger CHS* series. Available in four models ranging in power from 20 watts to 100 watts, this new line will operate at full output from −20°C (−4°F) to +65°C (+149°F). In higher powered models, *CHS100* and *CHS50,* all-silicon semiconductors are used. Rated at 100 watts and 50 watts, respectively, these amplifiers have two microphone inputs. The 35-watt *CHS35* offers two mike inputs and can be operated from a 12-volt battery as well as ac. Model *CHS20* is rated at 20 watts and has one mike input.



All models have two auxiliary inputs on a fader control. The *CHS* chassis has a panel-mounted preamp designed for two additional microphones. The accessory, *PMA-2,* can be inserted in less than five minutes. All models have both high- and low-impedance microphone inputs. A built-in circuit permits microphone precedence over music or adjustment of volume from distances up to 2,000 feet. Memory Markers aid in returning controls to previously determined levels without blare or dead spots. Other features include wide-frequency response, individual amplifier control, constant-voltage output, light-weight cabinet. Accessories such as phonograph tops, locking cover, rack panel mounting kit, remote controllers, carrying case are available. *Bogen CHS100* shown.—**Bogen Communications Div./Lear Siegler, Inc.**

Circle 50 on reader's service card

STEREO HEADPHONES. Norelco has introduced its new *Models K-20* and *K-60* stereo headphones. Both weigh eleven ounces. The standard *K-20* has a single tension-spring head band and plastic ear cushions. Frequency range is 20 to 20,000 Hz; impedance is 600 ohms per

channel. The *K-60* deluxe professional headset has a multi-adjustable dual head band and cushioned ear-fitting cups. Its frequency range and impedance level are the same as in model *K-20. K-20* is $19.50 and *K-60* is $39.50.—**North American Philips Co., Inc.**

Circle 51 on reader's service card

MICROPHONE HEADSETS, These new headsets permit two-way radio or wired communications in high ambient noise

areas, and are easily adapted to radio transceivers. The transistorized model works directly into common audio line.—**Industrial Communications Co.**

Circle 52 on reader's service card

3 NEW MICROPHONES, *Unispheres. Model 585SAV* has a volume control mounted on the microphone case, enabling the speaker to change the loudness of the PA system to which the mike is connected. *Model 565S* has an on-off switch as part of the swivel connector assembly. *Model 566* (shown in photo)

offers shock mounting to prevent pickup of mechanical vibrations and handling noise. It also features a Cannon-type connector and a combination impedance change (50 or 150 ohms), on-off switch. All of these models are designed to minimize feedback, breath sounds and wind noise. Models 585SAV, 565S, and 566 are $72.50, $100.00, and $140.00 respectively.—**Shure Brothers, Inc.**

Circle 53 on reader's service card

AM/FM STEREO COMPACT SYSTEMS, *models 1050* and *1030. Model 1050* is a powerful unit which features the Elac/Miracord *50* automatic turntable, EMI *model 92* speakers and a Benjamin solid-state receiver with 85-watt (IHF) output. A microphone and instrument input with gain controls permit playing guitar or other instruments through the system and doing "voice over" records. *Model 1030* features the Miracord *620* player and EMI *62* speakers and delivers 50 watts (IHF) output. Both units use the Elac *244* compatible mono-stereo magnetic cartridge with diamond stylus and they come with two EMI speakers. Model *1050* is $499.50 and Model 1030 is $399.50. Tape re-

corder accessory that fits under the cabinet of either model is $139.50.—**Benjamin Electronic Sound Corp.**

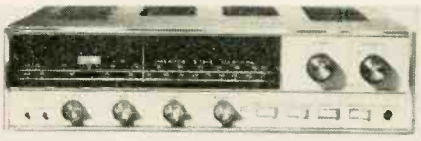
Circle 54 on reader's service card

AM/FM STEREO MUSIC CENTER, The *LRC-60* solid-state 60-watt receiver features four IC's, FET front end, and a BSR McDonald 500 4-speed automatic stereo turntable with a Pickering V15/AC-3 Dustamatic stereo cartridge. It plays 7, 10, or 12" records at 16⅔, 33⅓, 45, and 78 rpm. Impedance: 8-16

ohms; frequency response: 20-20,000 Hz ± 1dB; tuner FM sensitivity: 1.8 μV IHF; capture ratio: 1.25 dB. Provides a full set of audio controls; D'Arsonval tuning meter; automatic FM stereo/mono switching; stereo indicator light; stereo headphone jack; tape recorder jacks; and vernier dial drive. For 117V, 50/60 cycle ac.—**Lafayette Radio Electronics Corp.**

Circle 55 on reader's service card

AM/FM STEREO RECEIVER with IC's. *Model S-7800.* Each IC has 5 silicon transistors in a monolithic semiconductor package. Specs include 2-dB capture ra-

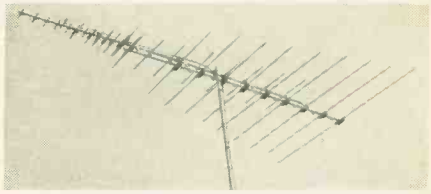


tio, 0.15% distortion at 100% modulation, and 55 dB of AM rejection. Features Field-Effect Transistors in rf and mixer stages for elimination of multiple responses. Receiver delivers 140 watts of music power into 4-ohm loads at 0.6% harmonic distortion. IM distortion is 0.1% at normal listening levels; FM sensitivity, 1.8 μV. The unit carries a 3-year warranty for defective parts, including transistors. $419.50. In walnut-grained leatherette case $428.50.—**Sherwood Electronic Laboratories, Inc.** R-E

Circle 56 on reader's service card

New Antenna Equipment

UHF-VHF LONG-RANGE ANTENNA, *Model CPC-33G,* with a single down-lead receives all 82 channels plus FM. The "Piggy-Back" power pack insures extra reception quality for both



color and black and white, even in fringe areas. A band-splitter is provided for use at the TV set. Finished in K-T Gold Coat, the unit has a built-in-lead-in support and strain relief for durable installation.—**Kay-Townes Antenna Co.**

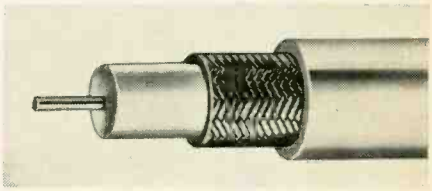
Circle 57 on reader's service card

PERFORATED TV ANTENNA WIRE. Improves color, uhf and vhf black and white reception. *PERFO 8-0* is constructed with 20-gauge copper conductors. Air spaces between the conduc-

tors allow little signal loss. Impedance is 300 ohms. Available in 500-ft. spools and 50, 75 and 100 ft. pre-cut lengths, the wire is light weight, flexible and less resistant to wind.—**Jersey Specialty Co., Inc.**

Circle 58 on reader's service card

75-OHM SOLID COAX, *model No. 8221.* Available in standard colors of black, white and gray, this 22-AWG coax has a foam polyethelene vinyl jacket. It is installed easily with RG-59/U connec-



tors and meets MATV, CATV and CCTV requirements for indoor or outdoor use. Features a flexible all-weather jacket and comes in 100-, 500- and 1000-ft lengths as a standard catalog item.—**Belden Corp.** **R-E**

Circle 59 on reader's service card

Miss-Q

Price of book, "Principles of Aerial Design," published by D. Van Nostrand Co. Inc., as reviewed (August 1967), should read $8.95 and not $1.75.

New 5 Band POLICE PORTABLE

"A SPECTACULAR CHRISTMAS GIFT"

Hear all police communications: patrol cars, base stations, motorcycles, helicopters. Also tunes Fire Departments, State Highway Patrols, Sheriff's Departments, auto telephones, taxis, all radio equipped vehicles. *Fascinating and exciting listening 24 hours a day!* Marine/Shortwave Band brings in all marine communications. Special Weather Band gives accurate forecasts and reports around the clock. Regular AM Broadcast Band brings in stations ordinary radios never get. *Also plugs into regular house current.*

5 BANDS: 150-175 MC, 30-50 MC, 1.5-4.5 MC 200-400 KC, 550-1600 KC

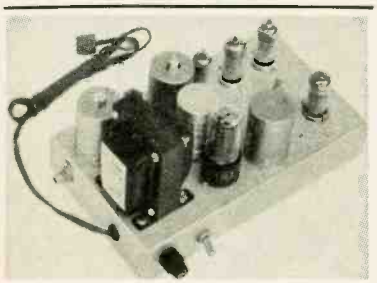
Complete with leather case, batteries, antennas, house current adapter. $129.95. Unconditional 10 day money back return privilege. *Write for Free Booklet.*

Nova-Tech, Inc., 630 Meyer Lane, Dept. RE, Redondo Beach, Calif. 90278

Circle 110 on reader's service card

Enjoy the "music-only" programs now available on the FM broadcast band from coast to coast.

• NO COMMERCIALS •
• NO INTERRUPTIONS •



It's easy! Just plug Music Associated's Sub Carrier Detector into multiplex jack of your FM tuner or easily wire into discriminator. Tune through your FM dial and hear programs of continuous commercial-free music you are now missing. The Detector, self-powered and with electronic mute for quieting between selections, permits reception of popular background music programs no longer sent by wire but transmitted as hidden programs on the FM broadcast band from coast to coast. Use with any FM tuner. Size: 5½" x 9". Shipping weight approx. 7 lbs.

KIT $49.50

(with pre-tuned coils, no alignment necessary)

WIRED $75.00 (Covers extra $4.95 ea.)

Current list of FM Broadcast stations with SCA authorization $1.00

MUSIC ASSOCIATED

65 Glenwood Road, Upper Montclair, N. J.
Phone: (201)-744-3387 07043

Circle 111 on reader's service card

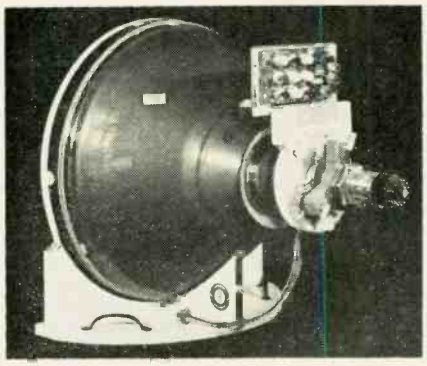
NEW PRODUCTS

IN-CONVERTER AND VOLTAGE REGULATOR, accessories for converting polarity and/or voltage in automotive electrical systems. *In-Converter* has dc input of 6 or 12 V and output of 6 or 12 V of polarity desired, or output of 18 or 24 V

of same polarity as input. *Voltage Regulator* accepts 24–32 vdc and furnishes output of 13 vdc at 14 watts. *Voltage Regulator* (positive ground), $14.95; (negative ground), $17.95. *In-Converter,* $22.95.—E. F. Johnson Co.

Circle 60 on reader's service card

COLOR TEST TUBE PEDESTALS, *models C21, R19.* For 19- and 21-in. TV's. Designed to secure test tube and convergence panel in position for

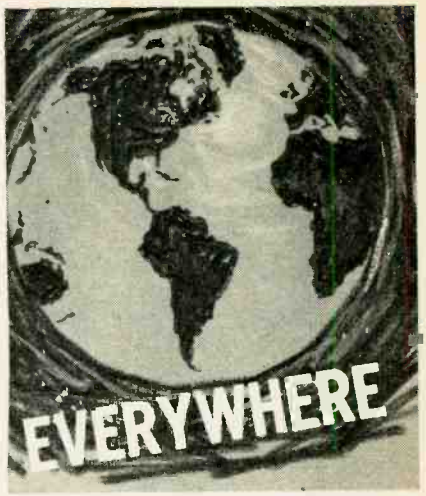


direct hookup. Provide a full picture view in service mirror. *C21,* for all 70° color tubes, 45 lb; *R19,* for 21-, 23-, 25-in., 90-92° color tubes. $14.50—Eight Ball Co. R-E

Circle 61 on reader's service card

How to Kill Color Ghosts

Improve your color-TV picture by getting rid of annoying ghosts and spurious signals. Learn how the professionals get clean color signals. Find out all about the color ghost situation in our January issue.



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222 Hartrey Ave., Evanston, Ill. 60204

Circle 106 on reader's service card

NEW LITERATURE

All booklets, catalogs, charts, data sheets and other literature listed here with a Reader's Service number are free for the asking. Turn to the Reader's Service Card facing page 72 and circle the numbers of the items you want. Then detach and mail the card. No postage required!

TWO-WAY RADIO COMMUNICATIONS SYSTEMS. This 16-page booklet enables a business/industrial user to select the right system for his requirements. It explains licensing requirements, range expandability and frequency selection, and how to create typical systems from **Johnson** units. With this booklet potential users of business/industrial radio can design their own two-way radio systems.—**E. F. Johnson Co.**

Circle 62 on reader's service card

POTENTIOMETERS, TRIMMERS, DIALS, INSTRUMENT MOTORS, *Catalog No. C-67.* This new 120-page catalog covers **Amphenol** products in depth. Each is shown in a cutaway view with a listing of mechanical, electrical and environmental specs.—**Amphenol Corp.**

Circle 63 on reader's service card

THE TAPE CARTRIDGE: *How it Began and What It's All About* is a 12-page booklet describing the tape cartridge as a medium of quality sound reproduction and recording for music lovers. It discusses the two types of cartridges—continuous loop and the cassette system. Diagrams make for easy understanding. Tips on proper cartridge handling are given.—**Audio Devices, Inc.**

Circle 64 on reader's service card

FREE SAMPLE KIT OF WIRE/CABLE HARNESSES & MARKERS. Engineers, draftsmen and contractors will be interested in this kit which includes Spiroband, strapping, cable tie and adjustable P-Clip harnessing systems; three types of markers, and a grommet-strip which is cut to size. A business reply card asking for additional information and samples is attached.—**Electrovert, Inc.**

Circle 65 on reader's service card

MAGNETIC TAPE RECORDING HANDBOOK, *Application Note No. 89.* 44-page handbook covers fundamentals of magnetic tape recording, including FM recording, predetection recording, pulse recording, how electrical signals are stored and recovered from magnetic tape and the function of the bias signal. Characteristics of recording head, tape transport mechanisms, record/reproduce electronics, and the tape itself are also covered.—**Hewlett-Packard**

Circle 66 on reader's service card

Write direct to the manufacturers for information on the item listed below:

INTRODUCTION TO TAPE RECORDING. *No. a67-21 "Let the Music Get Through to You."* a 4-color 24-page booklet, tells how magnetic tape and the tape-recording process work, what to look for when selecting a stereo tape player/recorder, and the advantages of stereo tape libraries over disc collections. 25¢—**Ampex Corp.** P.O. Box 3728, Chicago, Ill. 60654

RE

RCA Announces two important new test instruments for service, industrial and lab applications.

All solid-state battery operated

VOLTOHMYST® WV-500A

Eliminate warm-up time! Eliminate zero-shift that can occur in tube-operated voltmeters! RCA's new WV-500A VoltOhmyst is an all solid-state, battery operated, completely portable voltmeter that is ideal for service, industrial and lab applications. Seven overlapping resistance ranges measure from 0.2 ohm to 1000 megohms. Eight overlapping dc-voltage ranges measure from 0.02 volt to 1500 volts (including special 0.5 dc volt range), ac peak-to-peak voltages of complex waveforms from 0.5 volts to 4200 volts, and ac (rms) voltages from 0.1 to 1500 volts. Input impedance of all dc ranges is 11 megohms.

All measurements are made with a sturdy, wired-in single-unit probe with fully shielded input cable. The probe is quickly adapted to either dc measurement or ac and resistance measurement by a convenient built-in switch. *And an accessory slip-on high-voltage probe is also available to make possible measurements up to 50,000 dc volts.*

Solid-state reliability and convenience for only $75.00*

WG-411A high-voltage slip-on probe. For use with WG-410A or WG-299D ac/dc ohms probes. Extends dc voltage range of VoltOhmysts to 50,000 volts when used with WG-206 multiplier-resistor. $13.50*

In-circuit / out-of-circuit

TRANSISTOR TESTER WT-501A

Completely portable and requiring no external power source, RCA's new WT-501A tests transistors both in-circuit and out-of-circuit, tests both low and high power transistors, and has both NPN and PNP sockets to allow convenient transistor matching for complementary symmetry applications. The instrument tests out-of-circuit transistors for dc beta from 1 to 1000, collector-to-base leakage as low as 2 microamperes, and collector-to-emitter leakage from 20 microamperes to 1 ampere. Special low impedance circuitry assures reliable in-circuit testing.

Collector current is adjustable from 20 microamperes to 1 ampere in four ranges, permitting most transistors to be tested at rated current level. A complete DC Forward Current Transfer Ratio Curve can be plotted. The three color-coded test leads are provided for in-circuit testing, and for out-of-circuit testing of those transistors that will not fit into the panel socket.

Extra features... RCA reliability... for only $66.75*

**Optional Distributor resale price. All prices subject to change without notice. Prices may be slightly higher in Alaska, Hawaii and the West.*

Ask to see them at your Authorized RCA Test Equipment Distributor, or write RCA Commercial Engineering Department L30W, 415 South Fifth Street, Harrison, N.J.

RCA Electronic Components and Devices, Harrison, N.J.

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1967 ANNUAL INDEX

RADIO-ELECTRONICS January-December 1967 of Vol XXXVIII

A

KEY TO SYMBOLS AND ABBREVIATIONS

* Construciton Articles
† Section of full-length article
§ Transistorized

CI ..... Service Clinic
Corr ..... Correction
Corres ..... Correspondence
ER ..... Equipment Report
NB ..... News Briefs
NC ..... Noteworthy Circuits
Tech ..... Technotes
TTO ..... Try This One
WN ..... What's New

Regular departments not itemized are New Books, New Literature. New Products. What's Your EQ?

B

C

D

E

F

G

H

I

K

L

M

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V

W

X

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Z

Coming Next Month . . .

COLOR TELEVISION

Learn how to get rid of color ghosts and see the best possible picture. Keep up to date on modern high-voltage and shunt-regulator circuits in color sets. Find out how to make purity adjustments, and attack intermittents in chroma circuits.

SERVICING

Take a guided tour of your scope—how to get the most out of it. Learn how to troubleshoot relays and keep them in tiptop condition. Add to your file of case histories in CB transceiver troubles.

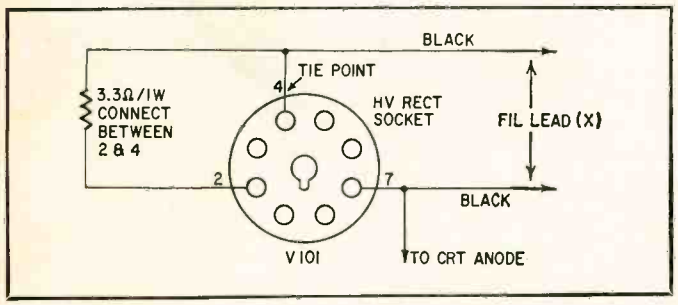
PLUS

Painless dB's—or how to use decibels without knowing logarithms. More applications for an 80-cent IC. Story of an unusual problem (how to use two-way radio in a subway tunnel) and its unusual solution. All these —and more construction projects—you'll find in our January issue.

TECHNOTES

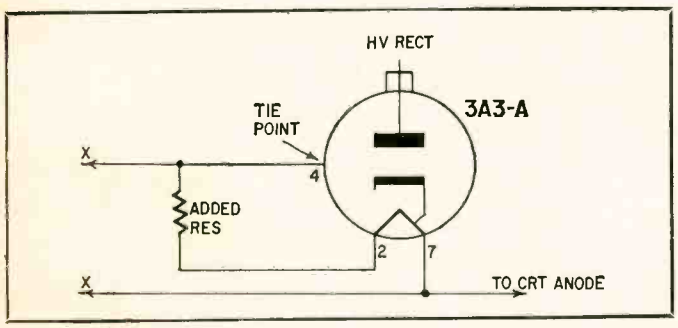
RCA CTC 16X HV RECTIFIER

Field reports show that the 3A3-A is being substituted for the 3CA3 high-voltage rectifier in this chassis. The 3A3-A



is an improved tube type and *is* a recommended replacement *provided* a 3.3-ohm, 1-watt resistor is inserted in series with the filament lead.

Some replacement tubes are double-branded 3A3-A/3CA3. These should be considered as type 3A3-A's when

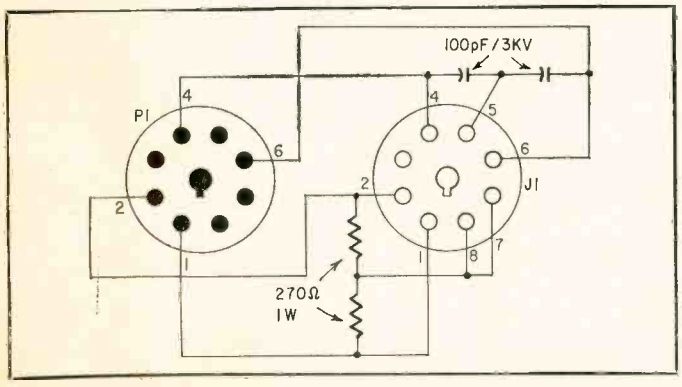


used as replacements in the CTC 16X chassis, requiring the addition of the filament resistor.

The resistor can be installed at the rectifier socket *without removing the chassis*. Transfer the black filament lead from pin 2 to pin 4 (used as a tie point). Connect the resistor between pins 2 and 4 as shown in the diagrams.—*RCA Television Service Tips*

ADMIRAL TV TEST-JIG ADAPTER

This diagram shows an adapter that enables you to use a color TV test jig having a 7-lead yoke to test current color TV sets employing 4-lead yokes. Plug P1 (Admiral part No.

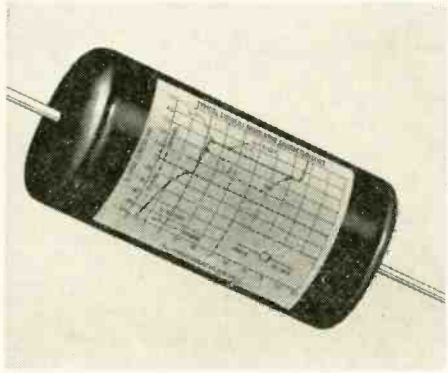


88A23-6) fits 3H10, 4H10, 5H10, 6H10 and 9H10 chassis. Socket (part No. 87A84-2) fits 94D304-1, -2, -3, -4; 94D275-1 and 94D306-1 deflection yokes.—*Admiral Service News Letter* **R-E**

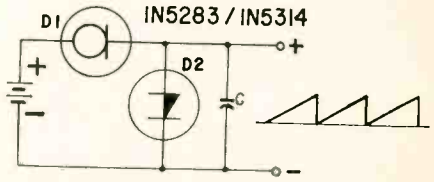
NEW SEMICONDUCTORS

FIELD-EFFECT DIODES

The Motorola 1N5283 through 1N5314 series of current regulators are field-effect diodes that establish a constant current flow regardless of applied voltage. They are the analog of the Zener diode which establishes a constant voltage independent of current.



The diodes are ideal for use as constant-current sources for differential amplifiers, ramp generators and for



transistor biasing. In voltage-reference circuits, the current regulator can supply a temperature-compensated Zener diode with a constant current to limit voltage changes caused by large swings in an unregulated circuit.

The current regulators can be used to simplify the design of sawtooth and ramp generator circuits. The diagram shows a simple sawtooth generator with a linear positive-going ramp. D1 is the current regulator diode and D2 is a 4-layer diode. The period of one cycle of the oscillator (T) is $C \times V_{BR}/I_P$; where I_P is the pinch-off current of D1, C is the value of the capacitor in μF and V_{BR} is the breakover voltage of the 4-layer diode.

The diodes are in a DO-7 glass

AND MICROCIRCUITS

cartridge. They have a peak operating voltage rating of 100, power dissipation is 600 mW and cover 32 current ranges. Minimum dynamic impedance for diodes in the series ranges from 25.0 megohms for the 1N5283 (a 0.22-mA device) to 235,000 ohms for the 1N5314, a 4.7-mA unit.

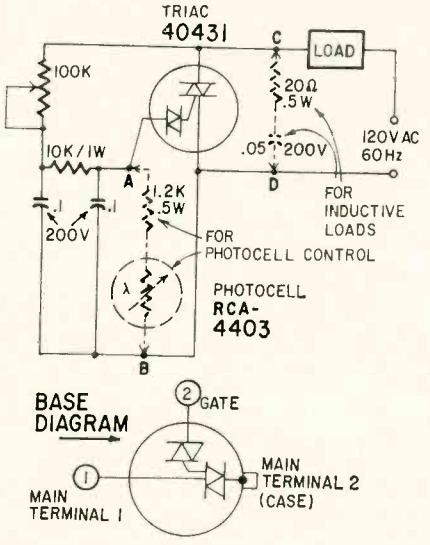
The price is $4.90 in lots of 100 and up—but can be expected to drop as usage increases.

TRIAC WITH INTEGRAL TRIGGER

The RCA 40431 and 40432 Triacs are gate-controlled full-wave ac silicon switches with built-in triggers. They are intended for phase control of ac loads in such applications as light dimming, speed controls for universal and induction motors and in heating controls.

They are sealed in modified TO-5 packages which are tin-plated so they can be soldered to heat sinks.

The 40431 is for applications requiring repetitive peak off-state voltages



up to 200 and an on-state rms current up to 6 amps with case temperatures up to 75°C. The 40432 is for off-state voltages up to 400 under the same conditions. **R-E**

Be Sure and See These Brand-New GL-TAB Books at Your Parts Distributor!

SERVICING TV RECEIVER CIRCUITS— Just the kind of "how-to-do-it" handbook every practicing TV service technician should have. Contains the TV service data most needed for trouble-shooting both monochrome and color receivers, all in one handy volume. Emphasis is on practical data which can be used in the home or at the service bench. 224 pps., 34 chapters. No. 414 Paperback $2.95

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TV TROUBLESHOOTER'S HANDBOOK: A carefully-planned reference source of over 350 different, tried and tested solutions to "tough-dog" TV servicing problems. A complete digest of late-model TV receiver troubles and cures, new and unusual circuits and descriptions of how they work, field and factory changes, recurring defects, etc. 125 illus.
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Circle 119 on reader's service card

continued from page 33

this is not important as there is plenty of signal for recording.

Construction

The parts layout is not critical as all circuits are low impedance. Figs. 6 and 7 are top and underside views and show the location of the few parts used.

The Triac is conveniently mounted on the small aluminum plate which is insulated from and fastened to the case with ½" insulated, threaded spacers. Transformer T1 is mounted on the opposite side of the cabinet (Fig. 7). P1, J1, J2 and J3 are mounted on the front. As Fig. 6 shows. R3, S1 and S2 are mounted on the top of the case.

Resistor R1 should be chosen to produce a 1-volt sync signal. The resistance value will depend on the voltage value and the amount of current drawn by the slide-changer motor or solenoid. If the motor draws about 0.3 amp, which is normal for home-type changers, R1 should be 3 ohms. Check the nameplate on your projector to find

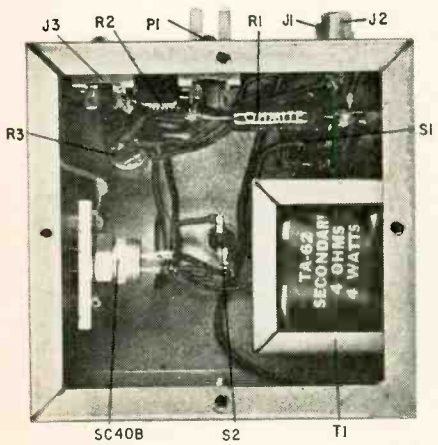

Fig. 7—Parts placement isn't critical within the box as the circuit is chiefly low impedance. Mount Triac carefully.

out how much current it draws. This figure may include the projector lamp wattage, which you must subtract. Better still, use an ac voltmeter across R1 and try different values until you come up with a 1-volt signal.

You will need a two-wire power cable with a receptacle to mate with P1 on one end. The other end of the cable should match the slide-changer remote socket. For the sync connections to the tape recorder, use phone plug on one end, and whatever you need on the other to match the recorder jacks. **R-E**

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NOTEWORTHY CIRCUITS

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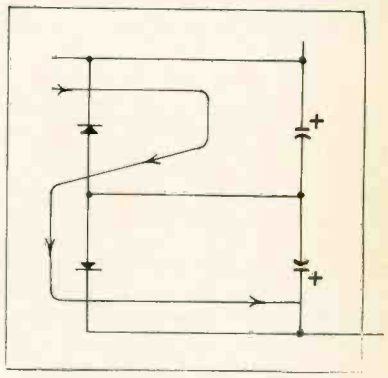


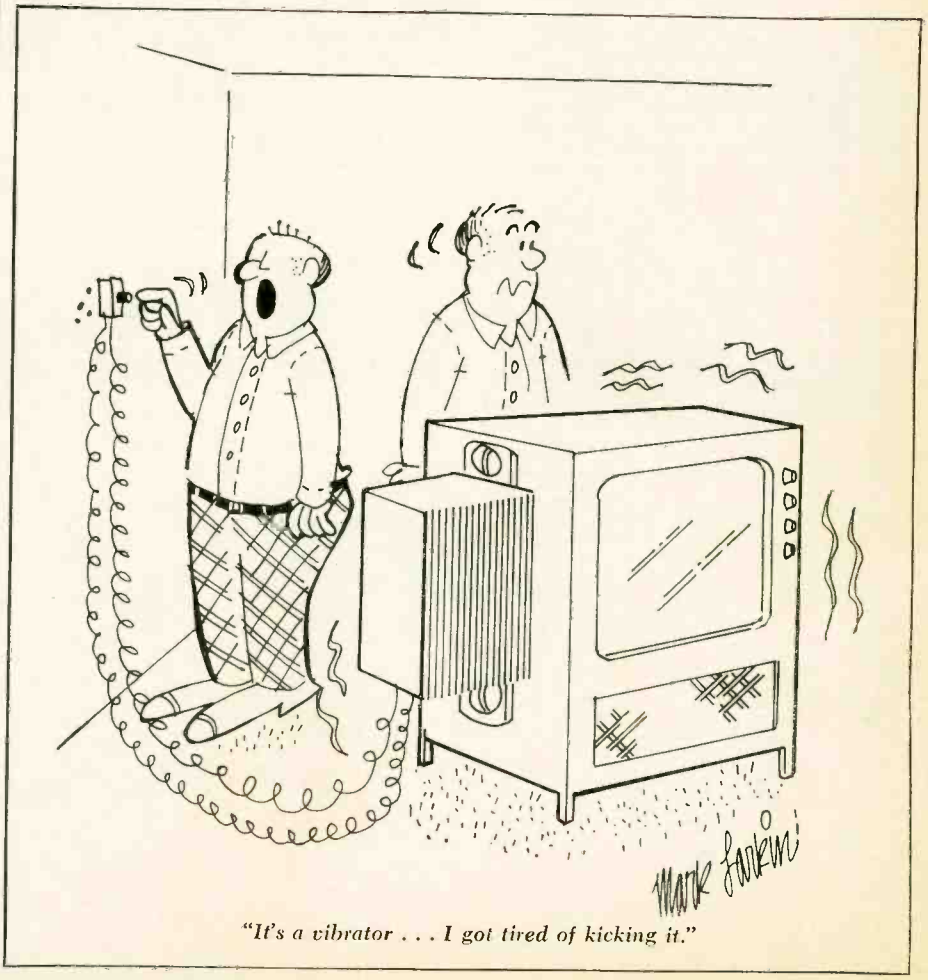
Occasionally an industrial electronic technician has to find a temporary substitute for a defective large-value ac capacitor. The old trick of replacing it with two capacitors of double the capacitance, back to back, is well known. Unfortunately, large-capacitance high-voltage electrolytics are not easily obtainable. In some instances the technician would have to parallel two capacitors to get the needed value, and thus would find himself using four capacitors to replace one.

The problem is solved in a neater way with isolating diodes. Their current rating should be at least equal to the peak ac. On the half-cycle when the upper electrode of the top capacitor in the drawing is positive, current flow (conventional) is as shown. The reverse is true, of course, on the next half-cycle.

Another advantage of this hookup is that the reverse voltage across each capacitor is limited to the forward voltage drop across its associated capacitor. Thus there is no reverse current. And, of course, the capacitors can be the same size as the one to be replaced.

In one instance, this circuit was used to replace a defective 150μf, 330-Vac capacitor in a Xenon arc-lamp power supply with two 150-μf, 450-Vdc capacitors and two 1N3254 diodes.

—R. W. Neale **R-E**



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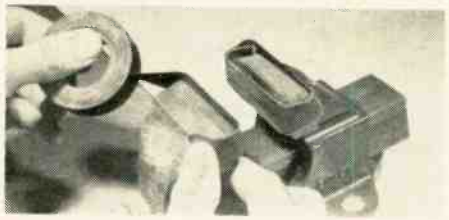

Don't let the hard, coarse jaws of your vise mar the finish on a new chassis or panel. Instead, wrap several turns of electrical or plastic tape around the jaws before clamping the work in place. The number of turns is determined by how tight the chassis will be clamped—more protection is needed for tighter clamping. The tape is easily removed and discarded after the job is finished.

—Robert E. Kelland **R-E**

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1. Date of filing: October 1, 1967.
2. Title of publication: RADIO-ELECTRONICS.
3. Frequency of issue: Monthly.
4. Location of known office of publication: Ferry Street, Concord, Merrimack County, New Hampshire 03302.
5. Location of the headquarters or general business offices of the publishers: 154 West 14 Street, New York, New York 10011.
6. Names and addresses of publisher, editor, and managing editor: Publisher, M. Harvey Gernsback, 154 West 14 Street, New York, New York 10011; Editor, Robert Cornell, 154 West 14 Street, New York, New York 10011; Managing Editor, Thomas R. Haskett, 154 West 14 Street, New York, New York 10011.
7. Owner: Gernsback Publications, Inc., 154 West 15 Street, New York, New York 10011; M. Harvey Gernsback, 154 West 14 Street, New York, New York 10011; Mary H. Gernsback, M. Harvey Gernsback, Maurice Coyne, Benjamin E. Winston As Trustees Under Trust Agreement dated September 30, 1965 c/o Benjamin E. Winston, Esq., 330 Madison Avenue, New York, New York 10017.
8. Known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages or other securities: None.
9. For completion by nonprofit organizations authorized to mail at special rates: Does not apply in this case.
10. Extent and nature of circulation. The average number of copies each issue during preceding 12 months are: (A) Total number copies printed (net press run): 223,037; (B) Paid circulation: (1) Sales through dealers and carriers, street vendors and counter sales: 46,074; (2) Mail subscriptions: 110,011; (C) Total paid circulation: 156,085; (D) Free distribution (including samples) by mail, carrier or other means: 2,416; (E) Total distribution: 158,501; (F) Office use, left-over, unaccounted, spoiled after printing: 64,536; (G) Total: 223,037. The number of copies single issue nearest to filing date are: (A) Total number copies printed (net press run): 216,677; (B) Paid circulation: (1) Sales through dealers and carriers, street vendors and counter sales: 47,789; (2) Mail subscriptions: 108,405; (C) Total paid circulation: 156,194; (D) Free distribution (including samples) by mail, carrier or other means: 2,187; (E) Total distribution: 158,381; (F) Office use, left-over, unaccounted, spoiled after printing: 58,296; (G) Total: 216,677.

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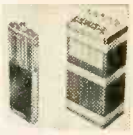

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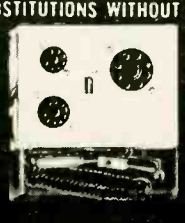

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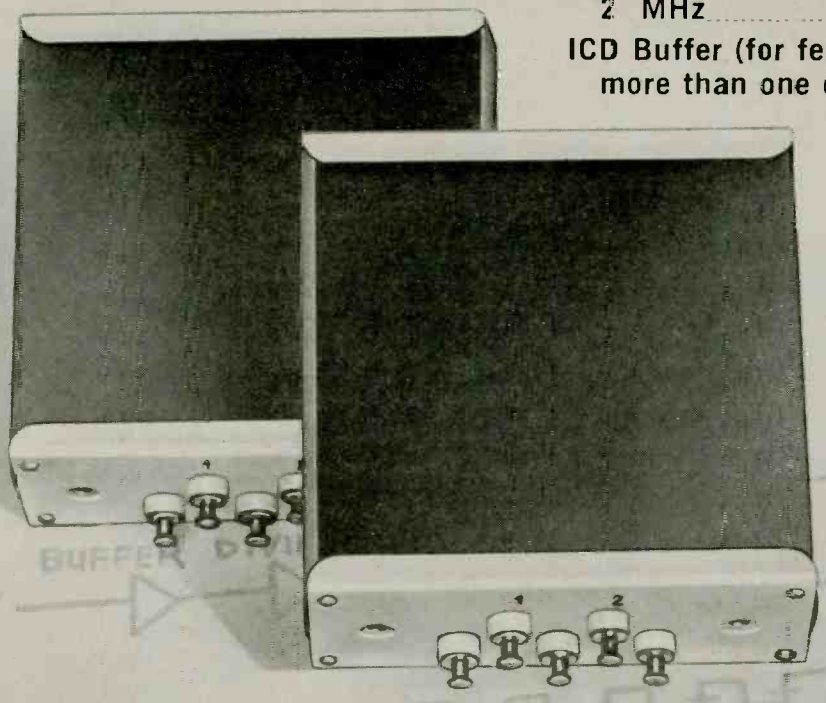

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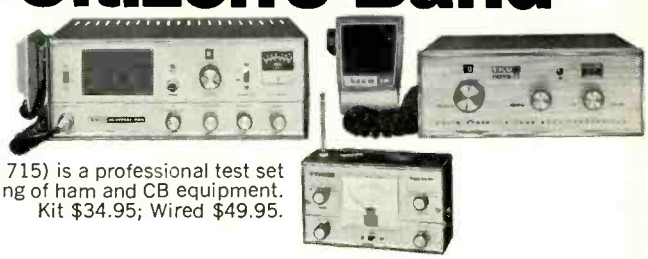

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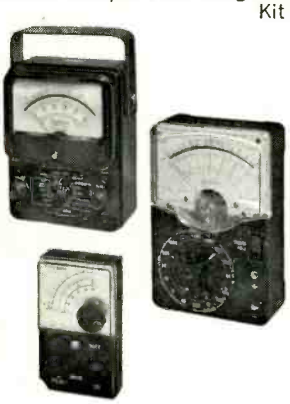

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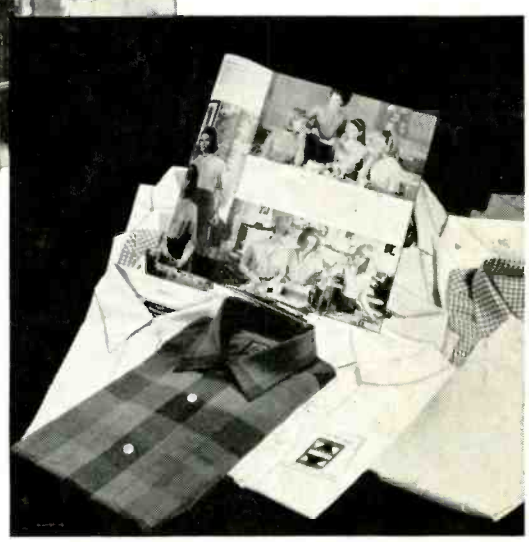

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