5 New electronic aids for your car

60c ■ APRIL 1970

Radio-Electronics®

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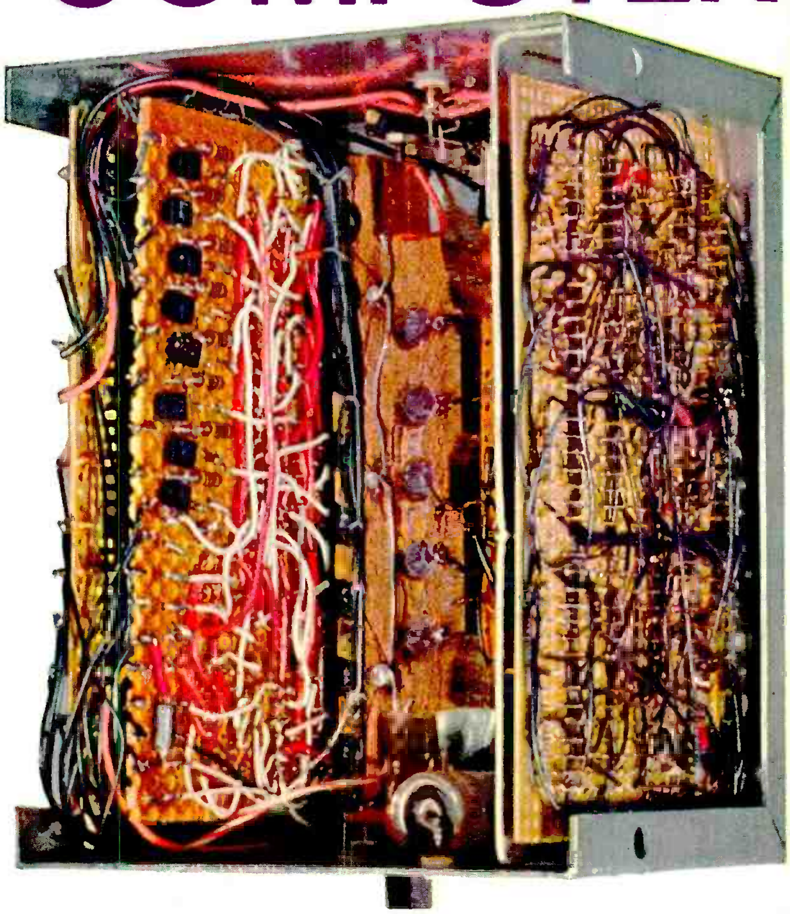
REPAIR CAR RADIOS p 57
CB REPAIR - p 66

Try to beat

p 44

R-E's "PENNIAC"

$150 GAME COMPUTER



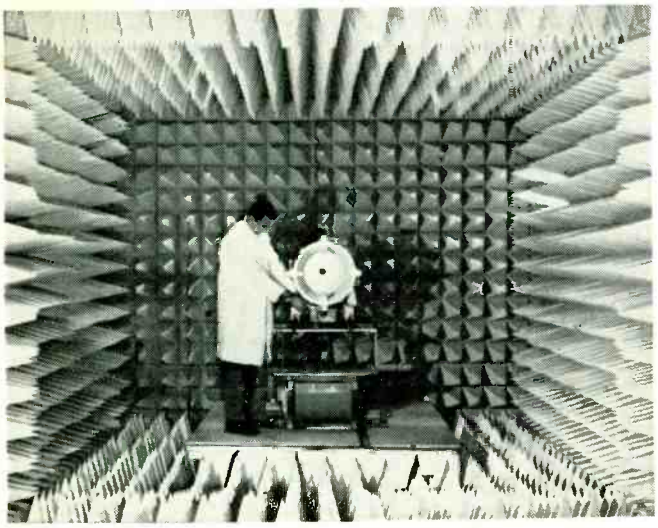
ELECTRONICS FOR YOUR CAR

Build excess-speed alarm
Tune up with a VOM
Easy way to add stereo speakers
Build lights-on reminder

QuickFix™ charts:
Troubleshoot Transistor TV

NEW & TIMELY

CHAMBER TEST FOR RF FEEDS

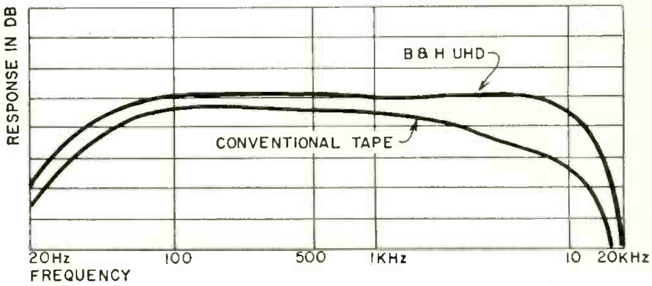


WALTHAM, MASS.—This anechoic chamber is being used by Sylvania to provide an echoless and interference-free environment to test rf feeds for earth station antennas used in the satellite communications program. The rf feeds are part of the large dish-shaped antennas that transmit and receive telephone, teletypewriter and TV communications via stationary earth satellites.

NEW TAPE HAS WIDER RESPONSE

NEW YORK—Bell & Howell has introduced new high-density recording tapes that use iron oxide particles 60–70% smaller than most tapes on the market and "gamma orientation"—electronic alignment and packing together of the particle coating. A new binder breakthrough, says B&H, allows more particles in each square centimeter, while an ultra-thin insulating shield surrounding each particle also helps tape quality.

The new tape is available in two densities. The response curve shown compares the response of the ultra-high-density tape with another widely sold brand at 3¾ ips on an Ampex 300. The UHD costs 20% more than the high-density tape.



DOPPLER RADAR SYSTEM MAPS STORMS IN 3D

BOULDER, COLO.—Using a new Doppler radar technique and high-speed digital computers, meteorologists can now study in 3D the internal development of storms.

The technique, conceived 10 years ago by Dr. Roger Lhermitte, a physicist with the Environmental Science Services Administration (ESSA), has had to wait for computers that could process the complex volume of data.

Two or three Doppler radars are used to probe a storm. The radial velocity of particles within the storm is determined by the change in frequency of the reflected wave. An electronic range gate allows sampling of radial velocity data at 24 points from front to rear of a storm. Lhermitte is currently developing a radar-housed computer that will sample several hundred points each second, scanning an entire storm in a minute.

The systems, still too complex to be made commercially, are being used to improve weather prediction.

LOOKING AHEAD

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

Runaway recorders

The booming popularity of the tape recorder makes it far and away the fastest-growing product in the consumer segment of electronics in the US. Yet as tape recorder and player sales rise, domestic manufacture of recorders is quietly declining.

Two major manufacturers are now in the process of abandoning US manufacture of audio tape recorders for the consumer mass market, although both plan to continue—and even step up—their offerings in this field via imports. One is Ampex, the company that introduced the tape recorder to America. The other is Bell & Howell. Ampex will continue to manufacture professional audio and video recorders in the US. Both companies will have consumer recorders built overseas to their specifications.

For many years, imports have dominated the recorder market, but with the growth of the cassette, less than 10% of all recorders sold in the US last year were built here. Both Ampex and Bell & Howell have been importing as well as manufacturing recorders here, and now will move their open-reel production to factories abroad.

These two defections leave only three major companies making mass-market consumer recorders in the US—Minnesota Mining (Wollensak brand), Telex and V-M, although several firms make semiprofessional recorders. These three companies say they have no intention of quitting domestic production. Several other domestic firms make 8-track tape players, but except for automobile units, the bulk

(continued on page 4)

COMPUTERS TO SPOT UNIQUE VOICEPRINTS

CAMDEN, N.J.—Prototype equipment that uses a computer to identify individuals by their "voiceprints" is under development by RCA. Computer-based speech-recognition systems measure energy-level variations in phonemes. Some 40 phonemes—such as the "p" in pin and "f" in fin—comprise the English language.

For identity authentication, a circuit card could be prepared and compared electronically with the voice fed into the system. Besides military applications, banks could use the system to authenticate telephone calls from customers giving verbal instructions for transactions.

AUTOMOTIVE ELECTRONICS IN THIS ISSUE

Without being aware of it, your foot may become a little too heavy on the gas pedal when you're driving. To prevent unwanted speeding tickets, why not build an electronic alarm that triggers when you exceed preset speed limits? The complete two-part project starting on page 33 uses a precision tachometer to determine rpm and speed. A frequency-sensitive circuit can then be set to trigger when rpm gets too high.

Radio-Electronics

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SPECIAL CONSTRUCTION FEATURE

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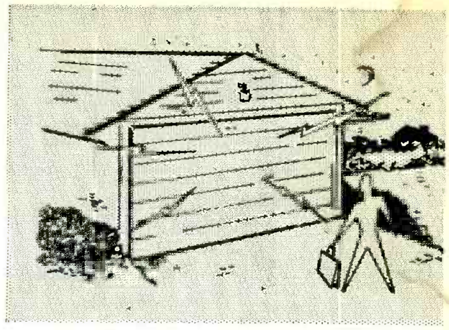
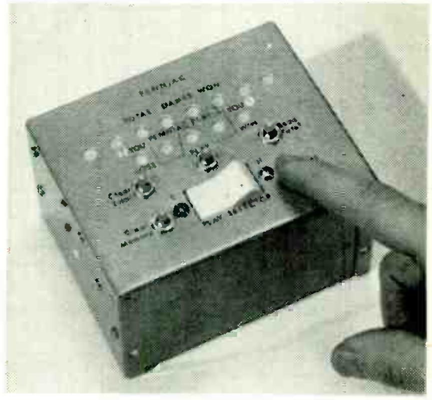
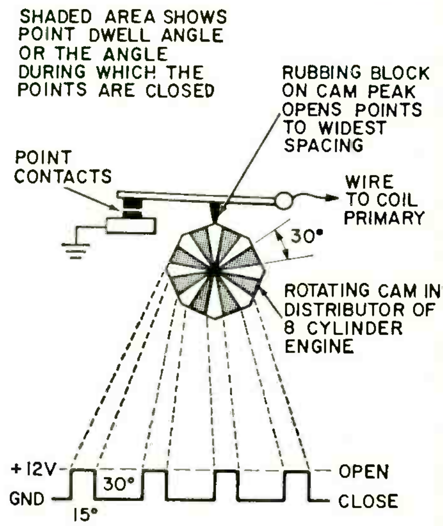


Lights-on reminder circuit won't let you walk away from your car with the headlights on. . . . see page 60



Penniac Game Computer computes your moves and plays a tough penny-matching game. Can you beat 66 IC's? . . . see page 44



IDEAL WAVEFORM OF THE SIGNAL ACROSS THE POINTS IN A STANDARD IGNITION SYSTEM

Tune your car for top performance with your VOM. For details of a low-cost tune-up procedure. . . . see page 23

RADIO-ELECTRONICS, APRIL 1970. Vol. 41, No. 4
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LIGHT BEAM FEEDS DATA TO COMPUTER

An electrical engineering professor, Dr. Jack Baird at the University of Colorado, has developed a technique for transmitting computer data from one building to another with an infrared light beam. The method has saved the university thousands of dollars and the three years often required for installation of a microwave or telephone system.

The setup uses a gallium arsenide light emitter, condensing lenses and a phototransistor at the receiver. The data-modulated light from computer terminals at the engineering center is sent 3000 feet to the computing center. Rain or fog does not affect the infrared wavelengths used, although heavy snow blocks transmission.

The university is linking other buildings to the computing center at about $500 per installation.

AUTOMOTIVE ELECTRONICS IN THIS ISSUE

Opening the garage door on a cold morning and finding the headlight switch on and a dead battery is no fun. Keep your temper and battery with an easy-to-build, headlight-on reminder alarm. It will activate any alarm you want to hook up. See page 60.

122 COLOR TV MODELS LISTED AS FIRE RISK

A list of 122 models of color TV sets said to have a greater risk of causing fires was reported recently by the National Committee on Product Safety. The various models are made by 11 manufacturers.

Fire and smoke damage claims were 3 per 10,000 sets manufactured for the models, over twice as high as the industry mean of 1.2 damage claims per 10,000 sets built.

Convinced that many fires are never reported to manufacturers, the committee asked the National Electronic Association, over 90% of whose membership are TV service/dealers, to also survey the TV fire problem.

NEW REGULATIONS CONTROL RADIATION PRODUCTS

Federal regulations covering electronic products that emit radiation—color TV sets, microwave ovens, sun lamps, etc.—now permit to be declared defective products that create a risk of injury. The new regulations, covering products made after Oct. 18, 1968, do not require direct evidence of injury to humans.

The Environmental Control Administration has proposed that manufacturers of radiation-emitting products be required to keep records for 5 years after offering the product for sale. The records would include test results and product durability and stability.

LOOKING AHEAD

(continued from page 2)

of this market is also supplied by foreign manufactures.

"Concert hall" at home

A Canadian stereo manufacturer is offering an accessory (for its own console and component systems) designed to provide many of the advantages of 4-channel sound from regular 2-channel discs, tapes and broadcasts. Electrohome Ltd., whose products are also sold in many parts of the US, has developed a system it calls "Environment I." It combines six sound sources, reverberation and a separate stereo amplifier to duplicate concert-hall sound in the home.

The complete Environment I setup includes a stereo amplifier with built-in time delay to feed two small omnidirectional "sound-cube" speakers in the rear corners of a room. Two satellite omnidirectional speakers are placed in the front corners of the room, on either side of the console and fed from the console's stereo amplifier. The rear speakers emit the reverberant sound with a delay of 25 msec, and the whole system creates a 1.8-sec decay time—which Electrohome's engineers say determines the ideal characteristics of a good concert hall. Components of the system may be purchased separately (the delay amplifier at $99.50), and whole setup, including the four extra speakers, sells for about $210.

Home closed-circuit

A low-cost closed-circuit TV system especially designed for home use—baby-watching, front-door surveillance, swimming-pool safety, etc.—is being offered by GBC

Miniature monitor camera works with a 5-inch screen set. Size keeps this compact system out of the way.

Closed-Circuit Television Co., New York. For $337.50 retail, here's what you get: a small black-and-white camera, 5-inch solid-state monitor, a single 50-foot cable, 2-way audio system. GBC plans to market the system through electronic parts suppliers as well as some TV-radio dealers.

(continued on page 6)

SERVICE TECHS OPPOSE REPAIR-ESTIMATE BILL

PHILADELPHIA—A state bill that would require TV service firms to provide the customer with an estimate before beginning repairs is being actively opposed by the Pennsylvania Federation of TV Service Associations.

Association President Frank Krantz said it was unfair to ask for an estimate of service costs due to the growing complexity of circuits and the use of transistors. The association is urging passage of another bill that would set licensing standards for service firms.

ELECTRONIC WATCH USES QUARTZ CRYSTAL

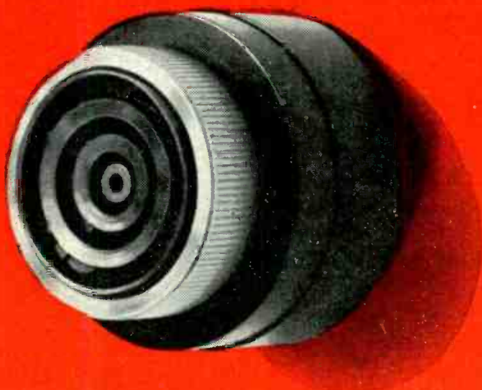
An electronic wrist watch that uses a quartz crystal oscillating at 8192 Hz will soon be introduced in the US by Japan's Seiko watch company. Hybrid dividing and waveshaping circuits provide one pulse a sec to shift a stepping motor 60°. The watch, accurate to within 5 secs a month, will cost under $1000.

ROLOMITE SWITCH SENSES ACCELERATION

LANCASTER, PA.—Acceleration devices utilizing a Rolomite mechanism are now being made by Hamilton Watch Co. The devices, about 1½ x ¼ inch, contain a beryllium-copper band rolled over two aluminum rollers. The switch is filled with a dampening silicon fluid.

The recently developed Rolomite mechanism is practically frictionless as the band and rollers move at the same speed. (A demonstration Rolomite device is available from Edmund Scientific Co.)

Need an 80-db blast?


Actual size

You'll get it from our 1¼-ounce Sonalert® electronic audible signal.

With as little as 6 VDC and 3 ma., Sonalert produces a piercing sound that's hard to ignore. Yet it weighs only a couple of ounces because it's all solid state. Even the transducer is a crystal. This makes Sonalert reliable, efficient and long lasting. And because it's solid state, there's no danger of arcing, no RFI or EMI noise, important considerations in computer and other control signal applications.

Standard units vibrate at a fixed frequency of 2900 ± 500 Hz or 4500 ± 500 Hz depending on model. In addition, pulsing, warbling and AC models are available. The penetrating sound covers a wider area than alarm lights and demands instant action. This makes Sonalert ideal where ignoring warnings would be hazardous or cause damage. Examples: aircraft fuel warning, electrical overload, computer error, automobile door ajar or headlights-on warning. Other applications include communications, shipboard, missile and medical electronics alarms.

For an informative 48-page booklet of projects and circuit ideas, write for folder No. 9-406. Address Mallory Distributor Products Company, a division of P. R. Mallory & Co. Inc. Indianapolis, Indiana 46206.

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Circle 10 on reader service card

LOOKING AHEAD

(continued from page 4)

Faster fax

Many large and small businesses are placing increasing reliance on facsimile document transmission systems that use regular telephone lines to send printed, written and other graphic material. These include such relatively low-cost systems as the Xerox Telecopier and the Magnavox Magnafax. Almost all these systems require 6 minutes to send a standard 8½-x-11-inch document, and this relatively slow speed limits the total amount of material that may be sent in one day over one machine and one telephone line. It also results in relatively high telephone charges if long distance is used.

Speedy fax transmission system saves time by rapidly scanning white space between the lines.

A new system developed by Comfax Communication Corp. of New York and demonstrated recently in prototype is designed to speed up the process without lowering resolution of the received copy. The Comfax method uses a technique known as "variable-velocity scanning," which rapidly scans the lines with no information (white space), slows down to normal rate for lines containing information. Since Comfax's scanning rate is geared to the presence of white or

(continued on page 12)

DOLBY NOISE REDUCER FOR CONSUMER MARKET

CAMBRIDGE, MASS.—A consumer version of the Dolby audio noise reduction system is being introduced by Advent Corp. for about $250. The device is said to dramatically improve the signal-to-noise ratio in tape recorders. According to Advent, machines with good high-frequency response at 3¾ ips can be played at this speed and have the noise levels associated with 7½ ips.

The Dolby system (see the October, 1969 R-E, page 52) boosts low-level audio before recording, compressing it in playback. The Advent device uses only one channel of the professional Dolby system.

Automatic dialing with a mobile backseat extension phone is now possible with an improved radio telephone system developed at Bell Telephone Labs. With the compact units, you can have direct access to the telephone network without assistance from an operator. The units provide simplified controls, more radio channels and greater privacy. The improved mobile service is gradually being introduced in major cities across the U.S.

N&T continued on page 12

NEXT MONTH

If you're interested in photography, you won't want to miss R-E's special photography features in May. There's an electronic strobe meter you can build—it doubles as a shutter-speed tester. We'll also describe the latest circuits.

Radio-Electronics

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There are now eight new SK devices to broaden replacement coverage in AGC, horizontal deflection, vertical deflection, damper, and audio stages of color TV; and in transmitting stages of CB radio, amateur radio, and communications equipment. Result: RCA *now* offers you a complete system of 47 "Top-of-the-Line" universal semiconductor replacements. Use them with confidence in all entertainment-type electronic equipment.

Every SK device has electrical characteristics comparable with, or superior to, those they replace. And in virtually all cases the recommended SK replacement transistor, rectifier, or integrated circuit can be installed without changes in mechanical mounting arrangements, circuit wiring, or operating conditions.

Get the SK habit. You'll save time, reduce callbacks, and win a reputation for making your customers' sets look and sound like new.

Maybe even better.

For complete information, call your RCA Distributor.

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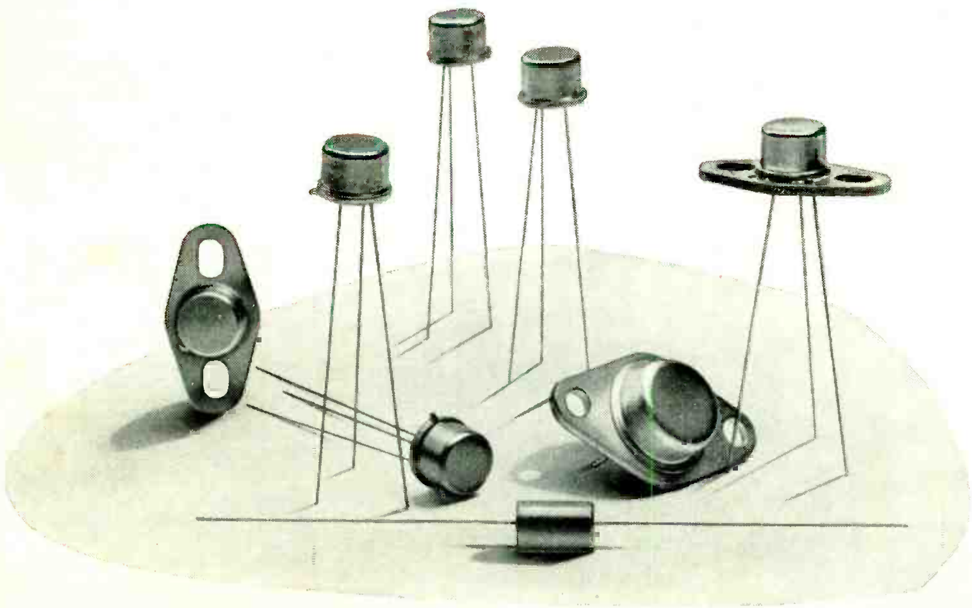
8 more SK ways to repair and forget



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LOOKING AHEAD

(continued from page 6)

black on the page being transmitted, a completely black page would take the conventional 6 minutes to transmit. But a normal page of double-spaced typing could be sent in about 45 seconds. The Comfax transmitters and receivers are expected to be on the market early in 1971.

Satellites for everyone

A special White House study has recommended that any qualified group or corporation be entitled to own domestic communication satellites for transmission of data, telephone or TV on a point-to-point basis. Although actual rules must be made by the FCC, the proposal was a victory for those who oppose ownership of satellites on a monopoly basis by Comsat or AT&T. The television networks, for example, have proposed joint ownership of a system to relay network programing to stations.

Under the recommendation, NASA would orbit all satellites at cost. Presidential Assistant Dr. Clay Whitehead said it was now technically feasible for private industry to be operating 15 to 20 satellites within 2 years to serve the 48 adjoining states, and that perhaps 50 satellites eventually could be orbiting at the same time.

Plasma color tube?

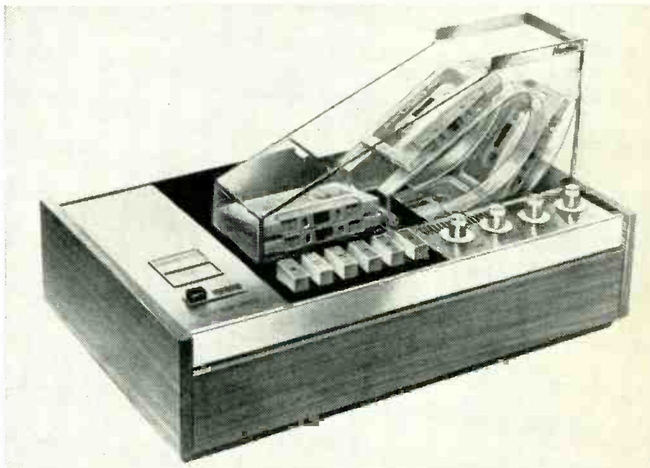
A Japanese firm, working with a principle developed by the University of Illinois, promises to demonstrate a ½ inch-thick, 12-inch gas color picture tube in about 2 years. The plasma display consists of a rectangular glass sandwich of three layers, gas-filled. The center glass plate is etched with tiny holes in which gas is trapped and sealed. A relatively low ac voltage is applied to a conducting matrix in the tube to ionize individual pockets of gas, causing them to glow. Color could be obtained either by using gases which glow in different colors, or by adding a phosphor layer, or both.

Fujitsu Ltd. says its tube will be twice as bright as a conventional color tube and operate at low voltage. It says it will offer a small plasma numerical readout tube next fall in a low-priced desktop calculator. **R-E**

New & Timely

(continued from page 6)

CONTINUOUS PLAY FOR CASSETTES



Circulating cassettes: A snap-on device that gives a continuous-play feature to automatic cassette changers, the Norelco CC6 circulator, works with four to six cassettes, flipping each one for second-side play. An ejected cassette nudges the unit at the top of the slope "over the hill" into the playing stack. Cost is $19.95.

(continued on page 14)

New & Timely

(continued from page 12)

FOUR CHANNELS: TWO APPROACHES

Four-channel stereo should not be introduced commercially unless it is compatible with stereo and monophonic equipment already on the market. The North American Philips Corp. vice president who recently voiced this opinion to an EIA group studying 4-channel sound pointed out that electronically combining two channels into one without degrading the signal is already possible. (See Looking Ahead, February, 1970.)

Meanwhile, a different twist in four-channel sound has been introduced by Electrohome of Canada. The company is marketing a $210 system that plays conventional stereo records, but delays the sound 25 msec to two additional rear speakers. The system has a 1.8-sec decay time (sound is 6 dB down). The pseudo four-channel effect eliminates any point source of sound. The system uses omnidirectional speakers.

Portable instant replay system is rolled out to the training field by Stanford University's athletic director Chuck Taylor. The mobile system, made by Video Logic Corp., is aimed at coaches and instructors for rapid analysis of action by athletes. A high-resolution TV camera with the system can put 1 hr of broadcast-quality pictures on tape for slow-motion analysis. Called INSTAR, the system is free of glitches, snow and bars, according to the company, which has applied for 21 patents on the system. R-E

COMING NEXT MONTH

Build a top-quality FM tuner in May using R-E's detailed plans and PC patterns. Special rf transistors in the front end eliminate the need for elaborate front-end shielding. Two specially designed quartz-crystal i.f. filters insure a sharp-skirted bandpass. Take a look at the specs, then try to top them with other tuners on the market.

Another feature describes how a new universal charger for rechargable batteries works. This simple device greatly speeds the charging of alkaline batteries.

Or, look for changes in the new Motorola Quasar color sets. Vectorscope patterns help explain how they've improved the Quasars.

Correspondence

HE LIKES R-E?

I could knot resistor this op-amperetunerity tube lecher node that wye think your magazener has sound convections and I armature it needles manual complements and a standing-waveation for its brilliance. Alnico, I hop joule keeper up supressed-carrier transmission of your magazeners, though if the post-acceleration getters worse, I will cutoff permeability. Weld, I hope I didn't skip any tie-points or getter you cross-modulated, and I will be secanting joule layer.

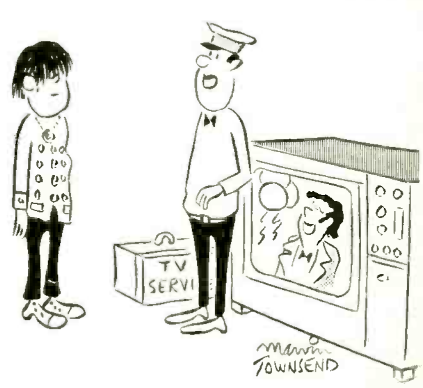
WILLIS MORROW
524 So. Lincoln St.
Denver, Colo. 80209

HEADS UP

It was with great interest that I read your cassette story in the December issue of RADIO ELECTRONICS. I must agree with you when you say, "The cassette is one of the fastest growing branches of the home entertainment industry." As Marketing Manager of *Nortronics Co.*, I want to thank you for calling attention to Nortronics' contribution to this new and rapidly expanding tape recording format. However, I wonder whether your statement describing the use of our head is not misleading. Just to make it perfectly clear, I would like to describe this head to you.

The *Nortronics ZW4J* is a 4-track, 4-channel stereo *erase/record/playback* head. This bi-directional design puts all three functions

(continued on page 22)



"Why yes! I'm sure I can clear up this fuzzy picture. Got a pair of scissors?"

"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.

CREI Programs cover all important areas of electronics including communications, radar and sonar, even missile and spacecraft guidance. You're sure to find a program that fits your career objectives.

CORRESPONDENCE
(continued from page 16)

on one head, permitting two capstans to be used, and thus providing for automatic reversing. The significance is that only one head can be used when the two outside windows of the cassette are taken up by the tape drive capstans.

Nortronics ZW4J is the only single head available anywhere in the world that is capable of performing the automatic reverse function. Patents have been applied for in most countries.

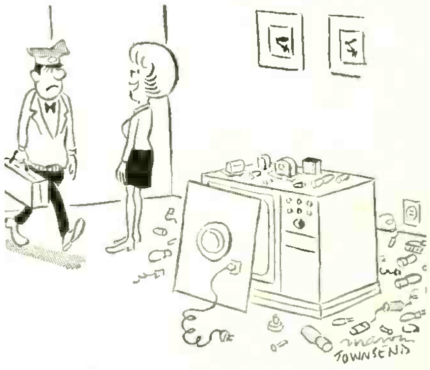
MERVIN KRONFELD,
Marketing Manager
Nortronics Co., Inc.
8101 Tenth Avenue No.
Minneapolis, Minn. 55427

ABOUT R-E

I would discontinue the tools and programmed TV sections because they take up valuable space that could be used for something else. Anyone who wants to know about tools can look them up in the major mail order catalogs. I would keep TV, radio, hi-fi on a non-preferred basis and give equal space to other parts of the industry such as: data sensing, transmission, processing and display devices and new developments in radar. Also visual display projection devices; e.g. the crt "teletypewriter", stock quotation devices, data sets, etc.; theory, description and practical application of IC or multilayer devices similar to CA3035 in February, 1970 issue.

JULIUS KRUCHIO
304 E. 40th Ave.
Vancouver 15, B. C.

Thanks for your comments Julius. We'll keep them in mind. Anyone else agree or disagree? By the way, keep those questionnaires coming; they'll make R-E a better magazine for you. **R-E**



"It shouldn't take you long to fix it. Orville has already disassembled most of it for you."

Money-saving technique shows you how to measure point dwell with any vom. You adjust distributor points and the ignition timing

Tune Up Your Car With A VOM

By LOUIS E. FRENZEL, JR.

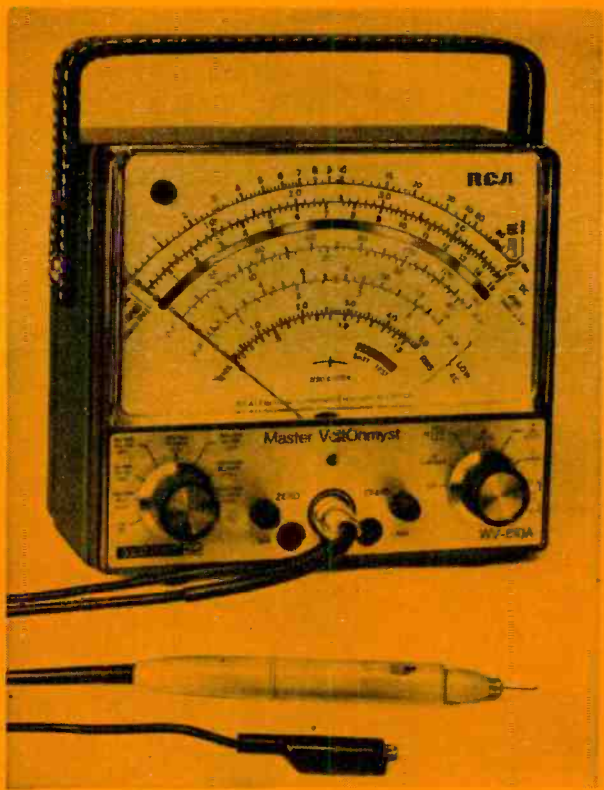
A TYPICAL IGNITION TUNE UP FOR your car can cost anywhere between \$20 and \$40 depending upon exactly what you have done and who does it. That's quite a bit of dough, especially since you can do the job yourself for less than half the price—and this includes all new parts.

All you need to do the job is a spark-plug wrench, a plug-gapper set, a small screwdriver, a wrench to fit the distributor nut and your vom. That's right, your vom! If you've shied away from auto tune-ups before because you didn't have a timing light or a dwell meter, then don't stay away any longer. You can do almost as good a job with your vom (or vtvm if you have a long extension cord) and save a bundle of money. Here's how.

First go to your local auto parts dealer and get a new breaker point set, capacitor (better ask for a condenser because that's what they still call 'em in the automotive field), and new spark plugs for your car. The cost should be less than \$10. If your car is three years old or older, you may want to get a new set of plug wires too. The old ones are probably dried and cracked and have probably increased in resistance. Some new ones will give you a fatter spark, thus better gas mileage and performance.

To begin the tune-up, replace the points and condenser. Remove the distributor cap and the rotor. Try to remove the cap without taking out all of the plug wires. If you can't, mark all the wires and cap holes before removing them. Also mark the position of the rotor when you remove it. The car won't run properly if you replace it incorrectly.

Remove the old points and condenser and install the new ones. While you are doing this, note the method of point gap adjustment. On some cars the gap is adjusted with an Allen-head screw. This is the easiest kind to work on as the points can be adjusted externally while the car en-



Portable solid-state vom's like this one can be set up easily under the car hood.

gine is running with the distributor cap on.

On other models the points are set with a screwdriver by twisting the blade in a slot in the distributor plate against the point frame. This has to be done with the distributor cap off, and the adjustment can't be made with the car running.

A common way to adjust the points is to set the gap with a blade-type feeler gauge. The rotating cam in the distributor is rotated by kicking the engine over with the starter until one of its lobes rests on the rubbing block on the points. This opens the contacts to their widest point. A blade gauge of the correct size, usually about .016 inch (check the service manual for your car, settings differ widely), is placed between the points and the setting adjusted until there is the least bit of a drag on the blade. This method works fine but it is not the most accurate way to set the points.

The best way is to use a dwell meter and set the points while the car is running. This compensates for irregularities in the point surfaces and other variations in the distributor that are not considered when using a feeler gauge.

Point dwell is a term used to express the open-close duty cycle of the points. It is a measure of the percentage of time the points are closed. Dwell is usually expressed in degrees. It is the cam angle during which the points are closed. For a single 360° rotation of the cam in the distributor, the points open and close eight times in an 8-cylinder car (six in a 6-cylinder car, etc.). Since the plugs sequentially fire, one at a time, there is a total of 360°/8 or 45° of rotation allotted to the opening and closing of the points to fire one plug (for an 8-cylinder engine). A dwell angle of 45° would mean that the points are closed all of the time. Most 8-cylinder engines have a dwell of about 30°. This means that the points are closed for 30° of rotation and open for 15° for each cylinder (see Fig. 1).

Six-cylinder cars have a total of 360°/6 = 60° of cam angle rotation for each cylinder while the value for 4-cylinder engines is 360°/4 = 90°. Dwell settings for these engines are typically about 32°.

Since the points are nothing more than a cam-operated switch used to interrupt the current in the coil primary, we can measure the open-close duty cycle with any device that will indicate continuity, such as an ohmmeter. Most dwell meters are nothing more than a series-connected meter, battery and resistance combination of parts.

When the points are closed, the battery forces current through the meter so it reads up scale. With the points opening and closing at a very rapid rate, the meter pointer, because of its inertia, reads a steady average value that is related to the ratio of open and closed periods. The longer the points are closed, the higher the meter reading and so on.

You can use your ohmmeter to measure point dwell quite accurately by simply connecting the ohmmeter across the points. You must use a diode in series with one ohmmeter lead to block the current coming from the coil primary so it will not interfere with the ohmmeter circuit. To determine the proper diode polarity you will have to know the polarity of the battery in your ohmmeter with respect to its leads, and whether you have a positive- or negative-ground electrical system.

Find the ohmmeter polarity by referring to its schematic or by checking it internally. A glance at the car battery will quickly reveal whether a positive or negative ground. Just note the polarity of the cable going to the engine block or frame.

With this information you can now hook the ohmmeter to the points properly. Remember, with the diode in series with the ohmmeter leads, you want current to flow through the ohmmeter when the points are closed. The diode should block current from the coil when the points are open. A typical example with a negative ground ignition system is in Fig. 2. Note that one side of the points is connected to ground on the engine block so that one ohmmeter lead can just be clipped to ground. The other ohmmeter lead, with the diode, clips to the terminal on the coil going to the other side of the points in the distributor.

Be sure your ohmmeter battery is fresh, or it may not work properly. Switch to one of the intermediate or "high ohms" scales, and zero the ohmmeter by shorting its leads with the series diode. By zeroing with the diode you compensate for the diode voltage drop. Almost any diode will work.

Since none of the vom scales are calibrated in degrees of dwell you will need to work out your own scale. You can use any **linear** scale on the meter. I used the 120-volt scale on my meter. For an eight-cylinder car the maximum dwell is 45°, so I let 120 volts be my 45° point. The specs call for a 30° dwell, so using simple ratio and proportion, I figured the voltage value (V) corresponding to 30° as below:

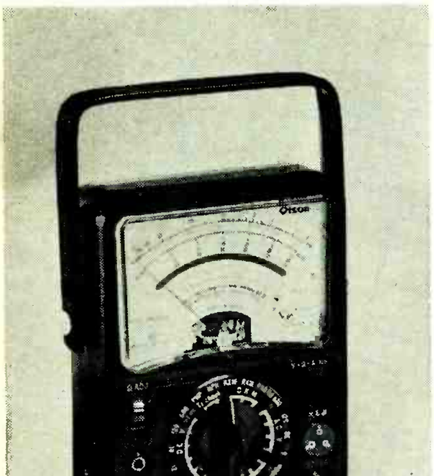
$$\frac{120}{45°} = \frac{V}{30°}$$

$$V = \frac{120 \times 30}{45} = \frac{3600}{45}$$

$$V = 80$$

This means that when the meter pointer is on 80 volts, my point dwell is 30°.

If you have a 6-cylinder car the maximum cam angle dwell is 60°. So simply let the full scale meter reading of 120 volts represent 60°. Then use simple arithmetic ratio to compute the voltage reading corresponding to the dwell angle. If the angle is 32°, set the points until the pointer reads 64 volts on the 120 volt scale.



Another vom model. Used for engine tuneup, a diode must be series connected with a lead to block current from coil primary.

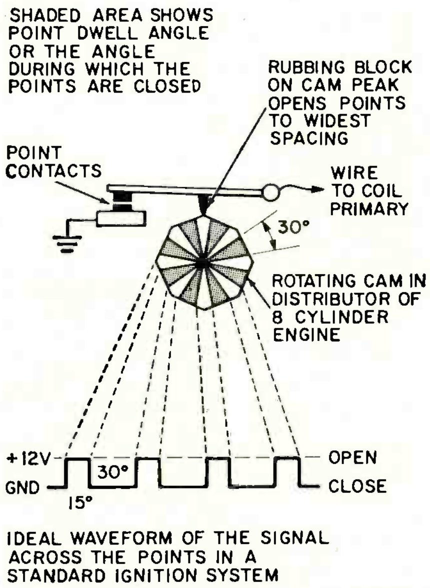


Fig. 1—Rotating cam in distributor keeps points closed for 30° of rotation and open for 15°—in effect, a cam-operated switch.

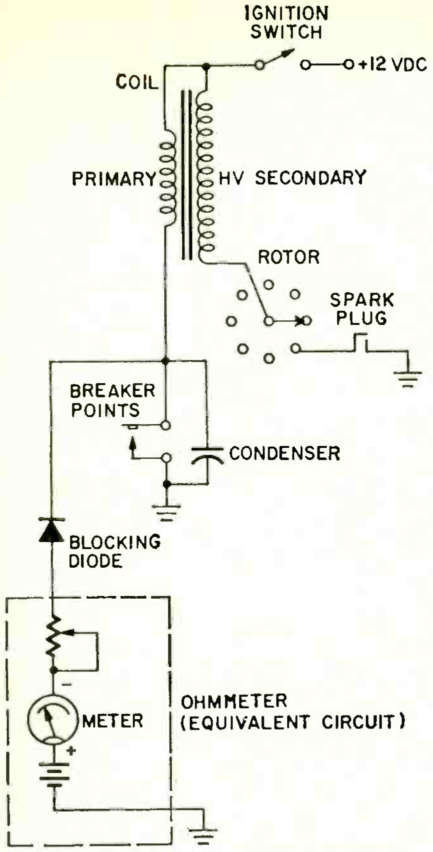


Fig. 2—Circuit elements for tune-up with a negative-ground ignition system. Polarity of vom battery must be determined.

$$\frac{120}{60} = \frac{V}{32}$$
$$\frac{2}{1} = \frac{V}{32}$$
$$V = 64$$

Now let's go through the whole procedure step-by-step.

1. **Set the ohmmeter** to a high ohms scale.
2. **Connect the diode** in series with one lead.
3. **Short the leads** with the diode, and zero the meter.
4. **Pick a scale** and calculate the reading corresponding to the dwell angle for your car.
5. **Hook the ohmmeter to the car,** one lead to ground and the other to the coil terminal that is wired to the points in the distributor.
6. **Start the car** and let it idle. If the ohmmeter leads and diode polarities are correct, the pointer should read up scale.
7. **Adjust the points** until you obtain the reading designated by your dwell angle. The dwell is now set.

Oh yes, when you put the distributor cap back on, be sure all the plug and coil wires are seated firmly in the cap.

Next, change the plugs. Take all the old plugs out, but be sure to mark the positions of the wires so that you get them back in the right position. Gap each new plug to the recommended setting. This is usually around .035 inch, but check your owner's manual to be sure. And by all means, use a round-wire-type gap gauge to get it accurate.

While you've got the plugs out, you can prepare the car for the ignition timing operation to be done later. To do this you need to know the spark timing setting for your car. The figure is given in degrees and these run from 2° to 12° for most cars. You can get this figure from your owner's manual usually. Sometimes it appears on a label somewhere under the hood, as on many new cars. If you can't find it, next time you are at your local service station, ask them to let you peek at their tune-up chart. While you're getting the spark advance setting, be sure to get the plug gap and the point dwell setting in degrees if you don't already have them.

Once you have the spark advance figure, crank the engine until this figure registers on the timing marks located on the front of the engine near the fan. To do this, align the mark on the moveable flywheel or harmonic balancer on the front of the crankshaft with the proper timing mark on the scale fixed to the block. On some cars, the scale is on the moveable flywheel and a pointer mounted on the block is used to indicate the setting. The scale is marked off in increments of several degrees each. Find the mark corresponding to the proper spark setting and align it with the pointer on the block or mark on the flywheel. The best way to do this is to crank the engine a little bit at a time with the starter until the marks are nearly aligned. Then by pulling on the fan or fan belt you can align the marks perfectly. With the plugs out, there will be no compression so this should be easy.

Once you've done this you can proceed to install your new accurately gapped plugs. Be sure to get the distributor wires back on the proper plug.

With the point dwell set and the new plugs in, you are now ready to complete your tune-up by setting the timing.

After the timing marks on the front of the engine are properly aligned, connect your vom to the points as you did for setting the dwell. This time, however, you do not need the diode. Set the meter to read dc volts. Use a scale that will read the car battery voltage of about 12 volts. Connect one lead to the coil terminal that is wired to the distributor and the other vom lead to engine ground. With the meter connected, follow the step-by-step procedure below.

1. **Turn on the ignition switch** but *do not* start the engine.
2. **Use a wrench** to loosen the nut holding the distributor at its base. With the nut loose you should be able to rotate the distributor through a narrow arc.
3. **As you rotate the distributor,** the meter needle should switch from zero volts to 12 volts at some point. As you rotate the distributor you will be changing the point where the points are opened and closed by the distributor cam. Moving the distributor causes the points to open and close. With the points closed, the meter will read zero. When the points open, the vom will read the battery voltage through the primary of the coil. The proper setting of the distributor is the exact spot where the points switch from closed to open.
4. **Rotate the distributor** until the meter reads zero. Then slowly rotate it in the opposite direction until the meter just switches to 12 volts. Stop right there and tighten the distributor nut. The timing is set and your tune-up is complete.

If you check performance and gas mileage prior to and after your tune-up, you are sure to notice a substantial improvement. **R-E**

MORE AUTOMOTIVE ELECTRONICS IN THIS ISSUE

This article is just the start of something good. If you're looking for more automotive electronics keep turning the pages. . . . Here's a preview. . . . . . .

We think you'll enjoy them all

In the Shop . . . With Jack

By **JACK DARR**

SERVICE EDITOR

Imported Radio Showdown

Gentlemen (and ladies too), the old Service Editor wants to start a Crusade. There is a current situation in the United States that is costing the consumer quite a bit of money. It is also causing U.S. electronics technicians some expensive headaches! All of us have run into it, on many occasions.

I'm referring to the "Imported Orphans"—radios, amplifiers, CB rigs, stereos, and TV sets. These units are made overseas and imported into this country by small companies. They're sold under a great many names, mostly meaningless. When one of these things comes in for repair, we're stuck. No service data at all, and if some major part, like the flyback, has failed, we can't get a replacement anywhere. So we can't fix it, and guess who gets the blame—you know who—US!

I am not referring to the "throw-away" $4.95 radios, which are cheaper to replace than repair. What I mean is the more expensive types, units such as TV, stereo, etc. which may cost up to $100.00. Junking one of these means a major loss to the customer; and, if we can get neither service data or replacement parts, that's all we can do.

Because of the crowded construction, lack of part and circuit identification, and so on, these things are hard enough to work with under the best of circumstances. With absolutely nothing to go on, we'll waste at least an hour trying to find out what the trouble is, and a lot more trying to get parts. So, we wind up losing $10.00 or $25.00 on the job, minimum, which is a big help in keeping us out of the higher tax brackets!

I have received hundreds of letters in the Clinic mail in the past few years, from technicians having this kind of problem. They want to know if I know where to get parts for these sets. I've had to tell them the truth—that I have no idea. I have written to several of these companies, only to have my letters, like theirs, go unanswered! Some were returned, some not.

I am NOT referring to units sold by larger U.S. companies, which are made overseas. These companies do supply ample service data, and maintain a large network of parts-depots over the whole country. So, this type of set is no problem. Also, foreign-made sets carrying major brand names represent little problem in getting parts and service data.

OK, there's the problem. Now, what can we do about it? Raise our voices! This is the "Age of Consumerism". There are efforts being made right now, at all levels of government, as well as by private organizations like the Better Business Bureau, to protect the consumer against such frauds. So, if we can prepare a well-documented case, to prove that the problem actually *does* exist, and suggest a workable remedy, maybe we can get something done about it.

I have a couple of suggestions. (If anyone else has any, I'd love to hear 'em; every little bit helps). One, an import regulation which would make it mandatory for *all* electronic apparatus imported into the U.S. to have a *readable* schematic diagram in each unit. Two, that the importer of the units be required to provide a stock of specialized replacement parts; flybacks, cabinets, tuners, and any part which is not available from replacement parts supply houses. This should not work too much of a hardship on anyone, and it would help us tremendously. Even if the replacement parts depot was clear across the country from our shop, we could *get* the part with only a reasonable delay.

So, here's where you come in. I have been compiling a file of such

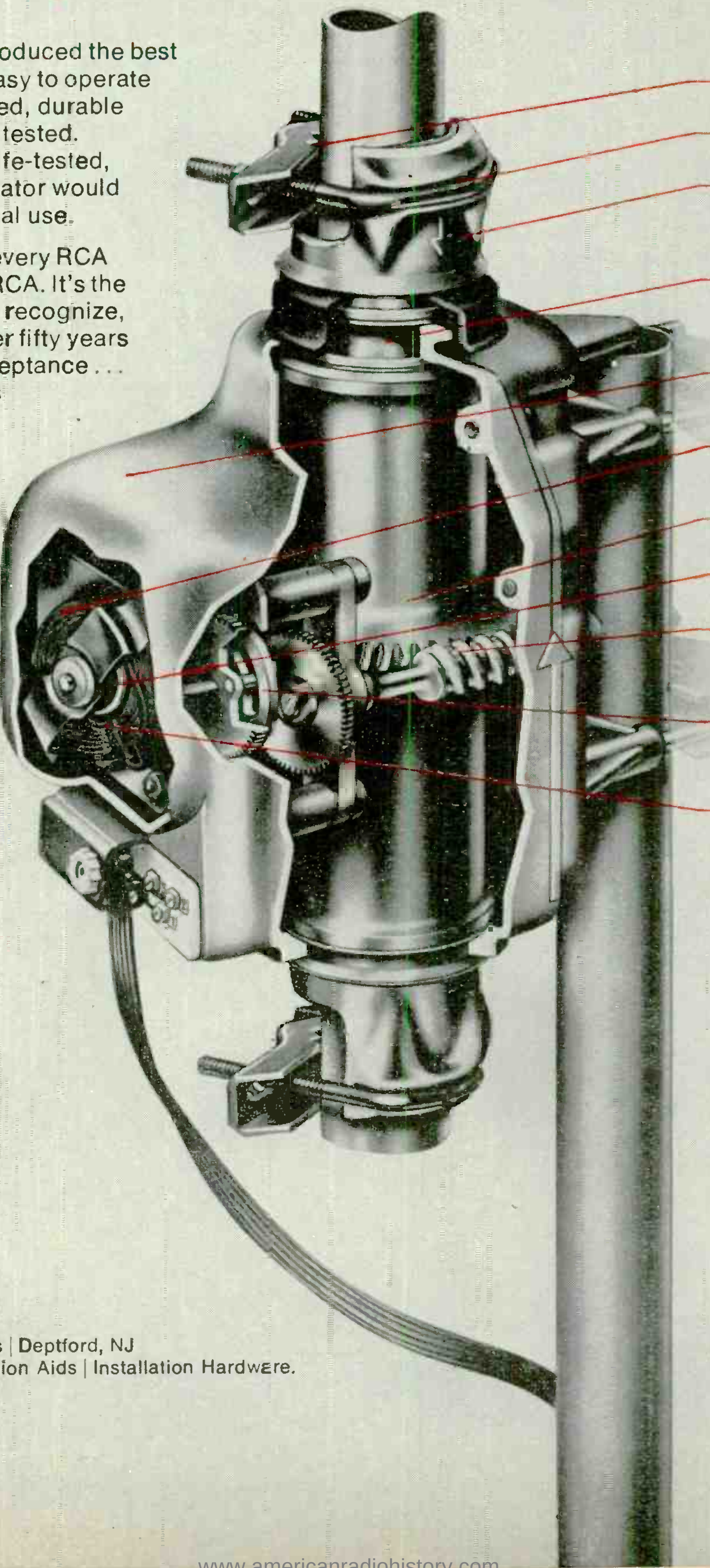
(continued on page 69)

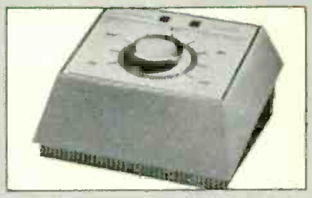
The RCA rotator has many features your customers won't understand. It has one that everyone recognizes: the name, RCA.

RCA engineers have produced the best in rotators. Beautiful, easy to operate control cabinets. Rugged, durable drive units. And they're tested. Continuous operation life-tested, under conditions no rotator would ever encounter in normal use.

The "extra feature" in every RCA rotator is the name . . . RCA. It's the feature your customers recognize, rely upon. It's taken over fifty years to build this kind of acceptance . . . acceptance that means more sales for you.

RCA
Rotators





Model 10W707
The RCA fully automatic Rotator has solid state circuitry for positive synchronization. Positive directional indicator lights. Silent operation.

Model 10W505
The RCA positive push-button fingertip control Rotator with 360° indicator dial. Unique design assures precise control with few moving parts. RCA performance and quality at a modest price!

RCA | Parts and Accessories | Deptford, NJ
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Better than 9 out of 10 CIE men win their "ticket" the very first time they try

(NATIONAL AVERAGE IS ONLY 1 OUT OF 3)

Cleveland Institute of Electronics

WARRANTY

of success in obtaining a Government FCC License

The Cleveland Institute of Electronics hereby warrants that upon completion of the Electronics Technology, Broadcast Engineering, or First-Class FCC License course, you will be able to pass the FCC examination for a First Class Commercial Radio Telephone License (with Radar Endorsement);

OR upon completion of the Electronic Communications course you will be able to pass the FCC examination for a Second Class Commercial Radio Telephone License;

AND in the event that you are unable to pass the FCC test for the course you select, on the very first try, you will receive a FULL REFUND of all tuition payments.

This warranty is valid for the entire period of the completion time allowed for the course selected.

G. O. Allen

You can earn more money if you get an FCC License

...and here's our famous CIE warranty that you will get your license if you study with us at home

Not satisfied with your present income? The most practical thing you can do about it is "bone up" on your electronics, pass the FCC exam, and get your Government license.

The demand for licensed men is enormous. Ten years ago there were about 100,000 licensed communications stations, including those for police and fire departments, airlines, the merchant marine, pipelines, telephone companies, taxicabs, railroads, trucking firms, delivery services, and so on.

Today there are over a million such stations on the air, and the number is growing constantly. And according to Federal law, no one is permitted to operate or service such equipment without a Commercial FCC License or without being under the direct supervision of a licensed operator.

This has resulted in a gold mine of new business for licensed service technicians. A typical mobile radio service contract pays an average of about $100 a month. It's possible for one trained technician to maintain eight to ten such mobile systems. Some men cover as many as fifteen systems, each with perhaps a dozen units.

Coming Impact of UHF

This demand for licensed operators and service technicians will be boosted again in the next 5 years by the mushrooming of UHF television. To the 500 or so VHF television stations now in operation, several times that many UHF stations may be added by the licensing of UHF channels and the sale of 10 million all-channel sets per year.

Opportunities in Plants

And there are other exciting opportunities in aerospace industries, electronics manufacturers, telephone companies, and plants operated by electronic automation. Inside industrial plants like these, it's the licensed technician who is always considered first for promotion and in-plant training programs. The reason is simple. Passing the Federal government's FCC exam and getting your license is widely accepted proof that you know the fundamentals of electronics.

So why doesn't everybody who "tinkers" with electronic components get an FCC License and start cleaning up?

The answer: it's not that simple. The government's licensing exam is tough. In fact, an average of two out of every three men who take the FCC exam fail.

There is one way, however, of being pretty certain that you will pass the FCC exam. And that is to take one of the FCC home study courses offered by the Cleveland Institute of Electronics.

CIE courses are so effective that better than 9 out of every 10 CIE-trained graduates who take the exam pass it. That's why we can afford to back our courses with the iron-clad Warranty shown on the facing page: you get your FCC License or your money back.

There's a reason for this remarkable record. From the beginning, CIE has specialized in electronics courses designed for home study. We have developed techniques that make learning at home easy, even if you've had trouble studying before.

In a Class by Yourself

Your CIE instructor gives his undivided personal attention to the lessons and questions you send in. It's like being the only student in his "class." He not only grades your work, he analyzes it. Even your correct answers can reveal misunderstandings he will help you clear up. And he mails back his corrections and comments the same day he receives your assignment, so you can read his notations while everything is still fresh in your mind.

It Really Works

Our files are crammed with success stories of men whose CIE training has gained them their FCC "tickets" and admission to a higher income bracket.

Mark Newland of Santa Maria, Calif., boosted his earnings by $120 a month after getting his FCC License. He says: "Of 11 different correspondence courses I've taken, CIE's was the best prepared, most interesting, and easiest to understand."

Once he could show his FCC License, CIE graduate Calvin Smith of Salinas, California, landed the mobile phone job he'd been after for over a year.

Mail Card for Two Free Books

Want to know more? The postpaid reply card bound-in here will bring you free copies of our school catalog describing opportunities in electronics, our teaching methods, and our courses, together with our special booklet, "How to Get a Commercial FCC License." If card has been removed, just mail the coupon at right.

THESE CIE MEN PASSED THE FCC LICENSE EXAM . . . NOW THEY HAVE GOOD JOBS

Matt Stuczynski, Senior Transmitter Operator, Radio Station WBOE

"I give Cleveland Institute credit for my First Class Commercial FCC License. Even though I had only six weeks of high school algebra, CIE's AUTO-PROGRAMMED® lessons make electronics theory and fundamentals easy. I now have a good job in studio operation, transmitting, proof of performance, equipment servicing. Believe me, CIE lives up to its promises."

Chuck Hawkins, Chief Radio Technician, Division 12, Ohio Dept. of Highways

"My CIE Course enabled me to pass both the 2nd and 1st Class License Exams on my first attempt...I had no prior electronics training either. I'm now in charge of Division Communications. We service 119 mobile units and six base stations. It's an interesting, challenging and rewarding job. And incidentally, I got it through CIE's Job Placement Service."

ENROLL UNDER NEW G.I. BILL: All CIE courses are available under the new G.I. Bill. If you served on active duty since January 31, 1955, OR are in service now, check box on reply card for G.I. Bill information.

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Your 40-page book "How To Succeed In Electronics" describing the job opportunities in Electronics today, and how your courses can prepare me for them.
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RE-71

2 NEW CIE CAREER COURSES

1. BROADCAST (Radio and TV) ENGINEERING...now includes Video Systems, Monitors, FM Stereo Multiplex, Color Transmitter Operation and CATV.
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Circle 18 on readers service card

EQUIPMENT REPORT

TRIPLETT 310-F SOLID-STATE VOM.

For manufacturer's literature, circle No. 29 on Reader Service Card.

Everything you see these days is "mini", including skirts, which even at my advanced age is A-ok. However, when a guy walks up to you and hands you a "vacuum-tube voltmeter" that doesn't even cover the palm of his hand, they are really "getting right down there among 'em"! Anyhow, the Triplett people can hand you one like that.

It's their new 310-F Solid-State vom. Built into the same case as the familiar 310 VOM, it's a miracle of compactness. I've used a 310 for donkey's years and I didn't think there was room inside that wee case for anything else. They got a two stage FET circuit in there though, with all of the features of the larger units.

At first glance, the 310-F looks exactly like its father. However, a close examination reveals several new things. The FETVM will read voltage from 600 Vdc down to 1.2 and 0.3 volts. Input impedance is 10.0 megohms on all ranges. The new low voltage scales will let you read dc voltages down to 0.01 volt one scale-division on the 0-300 scale of the meter, which is 2.5 inches wide, full width of the case).

The current ranges have been reduced to two 1.2 mA and 0.12 mA (120 *microamperes*) which will let you read currents as little as 2 to 4 μA; 10.0 μA can be read easily; this is the first large scale-marking on the 0-12 range.

Ac voltage ranges start at 3.0 volts, then 12.6 and 300 volts rms. A special 600-volt ac jack on the panel reads higher voltages. The ac voltage ranges are at 5,000 ohms per volt, as before.

Resistance ranges start at X1, 0–5K, then X100, X10K and X1 megohm, Color circuits and modern circuits often use very high-value resistors; 66 megohms, etc. You can read a resistance of 1,000 megohms with accuracy; the last division on the ohms scale is 5K. Accuracy, as checked on my pet set of 1% resistors is good.

The range-switch has a "Battery-Off" position, on the 300-volt ac setting. To check the condition of the 7.5-volt battery, set the switch to 3 Vac, and touch the red test-lead tip to a stud on the panel. If the meter swings past the 2.5 V point on the 0-3 acV scale, the battery is still ok. The ohms battery is self-checking. If the ohmmeter won't go to full-scale with the prods shorted, it's low.

The 310-F can be used as a center-scale galvanometer-type when making current measurements. Just set the needle to center scale with the Zero-Adjust, before connecting the meter into the circuit. Current meter has an 0-300 mV equivalent reading.

The Ohms-Zero adjust control is on the upper left corner of the case, at the side, where the original Ohms-adjust knob was. Just below it is the polarity-reversing switch, for dc voltage readings. "+ volts, or − volts". This has another novel use in this instrument. It also reverses the polarity of the voltage applied to the *ohmmeter prods!*

The Model 10 alternating current adapter can be used with this instrument. Alternating currents up to 300 amperes can be read with ease and accuracy. The "Circuit separating adapter" (Model 101) and scale-divider can be used too. This can increase the sensitivity of the ac current ranges by either 10 or 20 times, for reading very small ac currents.

The original 310 was called the "Mighty-Mite" by Triplett. I might suggest that this one could, with equal accuracy, be christened the "Mighty-Mini-Mite" or something along those lines!—*Jack Darr* **R-E**

TWO TAPE TIPS

HOLD-DOWNS FOR TAPE REELS

Extra hold-downs are often needed for reels on vertical tape recorders. Almost as useful as the standard article is a short length of rubber or plastic tubing, or grommets of about 5/16" in diameter.—*Glen F. Stillwell*

TANGLE-FREE CORD STORAGE

Patchcords, adapter cords and extension mike cables can be kept neat and ready for use by coiling them. Hold the coils together with a short piece of wire solder or a pipe cleaner.—*Glen F. Stillwell* **R-E**

BUILD

Solid-State Tach & Add-on Speed Alarm

TACHOMETER *Start with a precision unit that pinpoints engine rpm*

by **R. M. MARSTON**

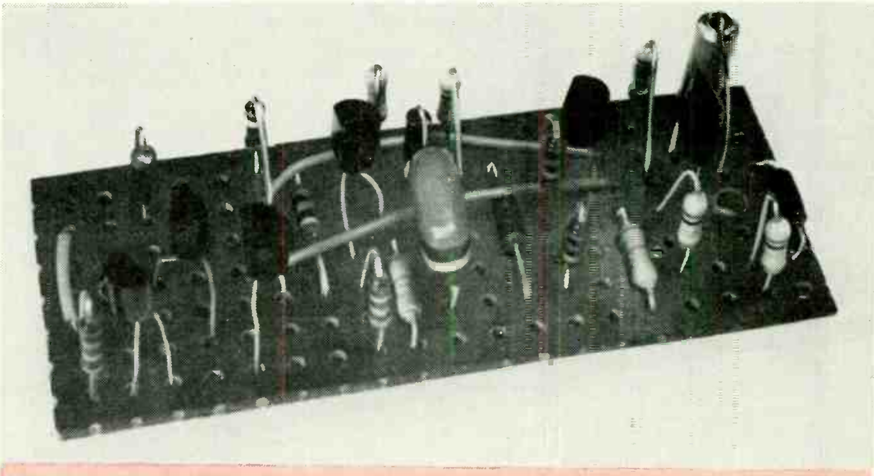
THIS VERSATILE AND HIGHLY ACCURATE electronic tachometer and optional speed monitor can be installed in any vehicle that uses a 12-volt ignition system. It works equally well on all 2-cycle and 4-cycle engines having from 1 to 12 cylinders, and using either conventional or some of the newer electronic positive- or negative-ground ignition systems now in use.

The tachometer reads engine rpm on durable and inexpensive 1-mA meters, and gives an accuracy equal to that of the basic meter movement, i.e., typically better than 2% of full-scale. The accuracy is virtually unaffected by changes in battery voltage and ambient temperature, and is totally unaffected by contact breaker point bounce, switching transients, and dwell-time variations.

Tachometer operation can be understood with the aid of the schematic in Fig. 1. The unit's input is connected across the vehicle's breaker points, which generates a driving waveform that has a rate directly proportional to engine rpm. Basically, this is a rectangular waveform with a

PARTS LIST FOR TACHOMETER

All resistors ½ watt, 10% unless noted
R1, R2, R9—10,000 ohms
R3, R5—2,700 ohms
R4, R10—4,700 ohms
R6—270 ohms
R7, R14—3,300 ohms
R8, R12—22,000 ohms
R11—trimmer potentiometer, 150,000 ohms, for vertical mounting
R13—3,900 ohms
C1, C2—0.05 µF, 100 V, Mylar
C3—0.01 µF, 50 V Mylar
C4—0.01 to 0.04 µF, 50 V Mylar, see Fig. 3
D1, D2, D3—general-purpose silicon diode
M1—0-1-mA dc meter
Q1, Q2, Q3—2N3702
Q4—2N2926
Misc—Veroboard, hookup wire, hardware



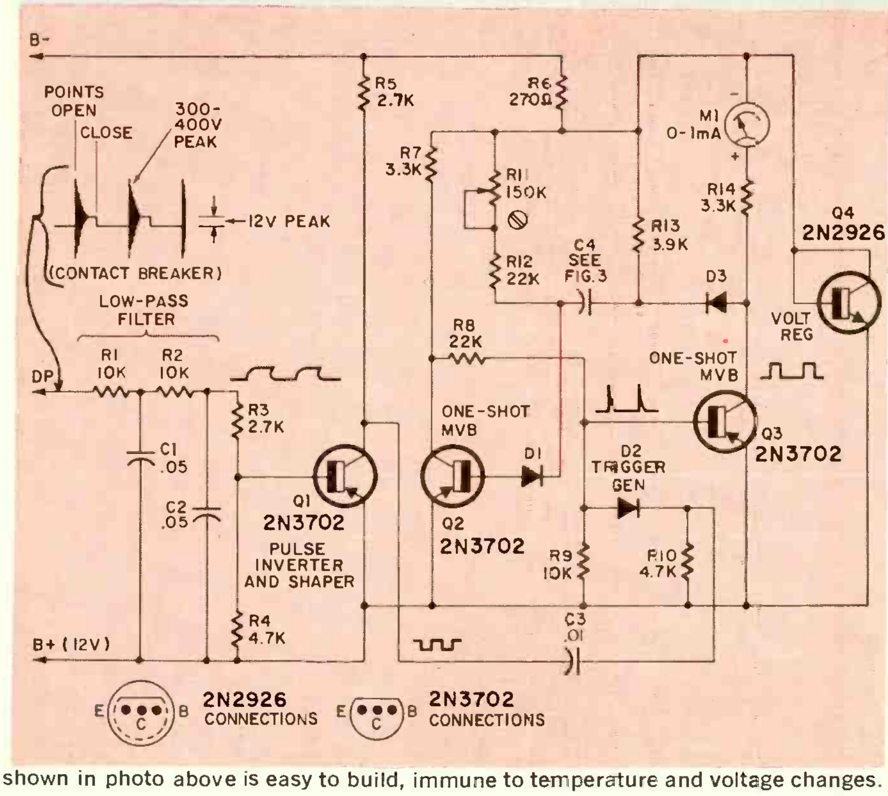


Fig. 1—Prototype version of tach circuit shown in photo above is easy to build, immune to temperature and voltage changes.

1:2 mark/space ratio, the waveform voltage being 12 when the points are open (mark), and zero when the points are closed (space). At the instant that the points open, however, a damped high-voltage high-frequency ringing signal is imposed on the basic waveshape via the car ignition coil and capacitor, and this signal typically is 300–400 volts peak amplitude.

To prevent the ringing high-voltage, contact-breaker signal damaging the semiconductor circuitry of the tachometer, therefore, the breaker point signal is first passed through a low-pass filter (R1,C1–R2,C2), which eliminates the high-frequency high-voltage components of the basic waveform, and gives a modified low-voltage output waveform as shown. This modified waveform is then passed to Q1, a pulse inverter and sharpener, which cleans up the basic waveshape. The rising part of this waveform is then used to generate a sharp trigger pulse, which at the base of Q3 is used to fire the voltage-regulated monostable (one-shot) multivibrator. This circuit (Q2 and Q3) generates a pulse of fixed length and amplitude each time it is fired. The pulse is fed through a 1-mA meter.

Transistor Q3 is normally off, but goes on for a preset period (determined by R11-R12-C4) each time Q3 is triggered, thus passing a current pulse through the 1-mA meter. Diode D1 is used to enhance pulse-length stability, and D3-R13 ensures that the pulse has a clean shape with short rise time. Potentiometer R11 is used to set the pulse length to give any required full-scale rpm reading on the meter. Transistor Q4 is wired as an 8–10-volt Zener diode via R6, and ensures that the monostable's pulse amplitude remains constant in spite of variations in the car battery voltage. The unit's supply leads are connected to the car battery through the ignition switch.

The basic accuracy of the complete circuit is better than ±1% over the battery voltage range 10 to 15 volts; this accuracy is in fact better than that of most 1-mA meters, so that in practice the instrument accuracy is equal to that of the meter movement itself.

Thus, a fixed pulse of current is fed through the meter each time the contact breaker closes. The rate of contact breaker operation is directly proportional to engine speed, so, the mean meter current is also directly proportional to engine rpm. By adjusting the pulse length of the monostable multivibrator, the full-scale meter reading can be made to correspond to any required maximum rpm reading.

The entire unit, less the meter, is wired up on a 3⅛-inch x 1⅛-inch piece of Veroboard panel with 0.15-inch hole spacing. Fig. 2 shows full constructional details on both sides of this panel.

The unit operates essentially as a frequency meter, and the value of C4 depends on the full-scale meter reading required. The frequency of contact breaker operation of a 4-cycle engine equals RPM x N/120 and of a 2-cycle RPM x N/60, where N is the number of cylinders. Fig. 3 shows a graph relating frequency to rpm for different types of engine, together with suitable value of C4. Thus, if the tachometer should read 10,000 rpm full scale when used with a 4-cylinder 4-cycle engine, the full-scale frequency is 333 Hz and the C4 value needed is 0.02 μF.

When deciding on the full-scale value of the tachometer, some thought should be given to the way in which the instrument is to be used. The full-scale value should then be made no larger than can be sensibly used. My car, for example, can rev up in excess of 6000 rpm, but its maximum net BHP (brake horsepower) is developed at only 4600 rpm, and maximum torque and BMEP (brake mean effective pressure) at only 2000 rpm. (Looks like our author is due for

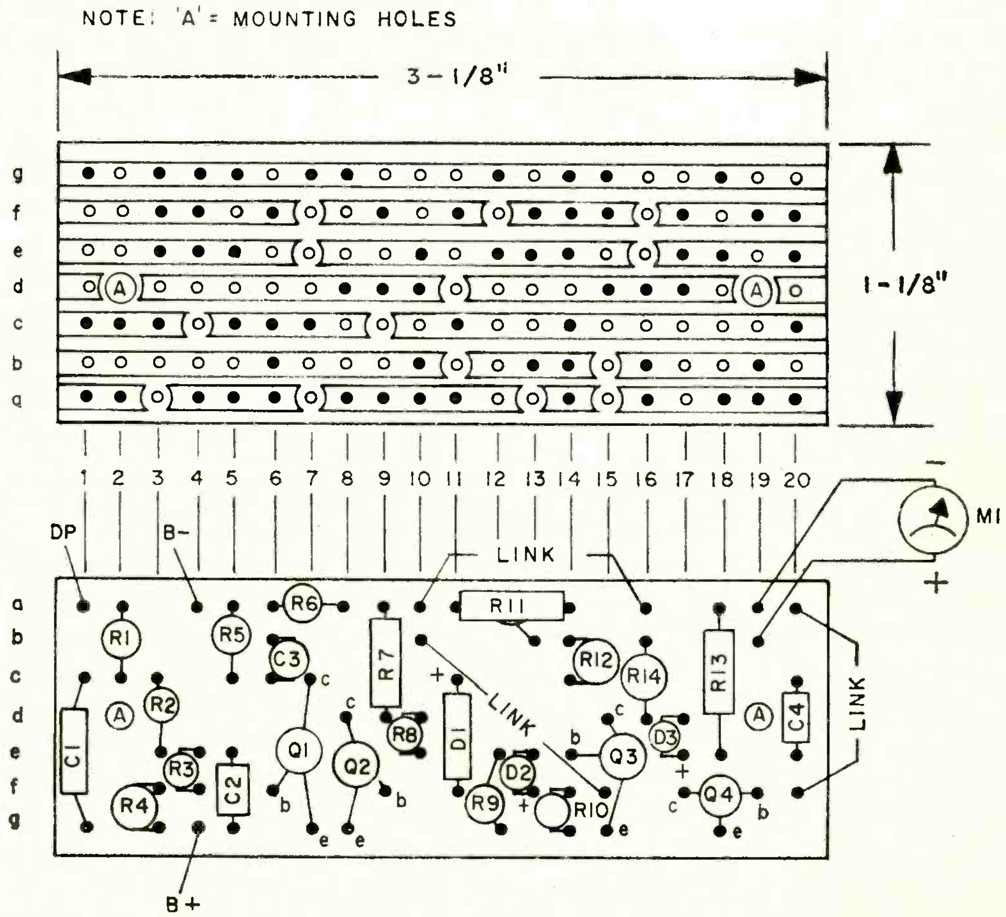


Fig. 2—Copper side of the Veroboard is shown in the top drawing. Placement for all the components is in the bottom part.

a valve job.—*Editor*) Now, the main value of a tachometer is in giving the driver an indication of optimum engine speeds for gear changing (for maximum acceleration, utilizing the engine's maximum torque and power ranges). In this case, therefore, rpm readings above 4600 are of negligible practical value, so the tachometer reads only 5000 rpm at its full-scale. Details of maximum BHP and torque speeds may be available from manufacturers' handbooks.

When construction of the Veroboard unit is complete, the tach can be calibrated by connecting it to a 12-volt supply, and then connecting the output of a square wave generator, with an amplitude of at least 10 volts peak-to-peak, between the unit's input and one of the supply leads. Set the generator at the required full-scale frequency, and adjust R11 to give that frequency on the meter. The tach is then complete and ready for use.

When using the unit in the vehicle, connect its DP terminal to the distributor points terminal, and connect its supply leads to the car battery via the ignition switch. On negative-ground vehicles, take the negative lead to chassis and the positive lead to the ignition switch, and vice versa on positive-ground vehicles.

EXCESS-SPEED ALARM

Add-on warning circuit tells you to 'ease off' gas pedal

This unit is used in conjunction with the electronic tachometer circuit. It automatically sounds an alarm or operates some other warning device whenever the vehicle exceeds a preselected speed limit in top (high) gear. Over-speed trip levels can be preset to suit individual needs. On the prototype unit, trip speeds of 30, 40, 50, and 70 mph are available through a 4-way selector switch.

Trip level accuracy of the circuit is about ±0.5% over the battery voltage range 10 to 15 volts, and over-speed sensitivity and backlash are equal to about 0.5% of road speed. If the unit is set to trip at speeds in excess of 70 mph, the indicator goes on as soon as speed rises to 70.35 mph, and goes off again at 70 mph.

Although the unit must be used in conjunction with the electronic tachometer circuit, the actual meter itself does not have to be included. The meter can be simply replaced by a shorting link.

The unit operates basically as an ultra-sensitive frequency-triggered switch, which closes a relay whenever the operating frequency of the vehicle contact breaker exceeds a preset limit. Its operation as a speed monitor depends on the fact that an absolutely fixed ratio exists between road speed and engine rpm (and thus contact breaker frequency) in any given vehicle, and is determined by (among other things) the ratio of the car's gear box. When the vehicle is used in top (high) gear, therefore, contact breaker frequency can be used to accurately represent road speed. The frequency-triggered unit can thus be set to switch precisely whenever the contact-breaker frequency, and thus the road speed, exceeds a preset limit. Relationships between road speeds and rpm (and thus frequency) are given in some vehicle handbooks.

The speed monitor (Fig. 4) must be used in conjunction with the electronic tachometer (Fig. 1). As we have seen, the signal from the breaker points is picked up and fed through a low-pass filter, and is then inverted and reshaped via Q1 and used to fire voltage-regulated monostable multivibrator Q2–Q3 via a simple trigger-pulse generator. Transistor Q2 is normally on, with its collector at zero volts, and Q3 is normally off, with its collector at about −9 volts. These two transistors changing state for a preset period each time that the breaker points close. Thus, a train of fixed-length pulses 180° out of phase are available at the collectors of Q2–Q3. The pulses have a repetition rate proportional to contact breaker frequency, and thus rpm and road speed in high gear.

In Fig. 4, the Q3 collector signal (from the tachometer) is next fed to another trigger pulse generator stage (in the monitor), and is then used to fire a second voltage-regulated monostable multivibrator, Q5–Q6. The action is such, however, that this second multivibrator is driven on for its preset period only at the instant that the Q2–Q3 switches off at the end of each of its own pulses. In multivibrator Q5–Q6, Q5 is normally on, with its collector at zero volts, but goes off for a preset period each time its circuit is fired. The voltage at the Q5 collector is then mixed with that of Q2's collector, to produce a voltage across C5 that is proportional to the peak sum of the two pulse voltage amplitudes. The voltage across C5 is then fed to a voltage-triggered switch

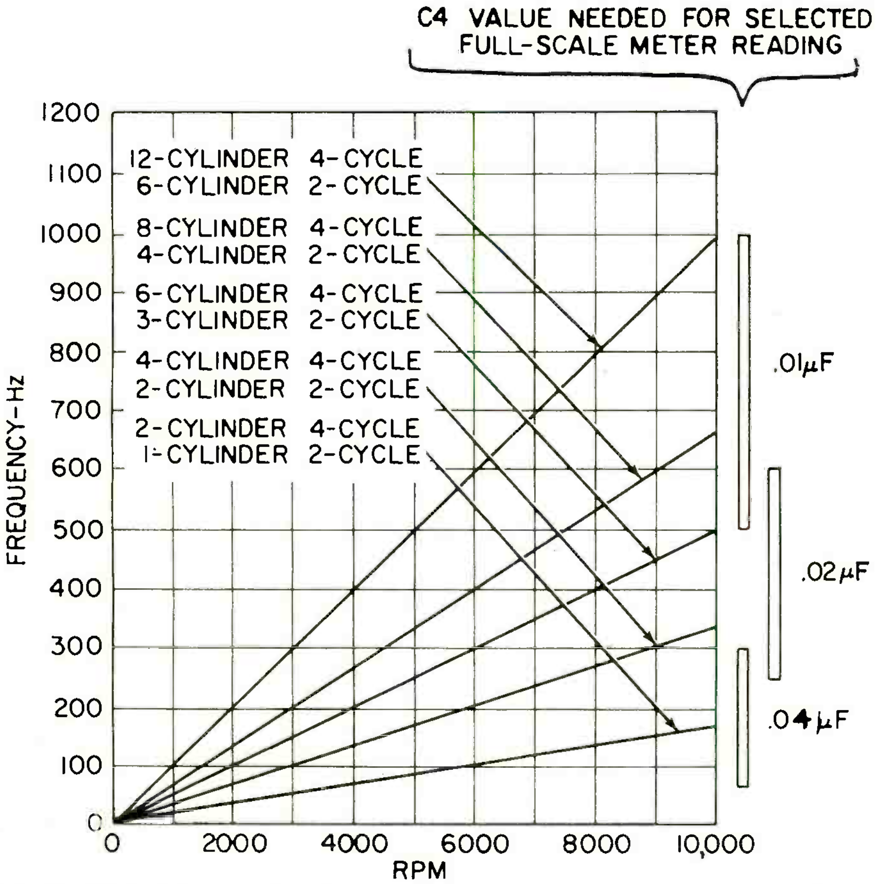


Fig. 3—Frequency, rpm and C4-value relationship for full-scale meter readings.

(Q7–Q8–Q9). The switch energizes relay RY1 whenever the voltage across C5 exceeds a certain value. Network C6–D6–R25 forms the trigger pulse generator. Monostable multivibrator Q5–Q6 is temperature stabilized by D5, and is powered from voltage regulator Q4 so it develops a pulse of very stable duration. The pulse duration is determined by the value of C7, which is selected on test, and can be preset via switch-selected trimmer resistors R20–R23.

Voltage-triggered switch Q7–Q9 operates in the differential mode. Here, a fixed reference potential of 4.5 volts is applied to the base of Q7, and the voltage across C5 is applied to the base of Q8. Collector current of Q8 is fed to the base of common-emitter amplifier Q9, which has relay RY1 connected as its collector load. Thus, if the voltage across C5 is appreciably less than 4.5, transistor Q7 is biased on and reverse biases the base-emitter junction of Q8. Transistors Q8 and Q9 and the relay are thus fully off under this condition. When, on the other hand, the voltage across C5 is appreciably above 4.5 volts, Q8 becomes forward biased, and thus drives Q9 on and energizes the relay.

Now, the important point in the operation of the speed monitor is that the Q2 and Q5 collectors are normally at zero volts, but that the collector of Q2 switches negative for a fixed period each time the breaker points close, and that at the end of this period Q2's collector returns to zero and causes Q5 to go negative for another preset period. Thus, if the first pulse has a duration of (say) 3 msec, and the second has a duration of 7 msec, a total pulse length of 10 msec is developed each time the points close. Fig. 5 shows how this simple fact is utilized to operate the indicator (relay) at breaker-point speeds in excess of 100 Hz, i.e., at point closure or dwell periods less than 10 msec.

Look first at the case where the dwell period is well above 10 msec, at 12 msec (= 83.3 Hz). In this case Q2 goes off at the moment that the points close, and Q5 is on, giving a potential of about 4.5 volts at point D (by the voltage-divider action of R15 and R16). As soon as Q2 goes on again after 3 msec, Q5 goes off for 7 msec, again giving a potential of 4.5 volts at point D. At the end of this period, both Q2 and Q5 are on for a period of 2 msec (until the points close again), giving a potential of zero at point D. Thus, C5 (point E) charges to a peak potential of 3.8 volts (= 4.5 volts, minus the forward voltage drop of D4). Relay RY1 (point F) is not energized because the voltage-triggered switch needs more than 4.5 volts to fire.

Now look at the case where the point-dwell period is precisely 10 msec, giving a frequency of 100 Hz. Here, the total period of the two pulses exactly coincides with the period of the points, so either Q2 is off and Q5 is on, or vice versa, at all times, and a steady potential of 4.5 volts is therefore developed at point D. A potential of 3.8 volts is again developed at point E, therefore, and the relay is again off.

Finally, look at the case where the two monostable pulses exceed the dwell period by 0.1 msec, i.e., where the dwell period is 9.9 msec, at a fre-

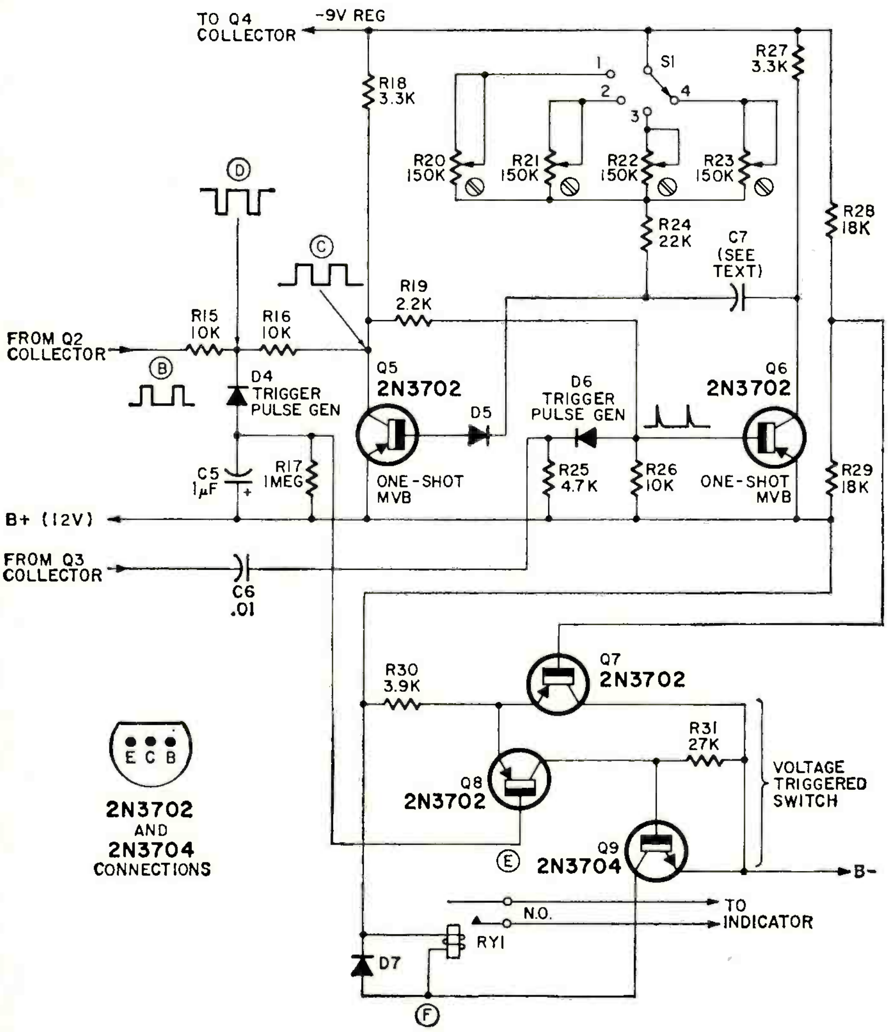


Fig. 4—Added to the tachometer, this circuit sounds an alarm when you inadvertently exceed preset speed limits slightly.

PARTS FOR SPEED MONITOR

All resistors ½ watt, 10% unless noted
R15, R16, R26—10,000 ohms
R17—1 megohm
R18, R27—3,300 ohms
R19, R24—22,000 ohms
R20, R21, R22, R23—trimmer potentiometer, 150,000 ohms
R25—4,700 ohms
R28, R29—18,000 ohms
R30—3,900 ohms
R31—27,000 ohms
C5—1 μF, 12 V, electrolytic
C6—0.01 μF, 50 V, Mylar
C7—50-V, Mylar, see text

Q5, Q6, Q7, Q8—2N3702
Q9—2N3704

D4, D5, D6, D7—general-purpose silicon diode

RY1—12-volt/dc relay, coil resistance greater than about 260 ohms, one or more set of normally open contacts.

S1—single-pole, 4-position rotary switch
Misc—Veroboard, hookupwire, hardware

quency of 101 Hz. In this case both Q2 and Q5 are off together for a period of 0.1 msec each time the points close. In this brief period the potential at point D rises to 9 volts, and causes C5 to charge to 8.3 volts, The voltage-triggered switch is thus driven on and causes the relay to operate. Note here that the total monostable pulse periods only have to exceed the dwell period by a minute amount to cause the relay to switch from fully off to fully on; the circuit is thus exceptionally sensitive. Also note that, by adjusting the pulse length of Q5, the circuit can be made to trip at any required frequency.

The major part of the add-on speed monitor is built, less RY1, S1, and trimmer resistors R20 to R23, on a 2⅞-inch x 1⅛-inch piece of Veroboard panel with 0.15-inch hole spacing. Fig. 6 shows component assembly and wiring details of this panel.

Capacitor C7 has a value of roughly 2 to 5 times the value of C4 (in the tachometer circuit), its precise value being selected on test as follows:

First, wire up the tachometer, connect meter M1 in place (either permanently or temporarily), and adjust the unit to give a sensible full-scale rpm reading. When the adjustment is complete, the meter can be either left permanently in place or can be replaced with a shorting link.

Hook up speed monitor

Next, wire up the complete speed monitor circuit (including RY1, S1, and R20–R23), as shown in Fig. 6, giving C7 a value roughly 2 to 5 times greater than that of C4, and connect

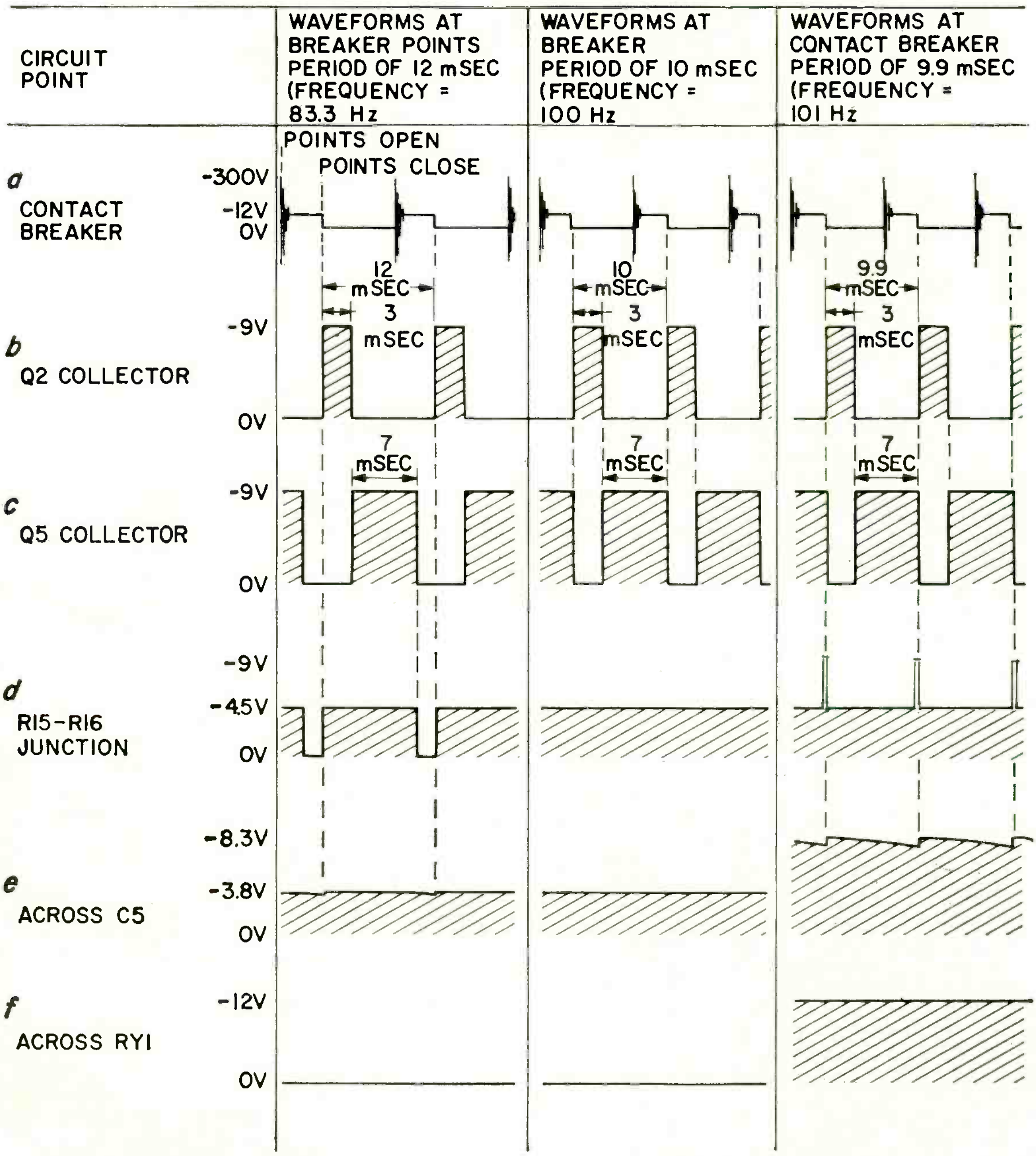


Fig. 5—Waveforms at key points in Figs. 1 and 4 when speed monitor is set to trigger at breaker frequencies above 100 Hz.

the unit to the tachometer circuit as indicated.

Consult the car manufacturer's handbook, and establish the rpm values at which the unit is required to trip at different high gear road speeds; convert these values to frequency, using the formulas given earlier. In the prototype unit, selected trip speeds are 30, 40, 50, and 70 mph.

Now connect the power leads of the complete unit (two on the tachometer, two on the add-on circuit) to a 12-volt supply, and connect the output of a square-wave generator, with an amplitude of at least 10 volts p-p between the tachometers distributor points (DP) terminal and one of the supply leads. Turn S1 to position 1, set R20 at mid-value, and give the complete unit a functional test by varying the generator frequency to check that the relay triggers on and off correctly.

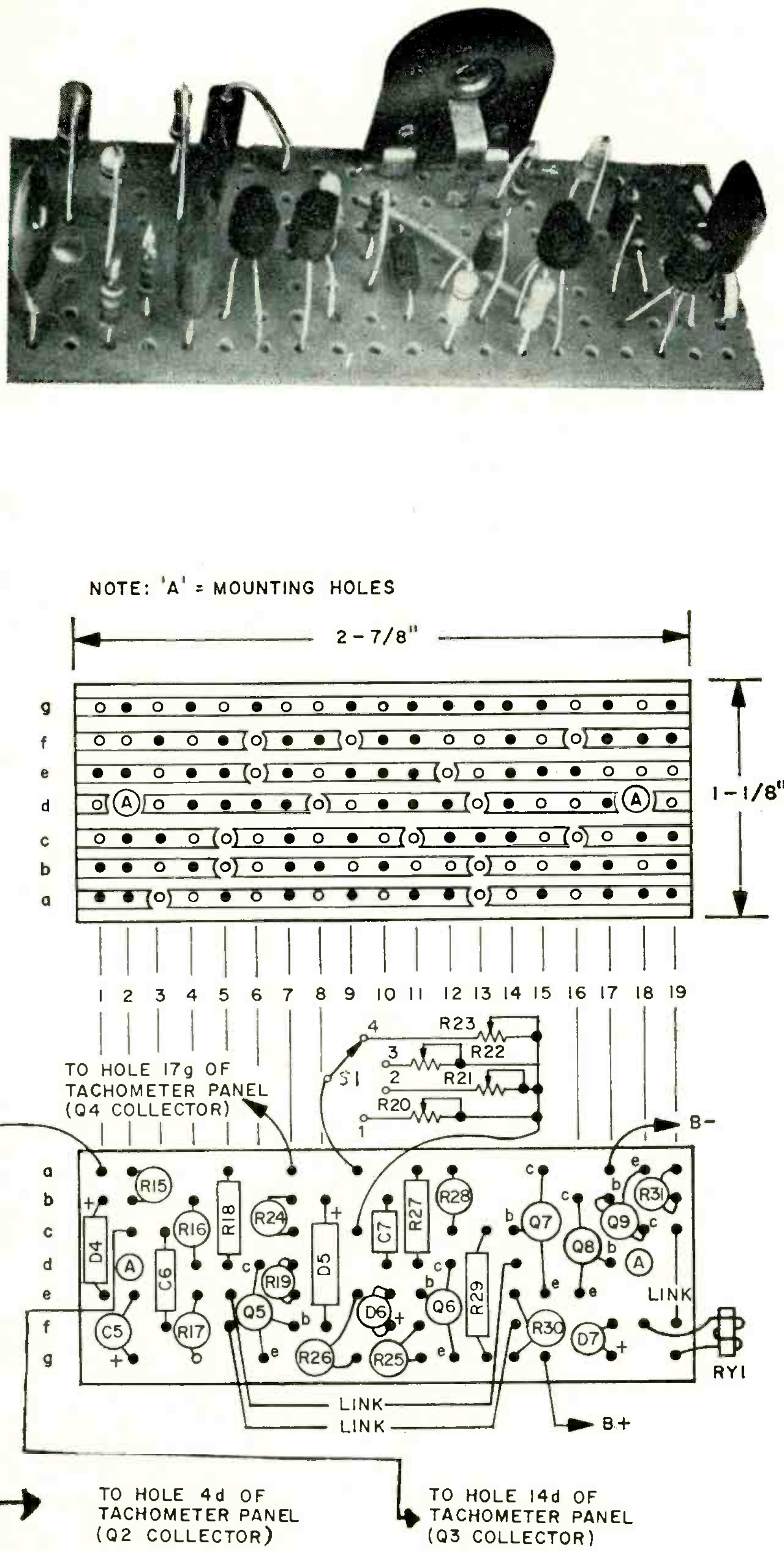


Fig. 6—Photo above shows simplicity of the speed monitor. Veroboard makes an easy-to-use chassis panel. Drawings show how panel is laid out and parts added.

Set high-speed cutoff

Once the unit is seen to be functioning correctly, set the generator to the lowest required trip frequency (i.e., equal to 30 mph in the case of the prototype unit), and adjust R20 so that the relay just operates at this frequency. Resistor R20 should be set in the range half-to-full value under this condition; if the R20 value is set considerably below half value under this condition, increase the value of C7 and readjust R20. If, on the other hand, the relay does not trip even when R20 is set to full value, reduce the value of C7 and readjust R20 until the correct operation is obtained for the circuit.

Once the above adjustment is complete, turn S1 to position 4, set the generator to the highest required trip frequency (i.e., equal to 70 mph in the case of the prototype unit), and adjust R23 so that the relay just turns on at this frequency; if the relay can not be made to trip at this frequency, even when R23 is adjusted to minimum value, increase the value of C7, and recheck the trip adjustment of the unit in positions 1 and 4 of S1, until a C7 value is found at which both adjustments can be made satisfactorily. In practice, the trimmer resistors enable a maximum-to-minimum trip frequency range of 6:1 to be accommodated using a single value for C7, so little difficulty should actually be experienced in establishing a satisfactory value for this capacitor.

Once the C7 value is finalized, complete the adjustments of R20 to R23 in the different S1 positions to give relay operation at the four selected frequencies. The unit is then complete and ready for use, and can be installed in the vehicle.

When using the unit in the vehicle, connect the tachometer's input (terminal DP) to points terminal on the car's distributor, connect the two positive leads together and the two negative leads together. On negative-ground vehicles, connect the negative leads to chassis and the positive leads to the ignition switch, and vice versa on positive-ground vehicles. The normally open (N.O.) relay contacts can be connected to a buzzer or a panel light, to give an audio or visual overspeed indication. **R-E**

NEW R-E EXCLUSIVE

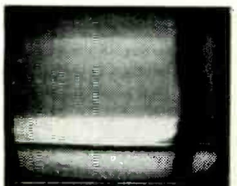
Transistor Sync Separator with noise inverter

Kwik-Fix™ picture and waveform charts

by Forest H. Belt & Associates*

SCREEN SYMPTOMS AS GUIDES

WHERE TO CHECK FIRST

SYMPTOM PIC	DESCRIPTION	VOLTAGE	WAVEFORM	PART
	Severe overload and loss of sync; some compression of raster lines	Q2 collector	WF3	R6 D1
	Jittery sync in presence of noise or flutter	no help	no help	D1 CI
	Bending and flagwaving	not much help	WF3	R1
	Overload; pic may get dark; sync poor	Q2 base	WF4	R2 C2 R9
	No video; raster slightly dark; sound okay	Q1 base	WF5	R2
	Raster blacked out; no sound	D1 anode Q1 base	WF5	R2
	No video; no sound; raster okay	Q2 base Q2 collector	WF4	R3
	Horizontal and vertical sync both bad	Q2 base Q2 collector	WF4	L1 D2 C2
	Vertical sweep compressed (or stretched)	Q2 base Q2 collector	not help much	R8
	No vertical sync	Q2 collector	WF4 WF5	R8 C5 D3

	No horizontal sync	no help	WF4 WF6	C6
	Horizontal way off frequency	no help	WF6	C6
	Thin horizontal line; vertical collapsed	no help	WF6	D3

NOTES:

Use this guide to help you find which key voltage or waveform to check first.

Study the screen and the action of the agc control.

Most helpful clues to the fault are found at the key test points indicated.

Make voltage or waveform checks as indicated for screen symptoms.

Use the Voltage Guide and Waveform Guide to analyze results.

For a quick check, test or substitute the parts listed as the most likely cause of the symptoms.

THE STAGES

This transistor sync separator is used often, in one variation or another. It appears in both black-and-white and color sets, and in hybrid as well as transistor chassis. Sometimes the noise stage is omitted from monochrome sets.

The noise stage goes by the name of noise inverter, noise gate or noise canceller. By whatever name, the stage turns off the sync separator stage momentarily whenever a noise pulse accompanies the video. The separator remains off only for the brief duration of the noise pulse. That doesn't interrupt normal sync operation at all.

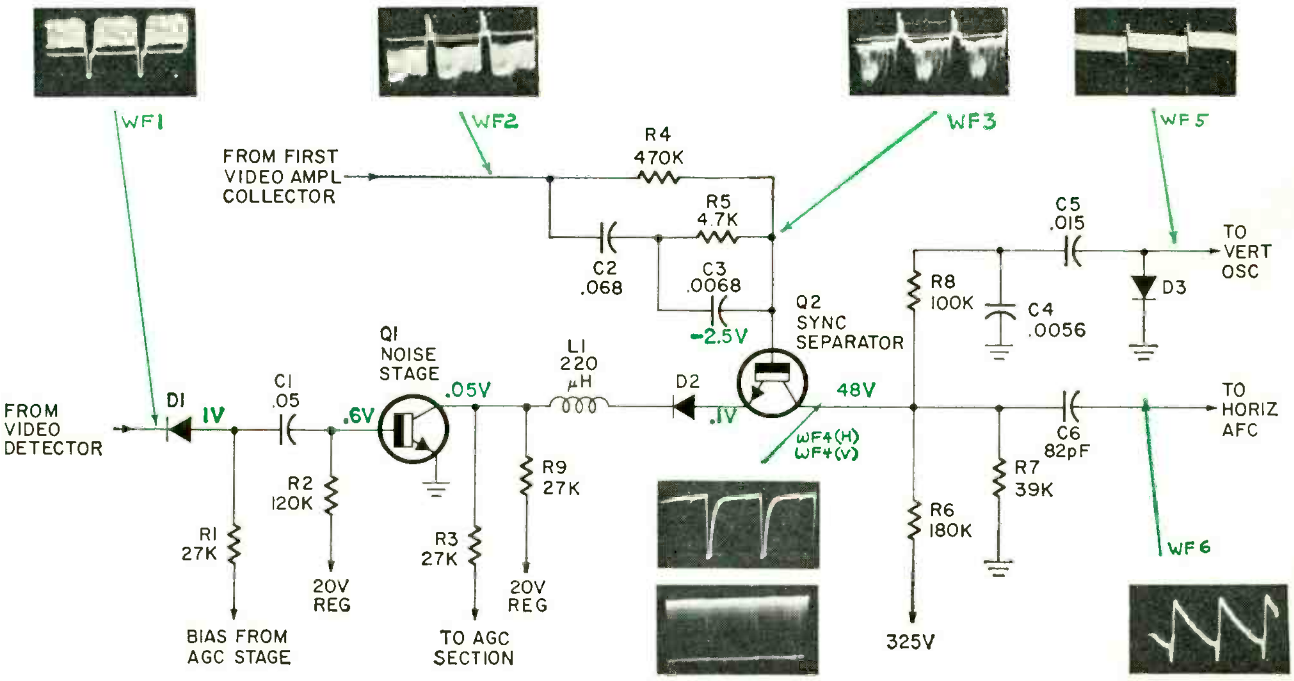
Ordinarily, the sync stage amplifies the sync pulses only, even though both video and sync are applied. The video and blanking are eliminated. The output (WF4) can be viewed on the scope at either a horizontal or vertical rate.

SIGNAL BEHAVIOR

An amplified video signal from the video amplifier collector, with positive going sync, is applied to the base of Q2 through compensation network C2–C3–R4–R5. The transistor conducts only when the signal amplitude overcomes the reverse bias between base and emitter. Therefore only the sync pulses, which are above the blanking-pedestal level, are amplified. The output of Q2 is a mixture of horizontal and vertical sync pulses. Both versions of WF4 are shown on the schematic.

The small value of C6 keeps vertical pulses (at 60 Hz) from being coupled to the horizontal afc, but passes horizontal pulses readily. Integrator network C4–C5–R8 shapes the vertical pulses and eliminates horizontal-pulse serrations from them. It also blocks all those horizontal pulses that occur in between vertical pulses. Diode D3 clips the amplitude of sync applied to the vertical oscillator.

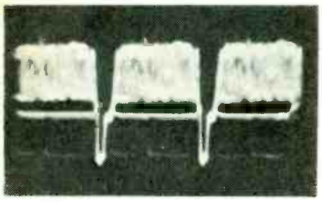
A low-level video signal with negative-going sync comes directly from the video detector. It is applied to the noise canceller, which senses any noise impulses that may occur.



DC VOLTAGES AS GUIDES

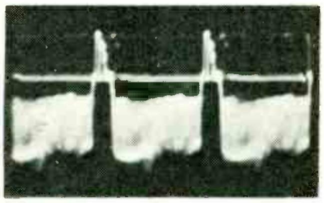
Voltage change	to zero	very low	low	slightly low	slightly high	high
D1-anode **Normal** **1 V** Varies somewhat with setting of agc control. May be varied from −3 to +4 volts.	R1 open **R2 open	R1 open	R2 shorted C1 shorted C2 open, shorted D2 open L1 open	R4 low		
Q1-base **Normal** **0.6 V**					R2 shorted	R2 open
Q2-emitter **Normal** **0.1 V** Changes as video (white) content of picture changes. Only varies a tenth of a volt or so. Goes to 0.3 volt with no station signal.	**R4 open				R2 shorted R6 open	R1 shorted R2 open R9 low C2 open D1 shorted D2 open L1 open
Q2-base **Normal** **−2.5 V** Changes as video (white) content of picture changes. Goes to zero when there's no station signal.	*R1 shorted *R2 open, shorted *R3 shorted *R4 low *R6 low *R9 low *C2 open, shorted *D1 shorted *D2 open *L1 open		R1 open	R8 low	R4 open	R4 open
Q2-collector **Normal** **48 V**	R4 low R6 open C2 open	R3 shorted R4 low R6 high C2 open D1 shorted	R1 shorted R6 high R7 low R8 low R9 low	R2 open, shorted C2 shorted C4 shorted C5 leaky C5 shorted	R7 high	R4 open R6 low R7 open D2 open L1 open
	*goes positive **goes negative					

NOTES:
Use this guide to help you pinpoint the faulty part.
The agc line is not clamped, despite some interaction with this stage.
Measure each of the five key voltages with a vtvm.
For each, move across to the column that describes the change you find.
Finally, notice which parts are repeated in whatever combination of voltage changes you find.
Test those parts individually for the fault described.
Find additional clues in the Waveforms Guide.



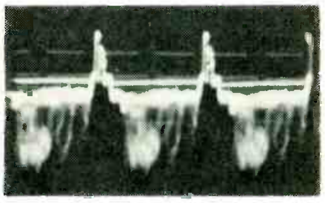
WF1 Normal 2.5 V p-p

Taken at the cathode of D1, this waveform is included for reference only. It is viewed best at the TV-horizontal rate of the scope. It comes from the video detector (actually from the base of the first video amplifier). Its sync is negative going. If this waveform isn't present, check the video detector before hunting trouble in these stages.



WF2 Normal 7 V p-p

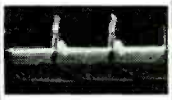
Another input waveform, shown for reference only. Make sure it is there and of proper amplitude before blaming these stages for poor operation. It comes from the output (collector) of the first video amplifier. Sync is positive going. Changes in amplitude of video in WF2 affect the bias developed at the base of Q2; that bias is from charge/discharge action in RC network C2–C3–R4–R5.



WF3 Normal 7 V p-p

Taken at the base of Q2, this is the video signal from which the sync is extracted. The action of compensation network C2–C3–R4–R5 gives the sync and pedestal a slightly odd appearance in this version of the stage. Other versions don't use so elaborate a compensation network. This one peaks the signal quite a bit, preparing it for sync separation.

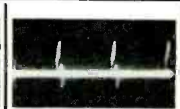
V p-p low	V p-p high	V p-p zero
D1 short		R2 open R2 shorted R3 shorted R4 open R9 low



4V p-p
D1 shorted

7V p-p
R1 shorted

10V p-p
R1 open



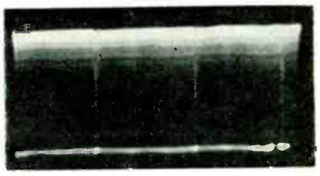
6V p-p
C2 open

4V p-p
C2 shorted

5V p-p
C3 open

12V p-p
R6 low

10v p-p
R6 open, high



WF4 Normal 40 V p-p

Taken at the collector of Q2, this is the output of the sync separator. It contains both vertical (left) and horizontal (right) sync pulses. You can see either one by viewing at its appropriate scope sweep setting. For troubleshooting, only the horizontal-sync waveshape is really informative. And usually, shape is more important than amplitude.

V p-p low		V p-p zero
R2 open R4 low R7 low R8 low C4 shorted D3 shorted		R4 low C2 open

40V p-p
D1 shorted

40V p-p
R1 shorted

10V p-p
R2 shorted

4V p-p
R3 shorted

40V p-p
C2 shorted

4V p-p
R4 open
D1 open
L1 open

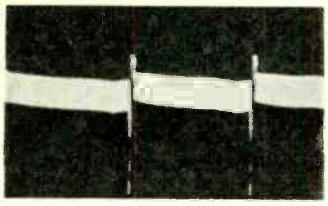
6V p-p
R6 open

200V p-p
R6 low

45V p-p
R9 low

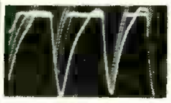
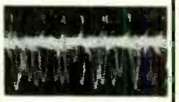
40V p-p
C3 open

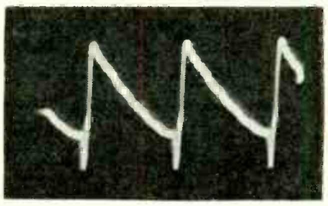
WAVEFORMS AS GUIDES



WF5 Normal 2 V p-p

This is the integrated and clipped vertical-sync output of the sync separator. It is taken across the diode, which is in the cathode of a vertical oscillator tube in the hybrid color set used for this example. The horizontal pulses that fill the space between vertical pulses in WF4 have been almost all eliminated—although you can see traces of them (the thick trace between pulses). The vertical pulses are negative going.

V p-p low	V p-p high	V p-p zero					
		D3 shorted	 3V p-p R2 shorted	 0.4V p-p R2 open R3 shorted R8 open C4 shorted C5 leaky C5 open	 1V p-p R6 open	 20V p-p C4 open	



WF6 Normal 25 V p-p

This is the horizontal waveform at the sync output. The sawtooth that dominates it is fed back from the horizontal afc stage to which sync is coupled. The negative pips that extend from the negative peaks of the sawtooth are sync pulses. Notice below that the sawtooth remains alone, without sync, unless something upsets the horizontal afc or oscillator as well as the sync stage.

V p-p- low	V p-p high	V p-p zero					
			 15V p-p R2 open R2 shorted R3 shorted R6 open C6 open	 25V p-p C6 leaky			

Use this guide and the Voltage Guide to help you pin down fault possibilities.
Clamping the agc line is not necessary. Waveforms in this guide are without outside clamping or biasing.
With the direct probe of the scope, check the six key waveforms (only four of them give trouble clues within the stages). The scope sweep should be set at H/3 or about 5 kHz, to show three cycles of the waveform. (Only WF4 is taken at 20 Hz.)
Note amplitude. If it's low or high, check parts under those descriptions.
Note waveshape. If there's a change from normal, despite amplitude, check the parts indicated.

No signal reaches Q1 unless its amplitude is high enough to overcome the reverse bias on gate diode D1. Only noise impulses with amplitude higher than the tips of sync pulses can get through. Sync pulses and video are blocked by the diode.

If a noise pulse does occur, it is coupled to common-emitter amplifier Q1 by capacitor C1. Until that happens, the transistor is just a conductive ground return for the emitter of Q2. But a noise pulse cuts Q1 off. That, in turn cuts off Q2, and it can't pass the noise pulse that is at its base.

Transistor Q1 is thus part of the ground return for the emitter of Q2. L1 and D2 form the rest. Collector voltage for Q1 is applied through R3 from the regulated dc line. As long as Q1 conducts, so can Q2—that is, it can if its base bias permits.

However, base bias for Q2 is developed mainly by "grid-leak" action in the C2–C3–R4–R5 network. It's a class-C type of bias. It stays at a level that prevents the transistor from conducting except when the input signal goes above the blanking pedestal. In other words, the transistor conducts only during sync pulses (as long as no noise pulse has cut off Q1).

Some voltages change considerably with changes in signal. For example, the dc voltages at the collector of Q1 and the emitter of Q2 vary with the white content of the video. They change drastically if station signal is lost.

The dc voltage at the anode of D1 depends to some extent on the setting of the agc control and on the station-signal level. Voltage changes with signal at this point are slight. Their effect is to alter the level of noise signal that can get through D1.

More and less video signal changes the bias voltage at the base of Q2. But the effect is to keep the conduction level of the transistor always slightly above the blanking pedestal.

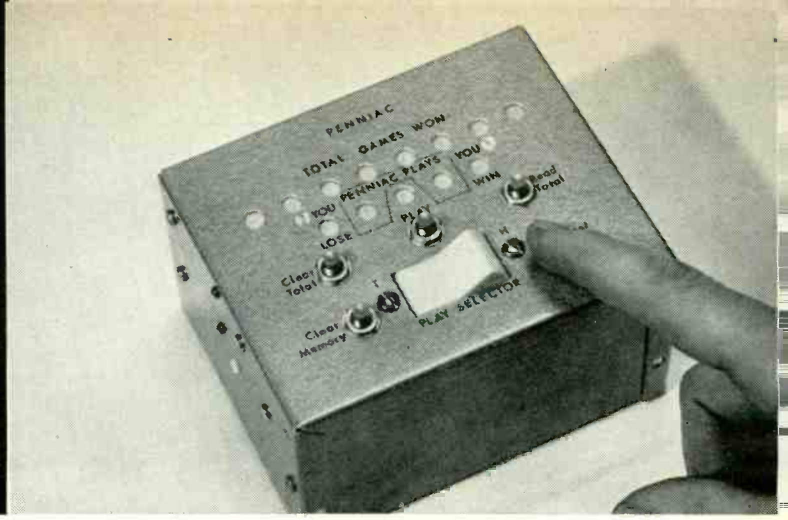
The fastest way to troubleshoot this stage is with a scope. WF4 is the key waveform.

First, isolate the sync separator from the noise stage. Clip a jumper from the cathode of D2 to ground. Then you can test the separator stage by itself, without worrying about misleading symptoms from the noise inverter.

Waveforms in the sync separator should be exactly as the schematic shows. With the jumper in place, the voltage on Q2's emitter goes to zero. Diode D2, if it's okay, still conducts normally.

A fast test for the noise stage can be made while the jumper is in place. Just clip across diode D1, too. That applies video to Q1 through C1. R9 and L1 are a collector load, if the first jumper is still in place. **R-E**

Try to beat R-E's "PENNIAC" $150 GAME COMPUTER



Penny-matching computer records your heads-or-tails play sequence and computes its plays accordingly. Has rechargeable power supply for its 66 IC's

by R. R. YOST

ALL WORK AND NO PLAY DESCRIBES THE LIFE OF MOST computers, but their human designers never have seen it that way. It wasn't long after computers became available that programs were written to teach them to play a good checker game and a pretty passable chess game.

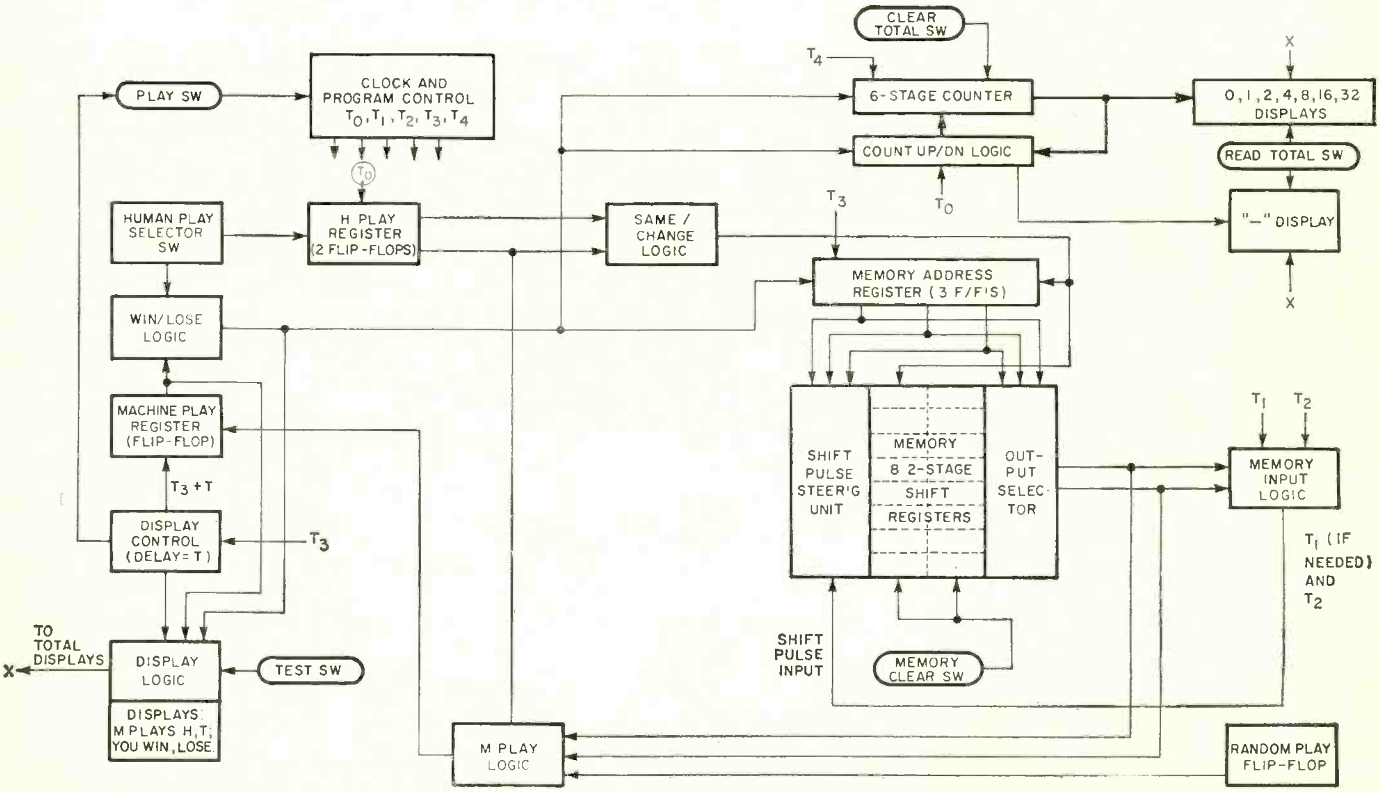
Even these accomplishments didn't satisfy us humans. We're now busy trying to teach computers to become even more human—to be able to adapt to and communicate with the world around them. Clearly, computers will someday be more than the dull work-a-day "accountants" they now are—they will be fascinating companions for our recreational and leisure hours.

The pint-size game computer described here is a step toward the day when adaptive game-playing computers will be in every home. It plays a very simple game by adapting itself to its human opponent. Its $150 construction cost puts it within reach of hobby groups, clubs and many individuals.

What Penniac does

Penniac plays a penny-matching game. The human chooses heads or tails and the computer tries to guess which it will be. If it correctly predicts the human's choice, the computer wins; if not, it loses and the human wins. Simple computers to play this game are not new. Dr. Shannon, of information-theory fame, described two such computers built at Bell Labs back in 1953, but not until inexpensive IC's became available did the construction of such a computer become feasible for a hobbyist.

Fig. 1—**Complex interactions** in Penniac are shown in this simplified block diagram. Three major sections are shown in Figs. 2–4, which should be studied with text and Fig. 1.



The adaptive feature of Penniac is its strategy for winning. It records the human's play sequence and memorizes his responses to each of a number of game situations. For example, if the human plays heads, wins, plays heads again, and wins again (a game situation), he may tend to change to tails (his response is to change his play).

To decide what the human is going to play next, the computer consults its situation memory to see what the human did the last time he was in the present situation. For each situation, it has stored an S, a C, or an R, based on the previous play history. An S means that previously, in that situation, the human played the same as before; C that he changed; R that the last *two* times this situation came up the human responded in different ways.

When the computer finds an R in the cell of its memory corresponding to the present situation, it makes a random choice of heads or tails.

Penniac, being pretty simple compared to its human opponent, can be beaten if you carefully remember what it has stored in each of its memory cells. (You probably will need pencil and paper for this.) Under this mode of play, it will lose three out of four games on the average. If you play completely random, so does Penniac and the result of a large number of games is a tie. Casual impulsive playing permits Penniac to draw ahead slowly, winning more games than it loses. Of course, luck plays a part!

Penniac is packaged in a 3 x 4 x 5-inch box, complete with its nickle cadmium (NiCd) batteries and their charging circuit. A counter is provided to keep track of wins and losses. To play with Penniac, you first turn the power on, using the switch on the right side. Then the won-games counter and the memory must be "cleared" by pressing the two buttons marked CLEAR TOTAL and CLEAR MEMORY.

Clearing the counter resets it to zero from the random count it assumes at turn-on, and clearing the memory sets

FIG. 2—PROGRAM CONTROL BOARD

I. Clock and Program Control
IC1: clock oscillator.
IC's 2, 3, 4: counter whose output states are used to steer control pulses to proper output terminals.
IC5a: Clock Control logic (stops clock after t_4).
IC5b, IC6a, b:
clock pulse shaper & drivers for steering logic.
IC6c: inverter and driver to reduce loading on IC3.
IC's 7, 8, 9: Clock Pulse steering logic input:
Y9: from H-Play pushbutton.
Outputs:
Y3: t_4 pulse.
Y5: t_0 pulse.
IC10a:T_0 pulse driver.
IC10b: T_1 pulse driver and inverter.
IC10c: T_3 pulse driver and inverter.

II. Win-Lose Logic
IC21: a, b, c, d; IC20 a, b.
Inputs: 24, 25 from H Play selector switch.
Outputs: X6, X7 to count Up/Down Logic.

III. Change-Same Logic
IC15 a, b
IC5a, IC16a, IC17a
Output 42: to memory.

IV. H Play Register
IC12a, IC13a.

V. Address Register
IC13b, IC14a, b.
Outputs: X1, X2, X3 to memory.

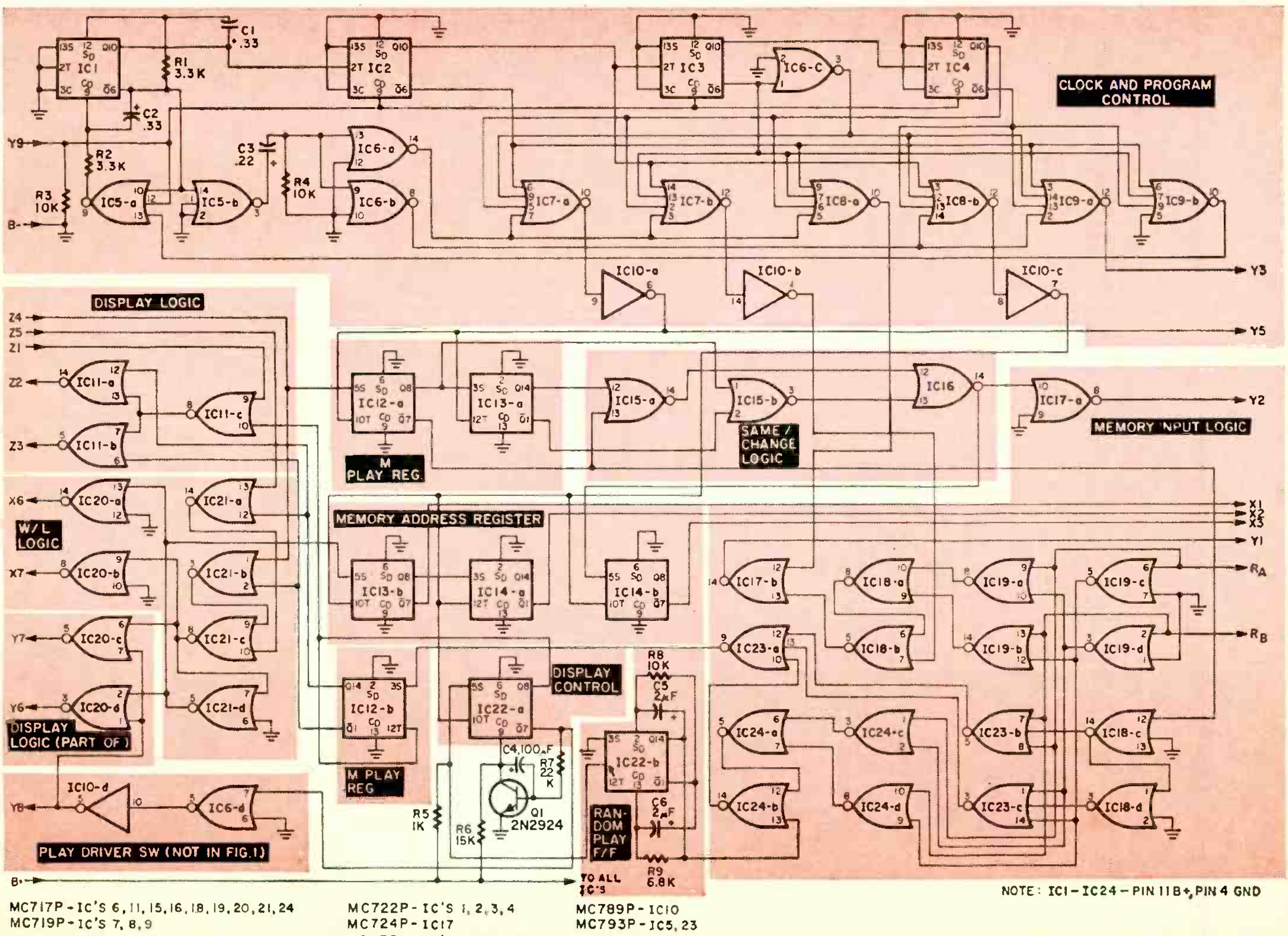
VI. Display Control Monostable F/F
IC22 a, IC6 d, IC10 d (inverter and driver).
Output 48: to Ready display and Play pushbutton

VII. M Play Register
IC12b

VIII. Display Logic
IC11a, b, c; IC20 c, d; plus elements on won-games counter board.
Inputs and Outputs:
Z1: from Test switch.
Z2, Z3: to M Play T, M display.
Y6, Y7: to display drivers, You Lose, You Win.
Z4, Z5: from H Play selector switch.
(Z4 to positive if heads; Z5 to positive if tails).

IX. Memory Input Logic
IC19a, b, cd; IC18a, b; IC 23a, b, c; IC 22b (Random Play FF).
Input:
R_A, R_B from memory output Selector
Output:
Y_1: t_1 and t_2 shift pulse to memory shift pulse steering unit.

X. Machine Play Logic
IC24a, b, c, d; IC 18c, d;
IC23a, b, c; IC 22b (Random Play F/F).
Inputs:
R_A, R_B: inputs from Memory Output selector.
Output:
Internally, to IC12b, Machine Play register.



MC717P - IC'S 6, 11, 15, 16, 18, 19, 20, 21, 24
MC719P - IC'S 7, 8, 9
MC722P - IC'S 1, 2, 3, 4
MC724P - IC17
MC778P - IC'S 12, 13, 14, 22
MC789P - IC10
MC793P - IC5, 23

PARTS LIST

C1, C2, C7, C9—0.33μF electrolytic
C3—0.22-μF electrolytic
C4—100-μF, electrolytic (Kemet K100 or equiv.)
C4—100-μF, electrolytic (Kemet K100 or equiv.)
C5, C6—2-μF, electrolytic (Kemet 2R 2μF or equiv.)
C8—4.7-μF, electrolytic
C10—100-μF electrolytic
C11—600-μF electrolytic
All capacitors 6 volts or more. All tantalum except C10 and C11 to conserve space.
R1, R2—3300 ohms. 1/8W
R3, R4, R8, R11—10,000 ohms
R5, R27, R28, R35, R36—1000 ohms
R6—15,000 ohms
R7—22,000 ohms
R9—6800 ohms, ½W
R10, R12–R19, R29, R30–R34—470 ohms
R20, R21—56 ohms, 1W
R22—5000-ohm trimmer potentiometer
R23—47 ohms
R24—4.7 ohms, 1W
R25, R26, R37—2200 ohms
All resistors ¼W unless noted
Semiconductors (integrated circuits (IC1–IC66, Motorola)
IC1–IC4, IC50, IC52–IC56, IC65—MC722P
IC5, IC23, IC63—MC793P
IC6, IC11, IC15, IC16, IC18–IC21, IC27, IC39, IC57–IC62, IC64, IC66—MC717P
IC7–IC9, IC26, IC30, IC32, IC33, IC36–IC38, IC42–IC44, IC47, IC49—MC719P
IC10, IC25—MC789P
IC12–IC14, IC22, IC28, IC29, IC34, IC35, IC40, IC41, IC45, IC46—MC778P
IC17, IC51—MC724P
IC31—MC725P
IC48—MC786P
Q1–Q10, Q12–Q16—2N2924 (Motorola)
Q11—2N2925 (Motorola)
D1—1N4154 diode
D2—1N4371A Zener diode (Motorola)
RECT 1—bridge rectifier MDA 920A-1 (Motorola)
Other parts
T1—6.3V, 0.6A transformer
RY1—250-ohm, 14-mA, spdt dc relay (Sigma 11F-250-G/SIL)
B1—3 1.25-volt nickel cadmium cells (G.E.)
LM1–LM13—4-volt, 40-mA lamps (4ES), baseless
S1—dpst slide switch
S2-S5—spdt, NC momentary pushbutton switch (subminiature)
S7—2-position dpdt rocker switch
MISC—perf board (0.1-inch centers), 6-lug terminal strip, standoff terminals, 3 x 4 x 5-inch metal case, No. 32 stranded wire, Vector type K24A pins

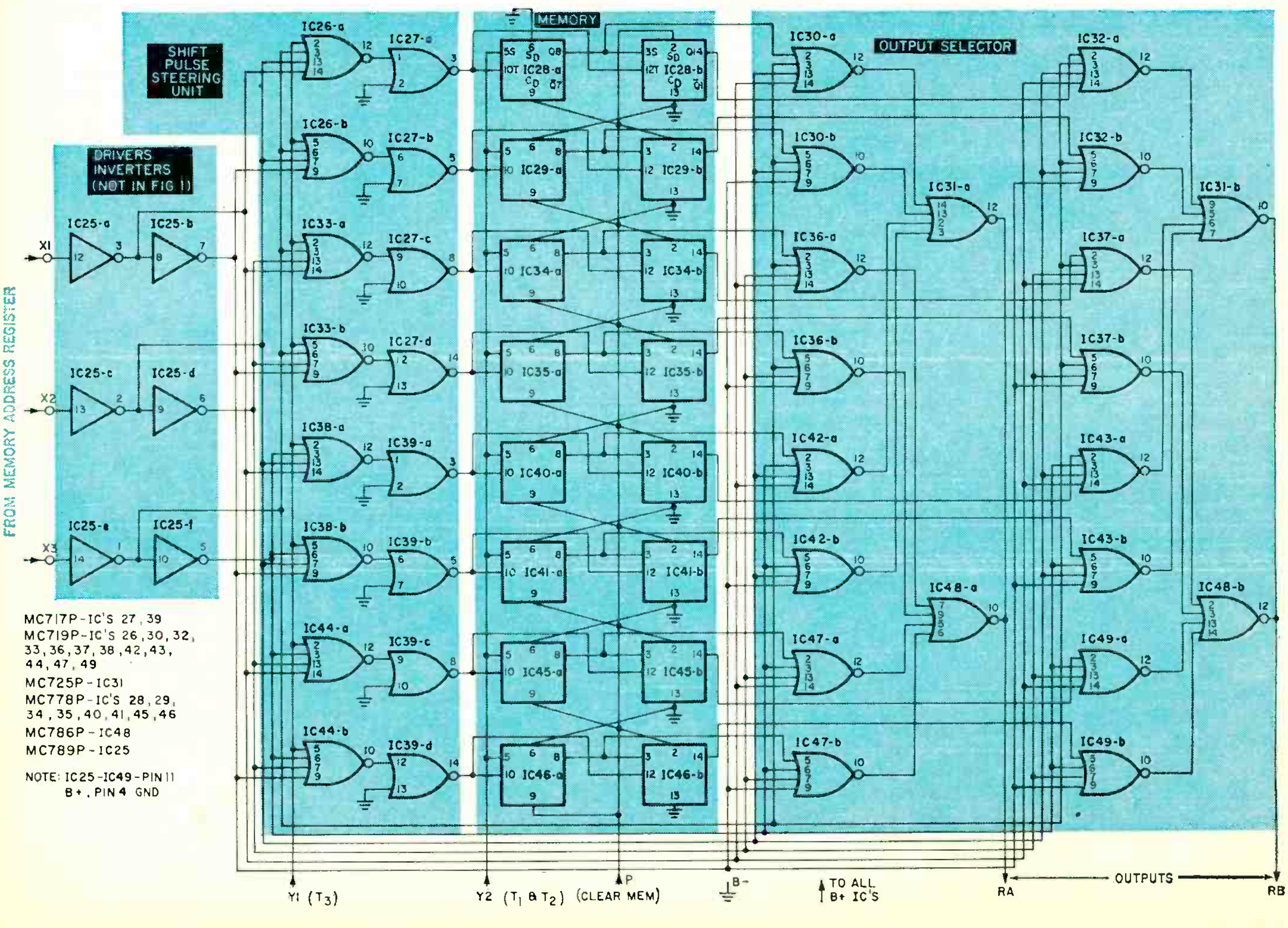
all cells to "R" (random). The human makes his first choice of heads or tails by setting the PLAY SELECTOR rocker switch to the right or left, and then enters his play by pressing the centrally located PLAY pushbutton. Lights come on for about 1 second to indicate what Penniac's play was and whether the human won or lost. The TOTAL WON GAMES lights also illuminate momentarily, indicating the net games won by the human.

For example, if the human selected heads and the computer also selected heads, the human would lose and the TOTAL WON GAMES would indicate −1, meaning the human is now one game behind. The counter is a binary counter and the total is obtained by mentally adding together all the illuminated numbers. If the human is seven games behind, for example, this would be indicated by −1 2 4. The counter has a range of ±63; on the count of 64 it resets to 0. After the 1-sec interval, all indicators go out and the central play indicator (P) comes on, signifying that the computer is ready for the next play by the human operating it.

The button marked TEST is provided to assure the human that the computer is not cheating. Pressing this button at any time tells you what the computer is going to play next. You can verify that changing the play selector switch will not affect the computer's choice. Also, you can verify, by holding this button down continuously, that the computer always makes its choice just at the end of the 1-sec display ON period, *before* you have made your next

FIG. 3—MEMORY BOARD

I. Shift Pulse Steering Unit
IC25 (driver), IC's 26, 33, 38, 44, 27, 39.
II. Memory
IC's 28, 29, 34, 35, 40, 41, 45, 46.
III. Output Selector
IC's 30, 36, 42, 47, 32, 37, 43, 49, 31, 48.
Inputs:
X1, X2, X3:from Address register.
Y1:from Machine Play logic.
Y2:input from Change-same logic.
P: from memory clear pushbutton.
Output:
RA, RB:to Memory Input logic and Machine Play logic.



selection.

The READ TOTAL button is provided so that you can check the won-games counter to find out how you stand.

Table I shows the results of playing a sequence of games. The second, third and fourth columns tell which of its memory cells Penniac "read" from, what it read therein, and which play number those contents were based on. The fifth column lists Penniac's prediction for the human's play. Column 6 contains the human's actual play. These plays were chosen to illustrate how Penniac adapts to the human's strategy; they also illustrate what happens when the human tries to vary his strategy so as to "fool" Penniac. Column 7 records whether the human won or lost and column 8 lists what Penniac wrote into the memory cell it had consulted for prediction. Column 9 contains a "+" when Penniac correctly predicted the human's play, a "−" when it was fooled, and an R when it played at random. Column 10 records games won by the human.

Of course, each game starts with the human's play and ends with Penniac predicting the human's next play. For example, after the human makes his third play, Penniac writes S in cell WSL, and then consults cell LSL to predict the human's 4th play.

Note that in this sequence of 50 games, Penniac predicted correctly 21 times, incorrectly 11 times, and played at random 18 times, in spite of the human's attempts to mislead it. At the end of the 50-game sequence the human is down 6 games, so he was actually somewhat lucky. If he had won only half the time that Penniac played at random, he would have been down 10 games.

How it works

For understanding anything as complex as Penniac, detailed schematic diagrams are not a good starting place. Fig. 1 is a block diagram that shows how the major elements of Penniac interact.

Clock and Program Control: This unit is controlled by the PLAY pushbutton; upon its release, a series of five output pulses is generated. Each pulse comes out on a different output lead. The pulses last about 0.2 msec and are spaced at 2.5-msec intervals. Each pulse is a command to a block-diagram element to perform its function at the time the pulse arrives.

Counter and Count Up/Down Logic: The usual flip-flop (F/F) counter counts up only; that is, it increases its stored total by one for each input pulse until all stages are holding binary 1's. Then the next input pulse results in all stages holding binary 0's. However, for the net games won, the counter must be able to count both up and down. If it is holding a positive total, a game lost by the human must reduce the stored count by one. On the other hand, if it is holding a minus total, meaning the human has lost more games than he has won, a lost game must increase the count. The Count Up/Down logic sets a "sign" flip-flop to the "−" or "+" state when the total is 0 and the human loses or wins, respectively. This happens *only* if the total is 0; for other values of the total the sign F/F does not change. When the sign F/F is in its "−" state,

FIG. 4—TOTAL GAMES WON COUNTER

I. Counter
IC's 50, 52, 53, 54, 55, 56.

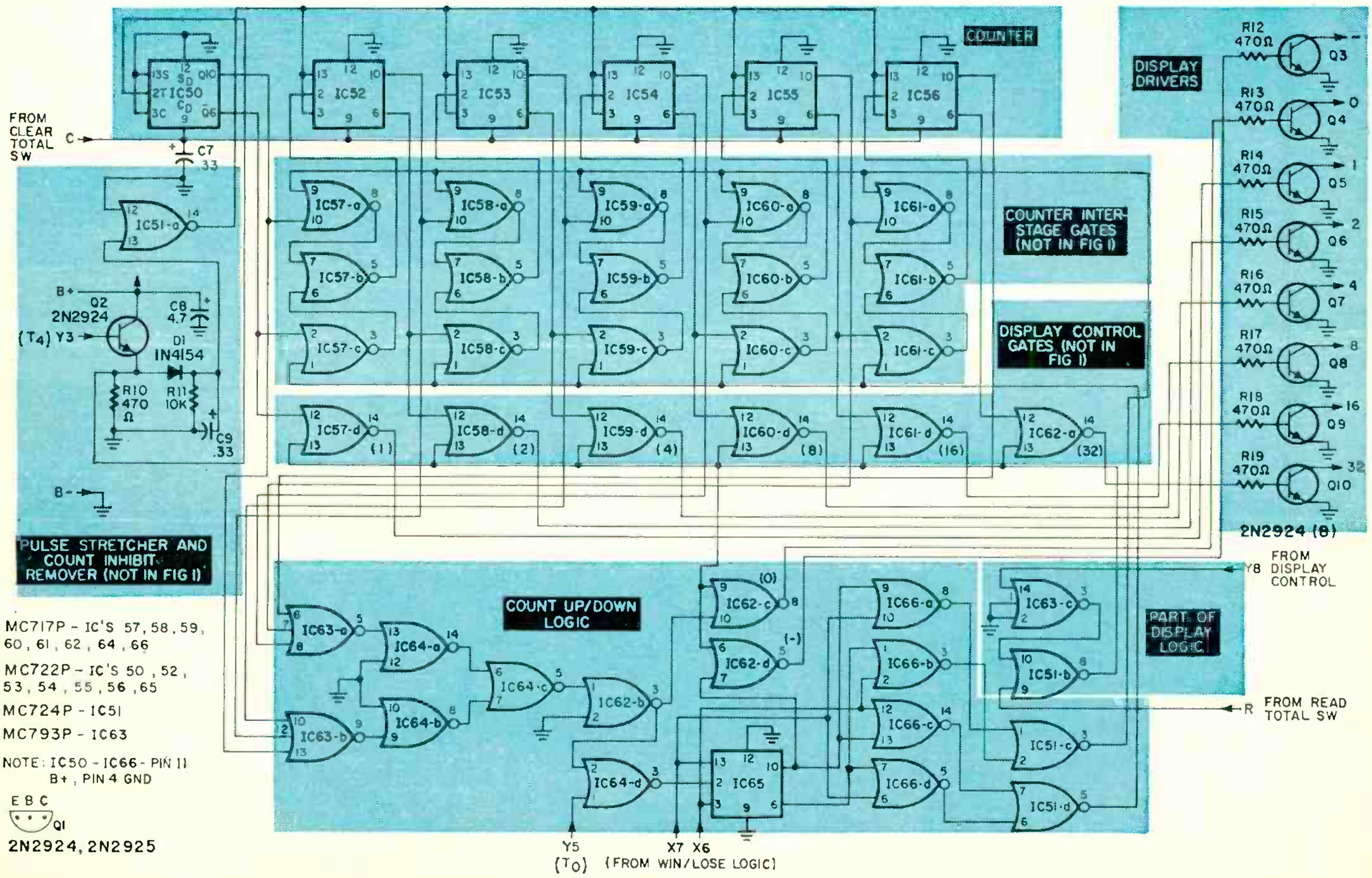
II. Count Up/Down Logic
IC's 57 a, b, c; 58 a, b, c; 59 a, b, c; 60 a, b, c; 61 a, b, c; IC66 a, b, c, d; IC51 c, d.
IC65 is Sign flip-flop. IC63 a, b; IC64 a, b, c, d; IC62 b are logic for driving sign flip-flop.

Display Logic: IC63c; IC's 57d, 58d, 59d, 60d, 61d; IC62 a, c, d.

Inputs pulse shaping and count-inhibit voltage generator: Q2 and IC51a.

Inputs:
C: Total-Clear pushbutton.
Y3: t_4 pulse to advance counter.
Y8: from display monostable F/F.
R: from Read-Total pushbutton.
Y5: t_0 pulse to Count Up/Down Logic.
X6, X7: from Win/Lose logic.

Outputs:
To lamps as indicated.
Y4: t_4 pulse to other circuits.



the count up/down logic sets the counter interstage connections so that a game lost by the human increases the count and a game won decreases the count. When the sign F/F is "+" it controls the counter so it counts up for games won by the human and vice versa. The sign F/F also controls the "−" display lamp.

H Play Shift Register: This comprises two cascaded F/F's. Upon pulsing the S terminal, the left one stores whatever is at its input terminal—in this case, the setting of the H PLAY SELECTOR switch—and the right-hand F/F stores what the left one held before the pulse. Thus this register stores the human's last two plays.

Same/Change Logic: The Same/Change logic network compares the last two human plays stored in the H-Play register to determine whether he played the same or changed. Its output is fed to the Memory-Address register and to the memory itself.

Win/Lose Logic: The Win/Lose (W/L) logic network compares the setting of the H PLAY SELECTOR switch with the machine's play, which is stored in the machine-play register F/F. Its output is a binary 1 if the human wins, a 0 if he loses.

Memory Address Register: This unit stores the last two outputs of the Win/Lose logic and the previous output of the Same/Change (S/C) logic. Its three binary

(continued on page 72)

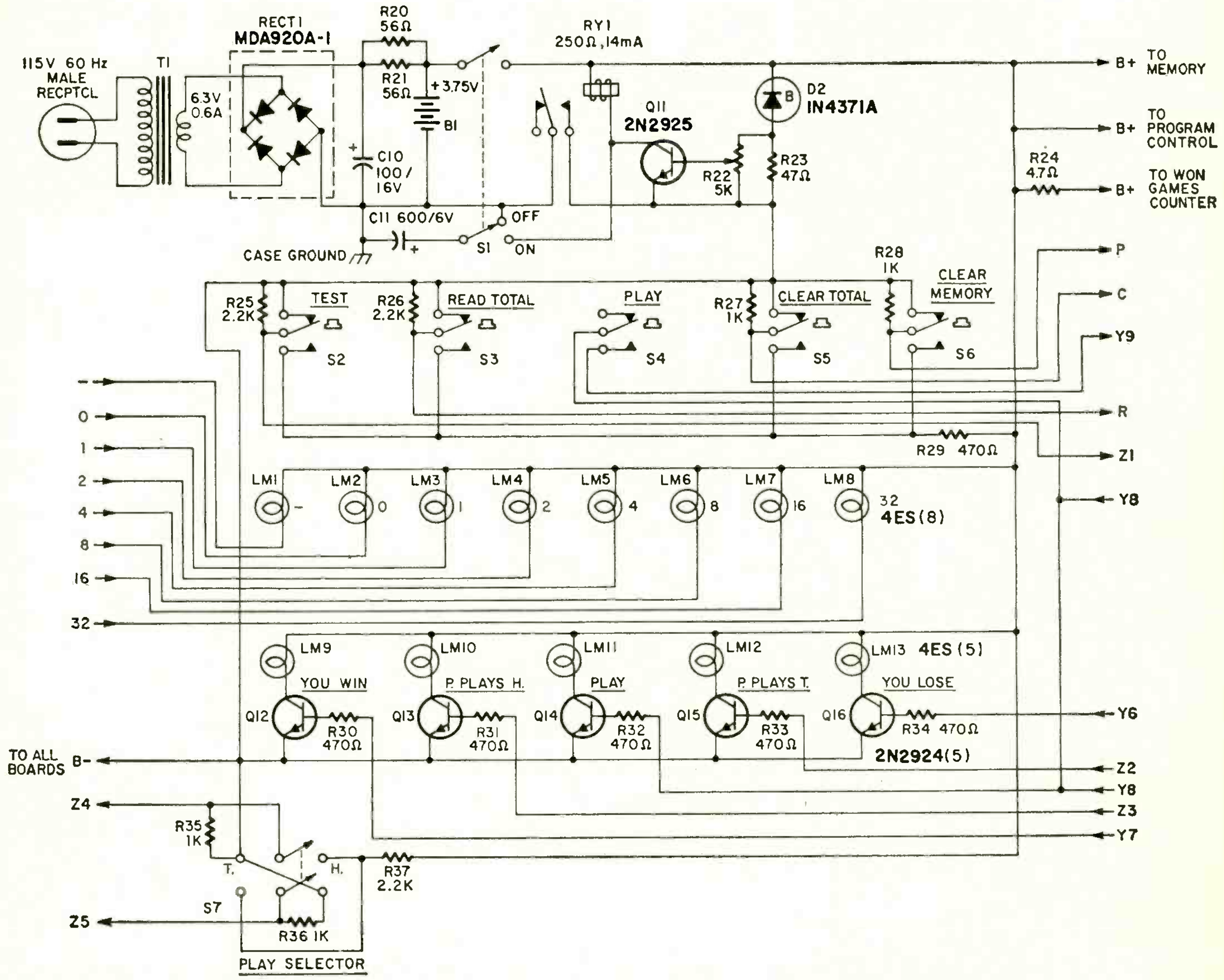


Fig. 5—Depending on component values, it may be necessary to connect R22 across Zener diode D2 to get the 3.3-volt dropout point within the adjustment range of the potentiometer.

TOOLS FOR ELECTRONICS

by TOM HASKETT

This issue, starting on the facing page, is the next part of our new series of articles on tools for electronics. It is the second part of our description of soldering tools. Next month we will continue the series with the final section of the article on soldering tools and the start of nutdrivers. We believe you will find all of this material a handy, practical addition to your R-E Reference Manual.

If you wish you can purchase a special hardcover binder to keep your Reference Manual pages together. It has a dark blue fabric cover and is gold stamped Radio-Electronics Reference Manual. The cost is $1.00, postpaid. Order from N. Estrada, 17 Slate Lane, Central Islip, L.I., N.Y. 11722.

Fig. 3 shows the schematic of the transformer-type gun. When you pull the trigger, the transformer primary is connected to the ac line. Notice that the primary has many turns while the secondary has only one.

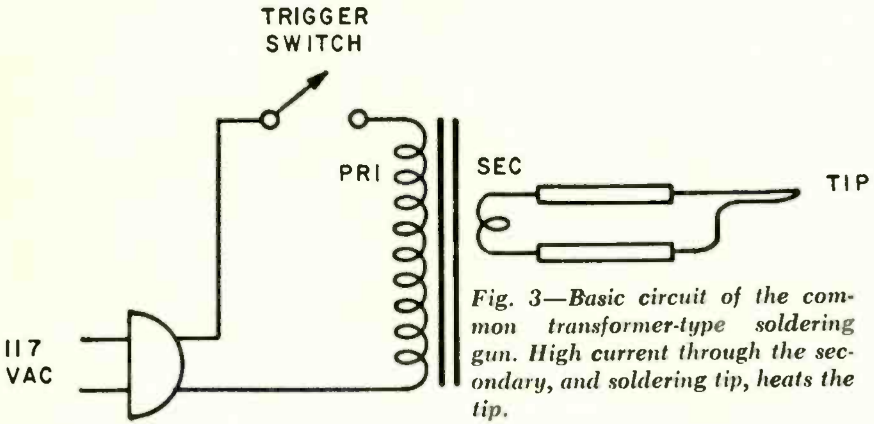


Fig. 3—Basic circuit of the common transformer-type soldering gun. High current through the secondary, and soldering tip, heats the tip.

Thus secondary voltage is low and current is high. This secondary current heats the tip.

Guns are available from 100 to 325 watts. Some have a dual-position trigger switch which connects the ac line to more or less of the primary, providing more or less secondary current. The model shown in Fig. 2 has a two-position trigger which produces 100 or 140 watts at the tip.

A transformer-type gun is most useful in installation and servicing, where you might solder connections only now and then. It's most useful for intermittent work; the one shown in Fig. 2 has a duty cycle of 1 minute on and 4 minutes off. A gun heats rapidly (it can melt solder about 5 seconds after you pull the trigger), requires no stand and is therefore convenient for occasional soldering. Also, the spotlight (some models have two) is useful because it lights your way into dark corners. But you cannot use a gun constantly, as in construction and assembly.

Gun tips are usually bare copper and several types are available. Most common is the chisel tip, for routine work. There is also a flat blade type, for cutting soft plastic and similar material. Tips are inexpensive and replacement is simple.

After some use, you'll find that the tip doesn't get hot easily or rapidly. When this happens, let the gun cool. Then loosen and retighten the tip nuts to renew the solid heat-transfer connection at those points.

idle for a half hour or so, the tip stabilizes at what's called **idling temperature.** This must be well above the melting point of the solder you're using. It must also be high enough so that rapid and frequent applications to the cold work won't immediately drop tip temperature below the solder-melting point. If you use an iron intermittently this is a less important consideration than if you use the iron continuously, as in production and assembly. In general, a small tip, which loses heat rapidly when applied to the work, should idle at a proportionally higher temperature than a large tip, which has more mass and therefore greater heat-storage capacity.

Continuous vs intermittent soldering

On a factory production line, a technician performs the same soldering operations over and over again throughout a work shift. A production soldering tool must therefore be durable and capable of constant and reliable performance to assure uniformity of soldered joints. It must be as light and maneuverable as possible to permit rapid production with maximum operator comfort. Except for special applications with low-temperature limitations (such as printed-circuit work, which may require operations as low as 400°F), most production irons operate above 800°F to allow the soldering of as many as 50 joints per minute while still maintaining suitable working temperatures.

Usually production soldering doesn't require great tip versatility for a single work station. An integral tip-and-heater unit with iron-clad tip and heater rating to handle the size of the job may be selected and used continuously, without requiring a great deal of maintenance. The tip should have a high idling temperature and the tip mass and heater output should be designed so the tip will rapidly recover heat which is lost during each soldering operation.

Maintenance and service technicians, and others who troubleshoot and repair equipment, perform soldering intermittently or occasionally, as much of their time is taken up with reading voltages, removing screws and covers, etc. During these periods, the soldering tool lies idle. If an iron is used, it must not overheat during long idling times. Conversely, it must be able to successively solder several joints. An iron with interchangeable tips (or heaters and tips) is preferred for this type of service, so that a variety of jobs may be performed. Irons should operate in the range of 750–900°F.

Finally, file the tip chisel sides down to bare copper and retin with fresh solder.

If you run out of tips on a weekend when the stores are closed, use a piece of copper busbar. Cut and shape it, and clamp it in the gun. Then file the tip into something like a chisel. This emergency gimmick isn't as efficient as the regular tip, but it'll get you by in an emergency.

Basic iron

In Fig. 4, you see the basic soldering iron. Within the shank there is a resistance-wire heating element, through which the 117-volt ac passes. Heat is then transferred to the tip by conduction. Note that the tip is electrically isolated from, though thermally coupled to, the heating element and the ac line. Some irons don't have the heat baffle, which minimizes heat transfer from the tip back to the handle (and the user's hand).

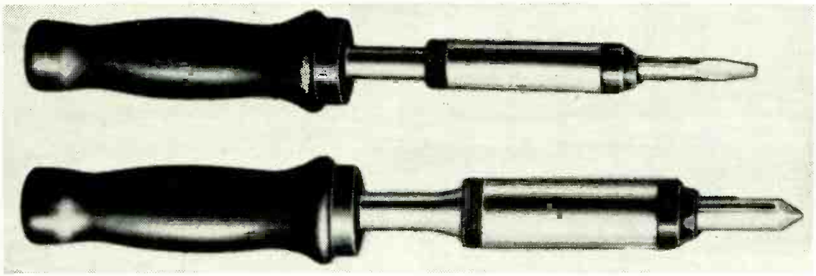


Fig. 4—Two basic soldering irons. The top unit is rated at about 150 watts. The larger unit is for heavy duty soldering and is rated at about 250 watts. Both irons are made by ESICO.

An iron requires several minutes to warm up to operating temperature, and must be placed on a stand or holder when not in use to keep the tip from burning or melting the work surface.

Soldering irons are generally available in sizes from about 60 to 500 watts, with at least one company making a 1250-watt size. The model shown in Fig. 4 is rated at 125–130 watts, which is about the most convenient size for general work. An iron is most useful where you are doing a lot of soldering continuously, as in construction and assembly. Unlike a gun, an iron is built for continuous service. You don't need as much wattage in an iron (compared to a transformer-type gun) because the tip has more mass and stores heat more readily than a gun's thin tip.

The size of an iron, its tip and its operating temperature are all related to the size of the work. After an iron has heated up and remained

Choosing the right size

For working with heavy sheet metal or large transformer cans, you need an extra large iron of 500 to 700 watts rating, with a tip from 1½ inches to 1 3/4 inches. For most production or assembly work, including heavy ground lugs, No. 12 or 14 wire and busbar, and light-gauge sheet metal, a large iron is best, with a rating of about 150–300 watts and a tip from 3/8 inch to 7/8 inch.

The medium-size iron, with a rating of about 50 to 150 watts, and a tip diameter of 3/16 inch to 1/4 inch, is useful for large PC boards, tube sockets and No. 20 or so wire.

When printed circuits and transistors became a significant factor in the electronics industry some years ago, it became obvious that you don't need 100 watts or so when soldering them. Very popular for such low-heat jobs is the soldering pencil shown in Fig. 5. Available sizes range from about 10 to 50 watts; tips are usually small, with widths from 1/32 inch to 3/16 inch. The pencil operates just as a standard-size iron.

Fig. 5—Two modern soldering pencils. These units are made in a variety of wattages and tip sizes. The units shown are the Oryx 115V on the left and the Wall 40-watt iron on the right.

Irons and pencils have removable, interchangeable tips, and there are two methods of connection. The pencil in Fig. 5 has a **plug tip** held in the shank by a setscrew. Note that the heating element is in the shank.

In Fig. 6 you see a pencil with a **screw-type** tip. Actually, the removable assembly consists of the tip and the ceramic-encased heating element. Thus when you change the tip you also change the size of the heating element. An integral tip-and-heater assembly is an advantage

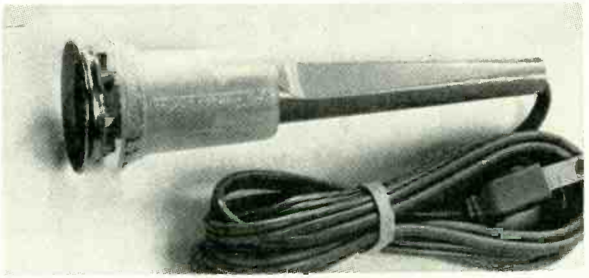


Fig. 6—This kind of pencil iron takes screw-in tips in a variety of wattages and sizes. The unit shown is an Ungar Model 777.

when making a joint near a heat sink, as the tip furnishes enough heat to overcome sink losses.

Some plug-type irons and pencils have removable heat cartridges, allowing you to pick a range of wattages with a single body.

You can get several types of tips for irons and pencils; the more popular shapes are shown in Fig. 7. Most useful seems the **chisel,** which

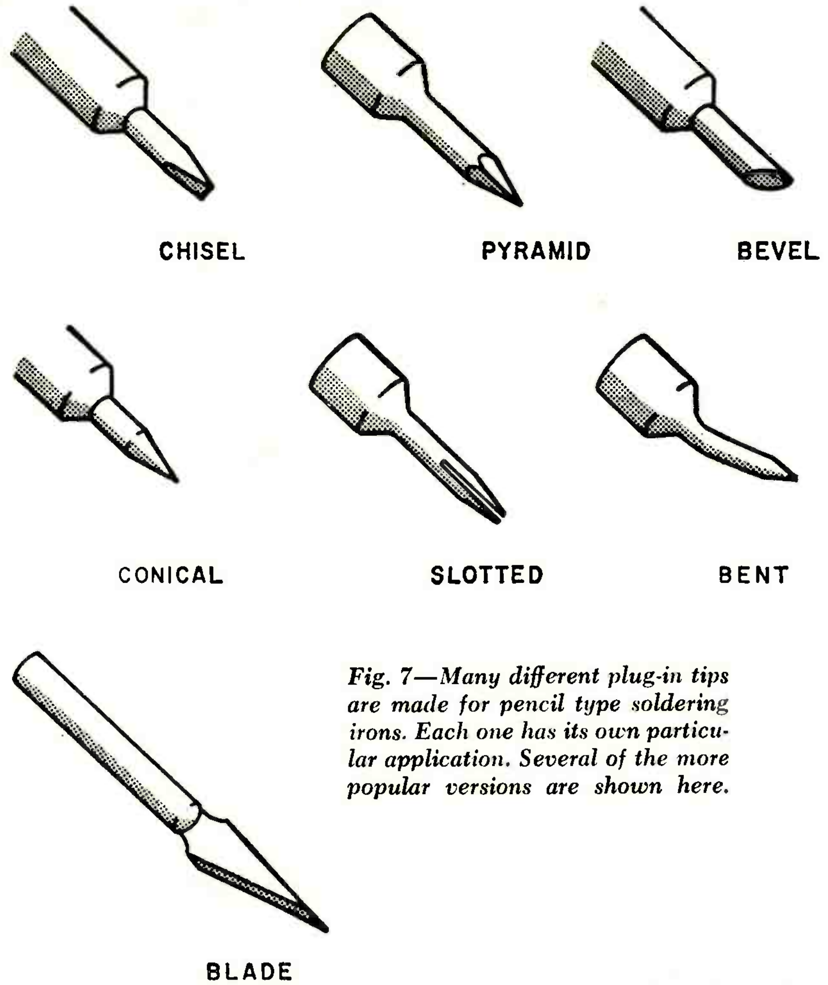


Fig. 7—Many different plug-in tips are made for pencil type soldering irons. Each one has its own particular application. Several of the more popular versions are shown here.

is usually standard. The **blade** is useful for heat-cutting through soft plastic.

gun-type iron. Some of these types have no trigger and run continuously; others have a trigger (and sometimes dual heat positions) and a quick-heating cartridge. Most have interchangeable tips.

Also called **offset** or **hatchet type,** an **angle iron** is useful where you have to work around a corner or in a chassis recess, and it can be held somewhat like a pistol. A sample is shown in Fig. 8; models are available in various sizes and heat ratings.

Fig. 8—Angle soldering irons are extremely handy in tight quarters. Some are made with extremely small diameter tips. The unit shown is made by Esico.

It is often useful in production and assembly to vary the tip temperature of an iron, depending on the size of the work. This is usually done with a variable transformer. Some models have a low-voltage secondary of 6, 12 or 24 volts. Others have a 117-volt ac receptacle for use with existing irons. A sample is shown in Fig. 9.

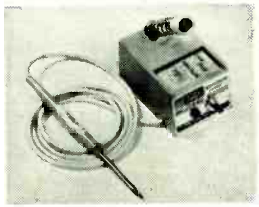


Fig. 9—Variable heat controls keep a soldering iron at a constant operating temperature so it is always ready to use. These units are particularly useful in production applications. Unit shown is made by Weller.

The variable-heat control idea has been carried a bit further in the automatic-temperature-control iron. In Weller's TCP soldering iron shaft is a temperature-sensing disc of nickel-iron alloy. A permanent magnet attached to a spring-loaded, normally off switch is attracted to the nickel-iron disc, because it is normally magnetic. Thus when the magnet is attracted to the disc, it pulls the switch on and closes the transformer secondary circuit, allowing current to flow through the heater.

However, ferromagnetic nickel-iron alloy has a curious property; it loses its magnetism when its temperature reaches what's known as the **Curie** point. When this happens, the permanent magnet is no longer attracted to the nickel-iron disc, and the switch snaps off, opening the secondary and stopping current flow through the heating element. When the tip cools down slightly, the disc temperature drops below the Curie point and the magnet is again attracted to it, closing the switch and applying current to the heating element once again.

Flat surfaces are easier to keep tinned and thus provide larger heat-transfer areas. To heat a large mass of metal, such as a chassis or shield can or a transmitter busbar, you need a large tip to provide broad working surfaces and high heat-storage capacity. On the other hand, for transistor, IC and printed-circuit work you need a small working surface. A tiny tip quickly gives up heat to the work, but regains heat fast.

Tip and heater sizes are generally proportional, because a larger tip requires more heat energy than a smaller one. A soldering iron with a separate, interchangeable tip requires more heat energy than an equivalent iron with the heater built into the tip.

The tips used with most irons and pencils today are made of copper and plated with iron or nickel. (Bare copper tips are occasionally used, but don't last as long as plated types.) Copper is used as the base metal because it is an excellent heat conductor and reaches and maintains temperature well. Unfortunately surface oxidation pits the copper and forms scale, gradually eating away the tip. Also, the solvent action of solder dissolves and carries away the copper. Plating generally prevents these undesirable actions. A plated tip often lasts 100 times as long as a bare copper type.

Maintenance of iron and pencil tips

When a bare-copper tip becomes pitted, it must be filed down to shiny metal. Don't file a plated tip, however; you'll remove the plating. Use a wire brush or sandpaper sparingly.

When an iron is idle for some time, it should be covered by an excess of solder. Before using it, wipe the tip on a moist sponge to remove the excess solder and burned flux, but leave a protective film of solder on the working surface. When the tip no longer stays tinned and solder won't flow readily on the surface, retin it as follows:

Heat the iron (or pencil) and wipe off as much solder as you can while the tip cools. When it's cold, clean the tip with a wire brush. Then reheat the iron and flow solder on the tip.

To prevent frozen tips, remove the tip now and then when the iron is cold. If the threads of a screw-type tip become corroded, wire-brush them clean.

The straight handle of an iron or pencil sometimes becomes uncomfortable when used for long periods. One solution is the **pistol-** or

The temperature of the tip is thus held fairly close to whatever temperature is determined by the particular alloy used in the disc. Several standard temperatures are available between 500° and 700°F.

A somewhat similar job is done by Wall's Model IDL DH (Duo Heat) soldering pencil. When the handle switch is depressed, the tip draws 180 watts to heat up fast. When the tip reaches operating temperature, a relay drops the pencil back to 40 watts. If the load drops the tip temperature too much, the relay cuts in the higher-wattage element.

Desoldering tools

One big problem in service work is undoing a solder job when you have to disconnect a component or lead. Since many transistors and IC's are soldered in the circuit, this can be a sticky process. One useful method is the **vacuum-type desoldering iron** shown in Fig. 10. You squeeze

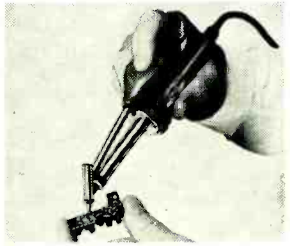


Fig. 10—Desoldering printed circuit connections is greatly simplified by using a vacuum-type desoldering iron. The Endeco model 300 is shown here.

the rubber bulb and apply the tip to the solder joint. When you see the solder go liquid, you release the bulb and the solder is sucked up.

The bulb and tip are available as accessories from Thermal for Ungar and Esico pencils. In addition, some manufacturers provide a separate rubber or Teflon bulb you can use with an ordinary iron or gun.

It can be difficult to simultaneously desolder a multiple pins of an IC connected to a PC board, and similar multi-connection components. A variety of desoldering tips is available and some are shown in Fig. 11.

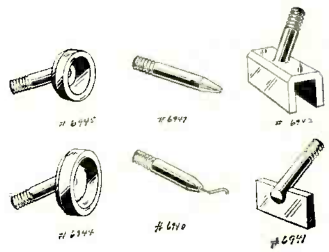


Fig. 11—This variety of desoldering tips is specially made for removing components from printed circuit boards. They are by Ungar.

(TO BE CONTINUED)

Remote speakers for car stereo

Simple switch or plug patch adds stereo extension speakers to your car tape deck

by **HOMER L. DAVIDSON**

HOW ABOUT ADDING TWO EXTRA stereo speakers to that auto tape deck you use on your outings? You can do it in one hour, and be ready to roll for the next picnic. Don't like picnics? Well, how about a teen-age dance on the terrace or in the backyard? Or a quick run to the beach.

Simple? You betcha—just cut into the stereo speaker wire going to the inside stereo speakers. Add three polarized plugs and you're in business (Fig. 1). Take the two stereo leads coming from the stereo tape deck. Connect a male polarized Jones plug to the left-hand right-channel stereo leads. Now ground the polarized spade terminal. This is the one turned sideways. Okay—the stereo tape deck leads are ready to use.

Now quickly wire those two female sockets. Take the other two speaker leads that you cut off and solder to another female socket (Fig. 2). Remember to wire the ground or common speaker wire to the polarized terminal. Now the two inside stereo speakers are ready to go.

Wire a 25-foot three-wire cable to another three-prong polarized plug. Solder up just as you did the inside stereo speaker plug. Connect, to the outside end of the cable, two outside PM speakers. These two separate speakers should be housed in metal or plastic baffles.

Make sure the impedances of the outside speakers match those of the auto tape deck. Generally, impedance is 8, 10 or 16 ohms. Two, 6- x 9-inch heavy-duty PM speakers will blast.

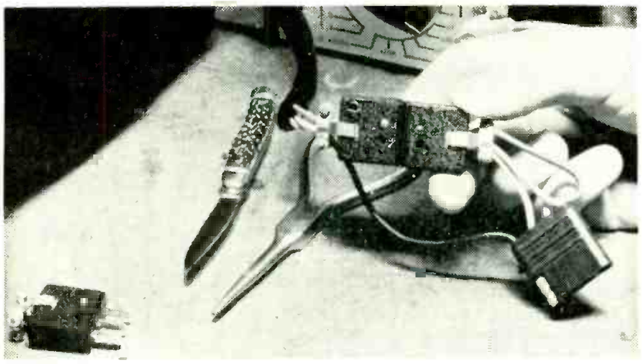
Don't remove the tape deck from the auto if you can reach the stereo speaker cable. Pull the cable down and unplug it from the two inside stereo speakers (Fig. 3). Cut the cable just ahead of the speaker cable connector.

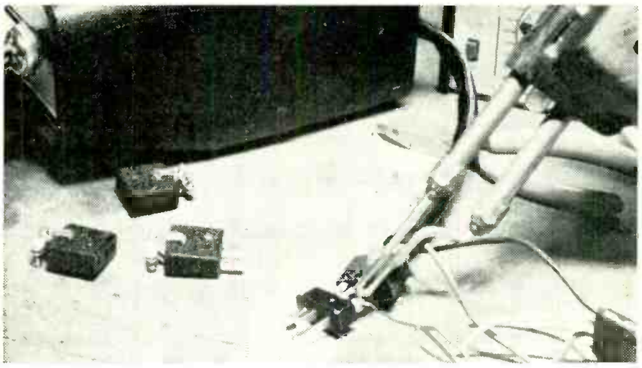
To use the outside speakers, plug the outside female lead into the male socket from the tape deck. Change to the inside stereo speakers by interchanging the speaker cable socket.

You may want to make a more permanent installation in which you need only flip a switch. Now, let's take a look at Fig. 4 and see how it's done. Pick up a stereo phono jack and a dpdt speaker switch.

Take the two leads coming from the stereo tape deck and solder to the two center terminals on the dpdt switch. Now solder the two stereo leads from the outside stereo jack to the inside speaker wires. Ground the common wire to both left and right channnels. Hook up the outside speakers to the stereo male plug and wire up the inside speaker wires.

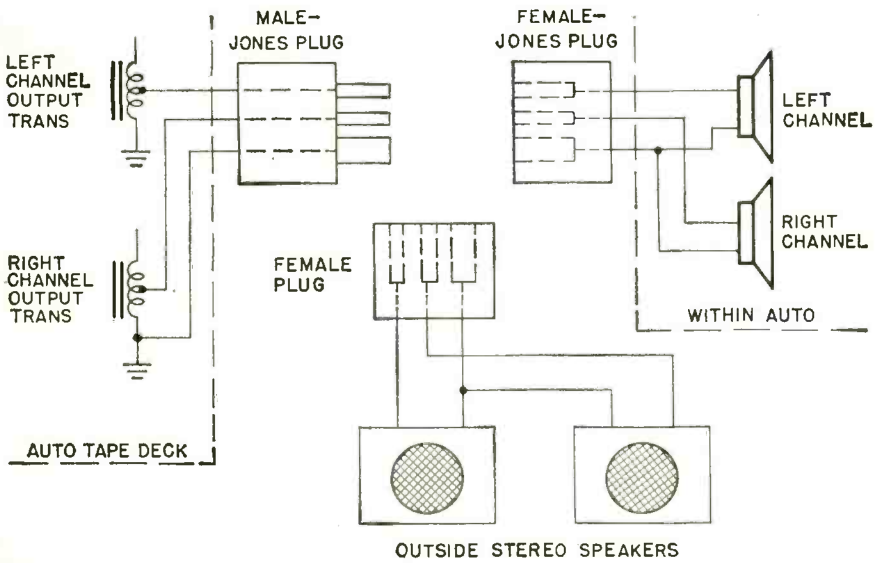
Just plug the outside stereo speakers into the stereo jack. Sit back, and flip that switch to either outside or inside speakers for your favorite recordings. **R-E**

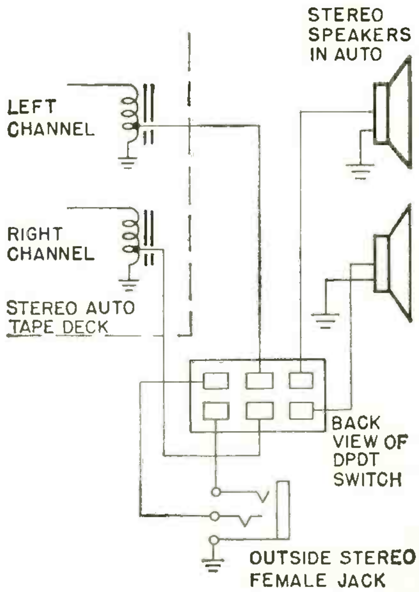


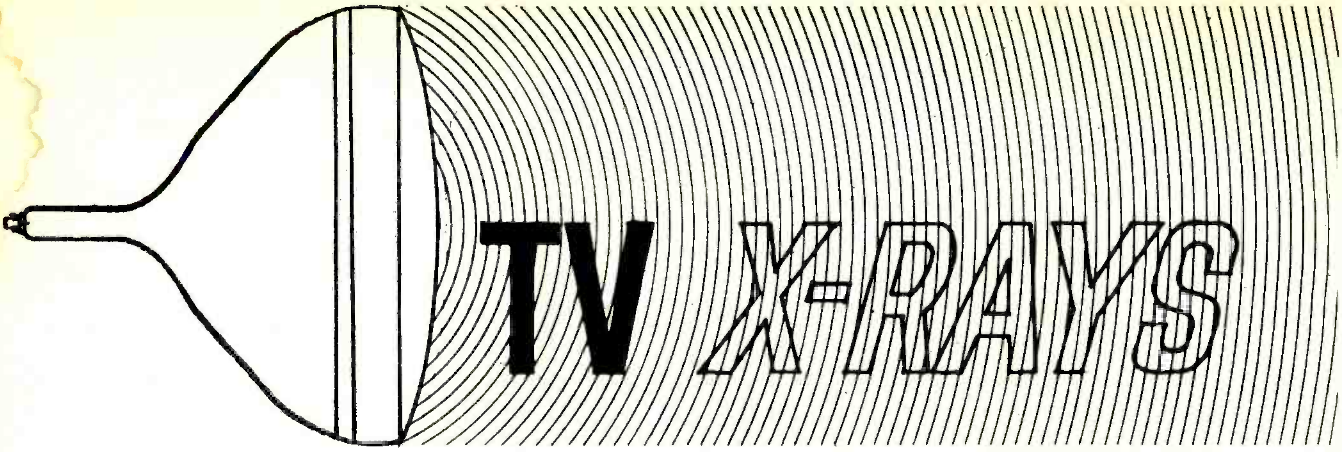


Figs. 1–2—Photos of plugs used to extend tape-deck speakers outside car.

Below (left) is Fig. 3 showing plug extension; Fig. 4 shows a switching setup.







TV X-RAYS

Where They Come From • What They Do
What You Can Do About Them

by DON WARD*

BECAUSE OF THE PUBLICITY GIVEN TO X-radiation from color television, the service technician must be familiar with the problem.

To protect the public from exposure to dangerous X-ray levels, Congress has charged the Department of Health, Education, and Welfare (HEW) with the task of formulating regulations influenced by the recommendations of the National Committee in Radiological Protection. For color television receivers, the recommended limit of permissible radiation is 0.5 milliRoentgens (mR) per hour, when integrated over an area of 10 square centimeters and when measured at a distance of 5 centimeters from any portion of the television receiver cabinet.

Before discussing the possible dangers, remember that it is almost the unanimous opinion of the various investigating committees, that there is no dangerous radiation from any current model receiver when it is correctly adjusted, in good operating condition, and operating on a normal voltage power line.

Many scientists share the view expressed by S. P. Wang of the Rauland Corporation. He states:

"The radiation level from assembled receivers has been measured both under normal and abnormal operating conditions. Results obtained at a realistic viewing distance of six feet indicates that even under abnormal operating conditions, the exposure dose rate level is close to the background level due to the natural environmental radiation."

It appears that the exposure dose-rate from a typical 23-inch color TV tube at a distance of 2 feet will be about ten times the rate measured at 6 feet, and that the dose-rate at 1 foot will be doubled again.

When you recall little children with their noses practically glued to the face of the picture tube, the 6-foot rule suddenly becomes impracticable. The receiver must be completely safe under all conditions.

X-rays are electromagnetic energy, differing from other forms of electromagnetic energy mainly in frequency or wavelength.

All X-rays are characterized by their ability to ionize air or other gases and tissues. This is the characteristic that makes them dangerous to humans. Radio waves are measured in meters or centimeters of wavelength, while the light wavelengths are more conveniently measured in angstroms. But the wavelength or frequency of X-rays is more conveniently designated in terms of "electron volts."

Radiation dose is measured in terms of "Roentgens." A Roentgen produces a specific amount of ionization in a certain volume of air under standard conditions. The dose-rate of radiation is, therefore, indicated in Roentgens per minute or hour.

Mr. George McCall of the Pinellas County, Florida, Health Department states that X-radiation from the face of the picture tube increases with increasing high voltage. Measurements taken by Mr. S. P. Wang suggest that the dose rate from a 23-inch color picture tube operating at 26 kV is approximately 2½ times its dose-rate when operated at 25 kV. A further increase of 2½ times can be expected at 27 kV.

How are X-rays produced?

Energy is proportional to the product of mass times the square of velocity. When an electron leaves the gun of the cathode ray tube, it is accelerated to a very high velocity by the ultor voltage (25 kV) and has greatly increased energy. When it strikes the face of the picture tube, its velocity is reduced to zero and, therefore, it must give up its energy. Part of that energy is converted to visible light by the phosphors illuminating the raster. Another small part is converted to heat which is absorbed by the glass, while most of the remaining energy is converted into X-rays. Obviously, the quantity of X-radiation should be directly proportional to the magnitude of the beam current and the value of the accelerating potential; and you might expect the greatest X-radiation when there is a full white raster on the face of the crt. Later we shall see that this is not quite true. About 80% of the electrons entering the electron beam never reach the phosphors, but strike the shadow mask, where their energy is converted into heat energy and X-radiation.

As previously indicated, X-radiation is proportional to both the magnitude of the beam current and the value of the accelerating potential. This high voltage is obtained from the flyback transformer and high-voltage rectifier. This system has a dynamic resistance which may have a value ranging from 13 megohms in some of the early color receivers to less than 8 megohms in more recent designs.

This means that as beam current varies with changes in picture brightness, accelerating voltage also varies. As beam current increases with increasing picture brightness, tending to increase radiation, ultor voltage decreases, tending to reduce radiation. Tests indicate that radiation from the face and shadow mask is at a maximum with an average picture brightness of a light gray value.

There are two distinct philos-

*Victoreen Instrument Division

ophies used in high-voltage power supply design. One states that as long as a correct ratio is maintained between accelerating voltage and focus voltage, both values may rise and fall with variations in beam current without seriously damaging picture quality. Such receivers have no high voltage regulation.

Another group of designers believes that better focus and convergence, better color purity, as well as better control of X-radiation will result if the high-voltage supply is well regulated. The most popular method of regulation uses a simple shunt regulator across the 25-kV supply. This introduces another source of X-radiation. Electrons striking the plate of the regulator tube at 25 kV must give up their energy at the plate in the form of heat and X-radiation.

Another regulator type uses a vacuum tube across some low section of the flyback transformer. This tube is biased to cutoff during the trace portion of the cycle, but is gated into conduction during the retrace by a pulse from the damper. This provides a variable load on the flyback that is proportional to the damper pulse. Regulating at low voltage levels greatly reduces the possibility of the regulator generating X-rays.

Another source of radiation is the high-voltage rectifier. At first thought, this would seem impossible, since the forward voltage drop across the rectifier is only a few hundred volts. But experiments show that the rectifier tube can be a very potent source of radiation. Electrons comprising the space charge in the rectifier tube are returned to its cathode during the non-conducting portion of the cycle, being accelerated by 25 kV plus the peak value of the negative portion of the ac cycle in the flyback transformer. If the rectifier tube is slightly gassy, the action is greatly increased. Therefore, there are three sources of X-radiation in the modern color TV receiver. They are (1) the picture tube, (2) the regulator tube, and (3) the high-voltage rectifier tube.

How does the manufacturer protect against radiation?

Modern picture tubes use a heavy lead-glass face plate that absorbs X-radiation whose energy level is 25 keV or less. But the radiation increases at a very alarming rate when the voltage exceeds 25 kV. As long as the high-voltage regulator is correctly adjusted and in good operating condition, and as long as the powerline voltage is normal, there is no danger of excessive radiation from the picture-tube face. [For detailed data on individual manufacturers precautions see "Looking Ahead," RADIO-ELECTRONICS, January 1970, page 2.]

Radiation from the rectifier and the high-voltage regulator can be safely held within the confines of a well-designed high-voltage cage.

What then, if any, are the dangers of exposure to X-radiation by the viewer? How can the technician safeguard his customer?

First, encourage the set owner to observe the 6-foot viewing distance whenever practicable.

Check the power line voltage. Radiation increases when the receiver is operated on high line voltage. The high-voltage power supply increases about 300 volts with each 1-volt increase in line voltage. Thus, an increase of a little more than 3-volts in line voltage can produce a 1000-volt increase in high voltage along with the accompanying increase in radiation emitted.

Check the adjustment of the 25 kV setting. Remember, the most likely cause of excessive X-radiation is abnormally high voltage. Tests indicate that radiation from the picture tube face is greatly multiplied by each 1000 volts above 25 kV. The Pinellas County (Florida) Health Department reports that of 149 color television receivers surveyed at owners' requests, 23 sets were emitting excessive radiation. Nineteen of these cases resulted from excessive high voltage. Replace all "weak" high-voltage rectifier tubes and regulator tubes, since gas and/or poorly aligned electrodes in the rectifier greatly increase radiation from the rectifier, and since reduced emission and/or transconductance of the high-voltage regulator increases radiation from both the regulator and the picture tube.

Check all components of the metal high-voltage cage. This cage not only protects against accidental shock hazard, but shields X-radiation eminating from the regulator and rectifier.

Surveys conducted by several interested agencies have found hundreds of receivers emitting radiation in excess of the established "safe" limits. In almost all cases, the situation could be corrected by restoring the receiver to its original condition with the replacement of substandard tubes and components and the correct adjustment of high-voltage controls. While there is little difficulty in guaranteeing that the receiver leaves the factory in "safe" operating condition, there is at present no method of insuring that this condition will be maintained in the owner's home during the set's useful life.

Manufacturers are, therefore, turning their attention to the development of "fail-safe" circuits (see "Add Anti-X-Ray Circuit to Your Color Set," RADIO-ELECTRONICS, January, 1970). The most promising approach to this goal seems to involve the use of solid-state horizontal amplifier circuits feeding a much lower voltage flyback transformer, which in turn is followed by a solid-state voltage multiplier type of high-voltage rectifier to produce the necessary 25 kV. This is regulated by a gaseous cold-cathode high-voltage shunt regulator incapable of generating X-rays. Solid-state amplifiers, rectifiers, and dampers cannot generate X-rays.

One such diode regulator was developed in 1948 by Victoreen. It has been successfully used in many military and scientific applications to control high voltage at low current. These applications include radar display circuits, geiger tube circuits, photomultiplier applications, low-power klystron and traveling-wave tube circuits as well as many others for simple but precise control of high voltage. The diode was used by three manufacturers of early color television receivers, but cost prohibited its consideration when the market became highly competitive. Recent design improvements, which adapt the diode to the demands of the flyback power supply, along with improved and expanded production facilities, promise to reduce diode prices to a level that could be economical in the home entertainment field.

The performance of a solid-state diode high-voltage regulator is almost identical with that of a Zener diode operating at much lower voltages. Its operating voltage is almost entirely controlled by its gas pressure. It has no filament or heater to be affected by changes of line voltage or deterioration with age. Its operation is not affected by changes of cathode material work function. **Any conceivable failure mode results in a lowered operating voltage.** Even if the metal envelope of the diode were punctured, allowing its gas content to escape and be replaced with air, it would continue to regulate, but at a greatly reduced voltage (about 14 kV). Therefore, since the proposed TV receiver has but one component that can generate X-rays (the picture tube), and since it is completely "safe" when operated at 25 kV or less, and since the Victoreen diode completely guarantees that the voltage will remain at 25 kV (or below in case of failure), the new design is completely "safe" for its entire life and cannot produce dangerous radiation even when controls are misadjusted.

It seems likely that the industry

will adopt this circuit philosophy, and that retrofit kits will be made available so that the service technician can modify existing older receivers, making them completely "radiation proof."

Can technicians check for X-rays?

The price of survey instruments with accuracies of plus or minus 10% and registering in units of milli-Roentgens per hour as required by Federal regulations, ranges from $800 to $1000. Their use is, therefore, restricted to organizations which find that price justifiable.

Radiation is produced when electrons at high velocity strike a target and give up their energy as X-rays. It follows that the energy or wavelength and frequency of the resulting X-rays are determined by the voltage that accelerated the electron. The resulting rays are then measured in terms of "electron volts." This unit is the energy required to move an electron through a potential of 1 volt. Thus, the primary radiation generated in the TV receiver has energy values peaking around 25,000 electron volts (25 keV). Unfortunately, our situation is not quite as simple as it might at first appear. When X-rays penetrate a material, some of their energy is absorbed by that material, and the emerging rays are of a lower energy level. At the surface of the material being penetrated by the radiation, an interesting situation occurs. Regardless of the energy level of the X-rays entering a material, much of the emerging energy peaks around a discrete energy value that is characteristic of the particular absorbing material. Thus, X-rays generated in a tube at 25 keV, and penetrating a lead-glass envelope emerge having a spectral content from 25 keV and below but peaking at 25 keV and 12 keV. The latter is known as the characteristic "lead line." Experiments by several independent investigators indicate that the spectral response illustrated by Fig. 1 is typical of the radiation from most types of color TV receivers. Note the difference between the content of the energy from the picture-tube face and that from the rectifier and regulator.

Since the danger of radiation comes from its ability to ionize air or tissue, the energy distribution of a particular flux becomes important. The most direct and accurate means of measuring the ionizing ability of any particular flux of radiation would be to measure the current flowing from a calibrated ion chamber located in that radiation beam. Unfortunately, this requires the accurate measurement of currents as low as one millionth of a microampere. Obviously, this type of instrument is both delicate and expensive.

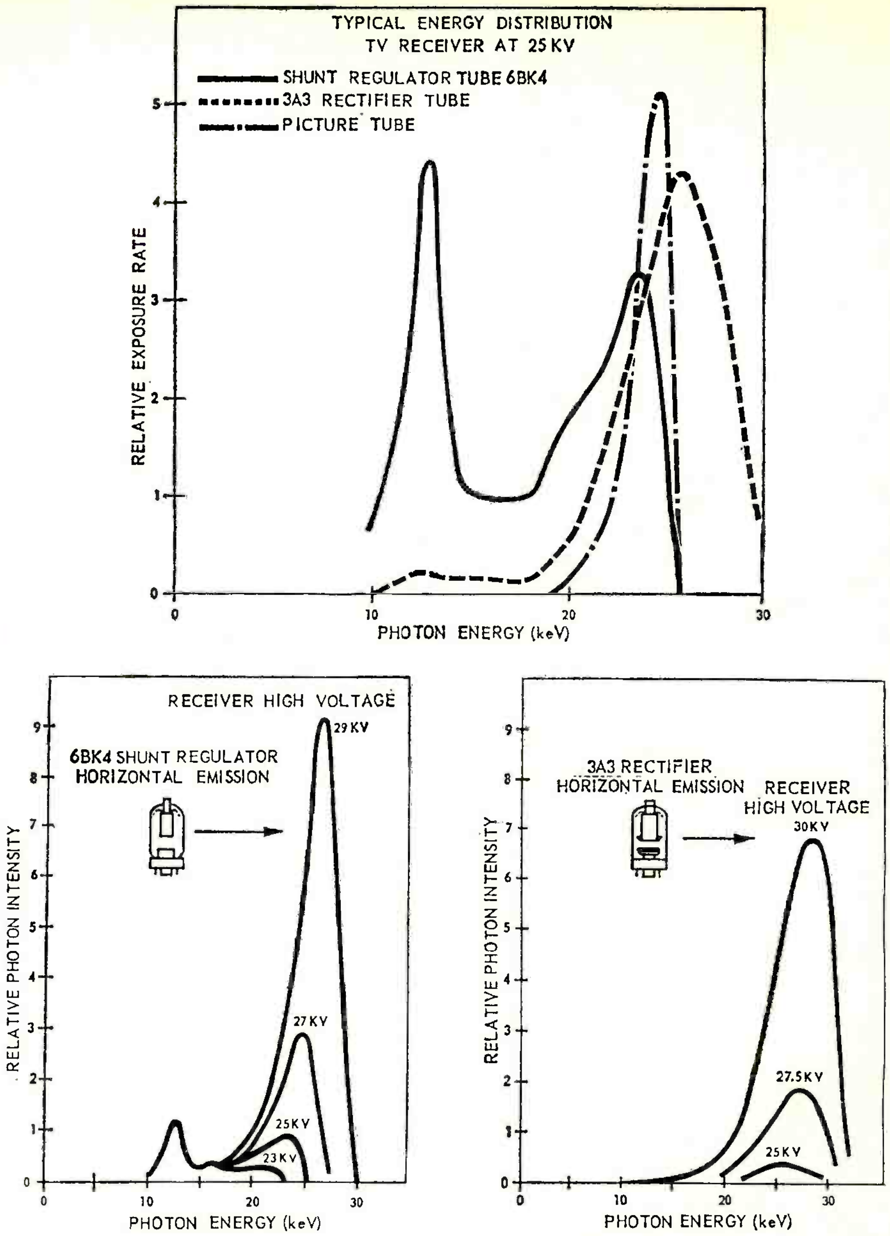


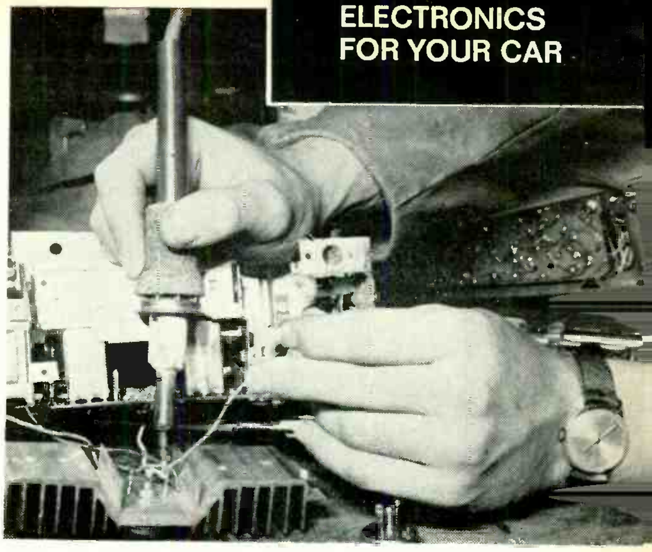
Fig. 1—Top graph shows varying X-ray energy levels from various set parts. Lower graphs show relative X-ray (photon) emission from specific tube types.

Due to the action known as "gas multiplication," the pulses of current from each ionizing event intercepted by a Geiger tube are increased to such a magnitude that no delicate and sensitive amplifier is necessary to record them. However, the Geiger counter records "counts" or ionizing events per minute, and is not a measure of energy or "dose rate" or Roentgens per unit of time. Since all pulses or "counts" are of equal magnitude regardless of the energy of the original photon which initiates the pulse, "counts per minute" can be translated into "milliRoentgens per hour" only at any one discreet energy level of radiation, and such translation is, therefore, not valid where the flux has a wide spectral energy distribution. In addition, the energy response curve of any Geiger-Mueller (GM) tube is extremely nonlinear.

However, let one assume that the spectral distribution curves of Fig. 1 are typical. Then a survey instrument using a GM tube of known energy response and calibrated in the actual flux from a TV receiver so adjusted to produce considerable X-rays might be developed. Using an ion chamber instrument as a calibrating standard could result in accuracy, simplicity, and price compatible with the needs of the typical television technician. Such an instrument would require one acceptable limit for readings from the face of the picture tube and another when readings are taken from the rectifier and regulator. It is hoped that such instruments will be available in the near future. **R-E**

10 SOLID-STATE CAR RADIO PROBLEMS

Automobile radios take a lot of pounding on the road. Tracking down intermittents and tough dogs can be easier when you know what clues to look for



Replacing power output transistors on their heat sinks is often called for.

by HOMER L. DAVIDSON

SOLID-STATE AUTO RADIOS ARE EASY to repair and a good chunk of profit can be made. Most auto radio problems can be serviced with a vtvm or FET vom, an rf or noise signal generator, and a transistor tester. A bench set up consists of a power supply, antenna, and test speaker.

Usually the solid-state auto radio must be pulled, repaired, and re-installed. Occasionally, the radio is dropped off at the shop for service. The average auto radio repair cost varies between $7.50 and $20.00.

Now let's examine some case histories and see how easily solid-state auto radios can be repaired.

1—Intermittent Delco

When a Pontiac model 7289752 came in for service, the radio was dead. But, when the radio was connected to the service set up, it appeared to be intermittent. With the radio dead, an audio signal was applied to the center-terminal of the volume control; audio was normal. When the noise-generator probe was touched to the second i.f. transistor base terminal the radio "popped" on. Again, the radio operated for just a few minutes.

The "A" supply voltage was lowered to 9 volts with the ac universal line power transformer connected ahead of the bench power supply. With the radio operating, cold spray was applied to the second i.f. transistor. After several applications the radio became intermittent.

Then by raising the radio supply voltage to twelve volts the auto radio began to operate. Each time the supply voltage was lowered to 9 volts and the suspected i.f. transistor sprayed with cold mist, the radio would go dead. The second i.f. transistor was replaced with a universal transistor.

After replacing the transistor, a loud local broadcast station became distorted. Most overload distortion in the solid-state auto receiver is caused by a defective avc limiter diode. The open avc diode was replaced with a 1N64 type.

2—Motorboating Ford

No doubt about it, this Ford model 4TBO had a put-put sound. Generally, motorboating is caused by improper filtering, a defective audio output transistor, or bad base circuit.

In locating the filter sections, I found a plastic filter capacitor that had the top section blown off. The filter section contained a 500-μF and a 50 μF capacitor rated at 3 volts. When a 500-μF filter capacitor was shunted across the defective unit the motorboating ceased. Since the exact filter replacement was not available, single 500-μF and 50-μF 15-volt electrolytics were installed (Fig. 1).

3—Tough dog intermittent

This problem was in a Ford model 8 TMF solid-state radio. The radio would operate for at least four hours before cutting out. At first, the intermittent was thought to be a loose antenna cable within the auto. Often, a loose or broken antenna or speaker cable will produce intermittents.

The radio would only quit for a minute and then operate normally for several hours more. To make the intermittent reappear, the "A" supply voltage was turned down to 9 volts. It is best to try and isolate the intermittent to either the audio or rf-i.f. section. When the radio is only off for a short period of time, start spraying each audio transistor and work towards the front of the receiver.

Each transistor should be sprayed four or five times in separate one minute intervals. This will let the transistor warm up some and then another application of cold spray can be applied. Usually, lowering the supply voltage and applying cold spray will make the intermittent transistor act up. But, it didn't work this time.

In many tough dog cases an intermittent radio may operate for long periods of time without acting up. Such a radio must be forced into its intermittent condition. By applying heat to each element wire, close to the transistor body, sometimes the suspected transistor will act up. Sometimes it is impossible to get close to the transistor elements without melting down some components. In these cases apply the soldering iron tip close to the body of the suspect transistor. After the heat has been applied,

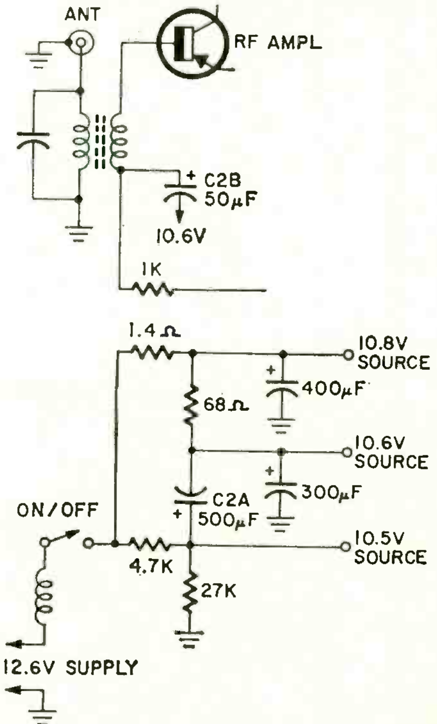
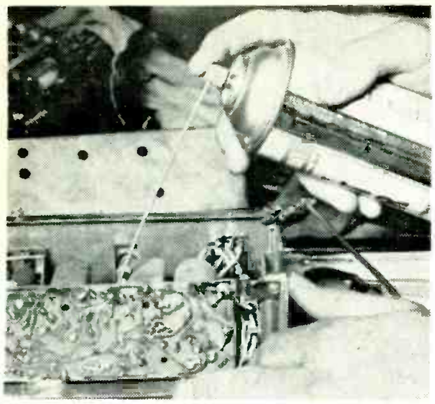


Fig. 1—Faulty filter capacitor (C2) caused motorboating in this Ford radio.



Intermittent transistors can be located by repeated spraying with a cold mist.

quickly spray the transistor with cold spray. Between extreme heat and cold applications the intermittent transistor will break down.

The defective part here was a 829E rf transistor. When removed from the circuit board and tested in a beta transistor tester, the intermittent transistor appeared normal. Even applying several coats of cold spray with the transistor connected to the transistor tester it would not indicate a defective condition. With the supply voltage lowered to 9 volts and after playing for two days the intermittent tough dog was reinstalled.

4—No-nothing Motorola

When a Motorola model TM 327 came into the shop, it was dead—no hum, audio, or anything. Even operating the on/off switch did not produce a flick in the speaker. This dead condition had to be an open power output transistor. The power transistor was removed and tested good.

After the power transistor was reinstalled, voltage measurements were made with a FET-vom. Voltages at all the power output and af amplifier transistors were way off (Fig. 2). Since the second af amplifier transistor was direct driven, it was removed from the circuit board and tested in a beta transistor tester. The 54C af amplifier was open. Before replacing the open transistor, the first af amplifier, a 54D, was checked in circuit and was also open. Was it possible to have two separate driving transistors open? Yep! Both transistors were replaced with a universal RCA SK-3020.

Again, power was applied to the radio and no stations could be received. The audio section appeared normal when an audio signal generator was connected to the volume control. When the noise signal generator tip was applied to the second i.f. transistor collector terminal, the signal was weak. A quick continuity check of the af detector showed that the diode was open.

After replacing the af detector, a signal could be traced to the converter base terminal. Only one local station could be tuned in at this point. Was it possible that another transistor was defective?

The 829A rf transistor was tested with the in-circuit beta transistor tester and was open. A high-leakage test of the rf-i.f. transistors indicated they were normal. In this particular auto radio, three transistors and a detector diode were open. Possibly high supply voltage or wrong battery polarity damaged the units simultaneously.

5—Dead Automatic

An Automatic model DX-4101 was dead. When a noise generator signal was applied to the volume control, the audio section was normal. But when the signal was applied to the first i.f. base terminal no sound could be heard. A signal was found on the collector terminal.

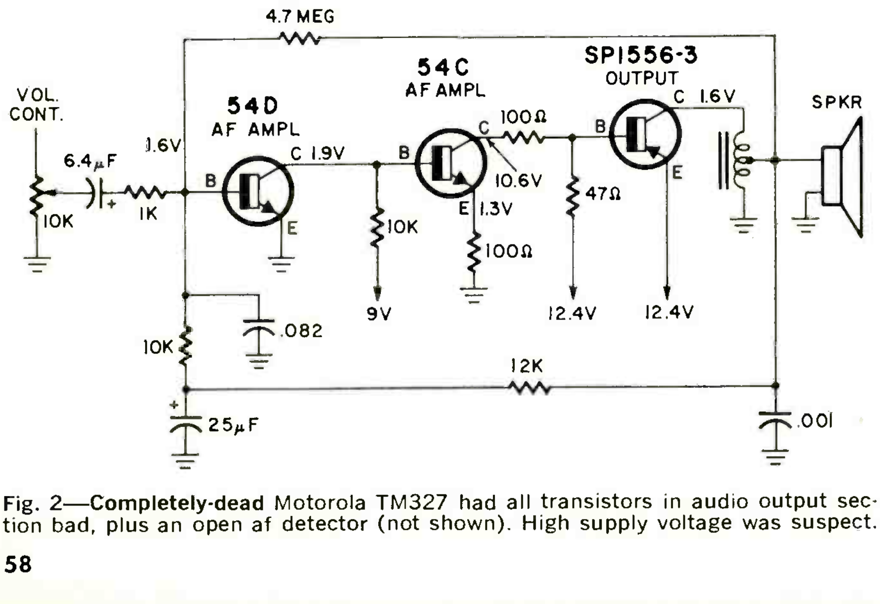
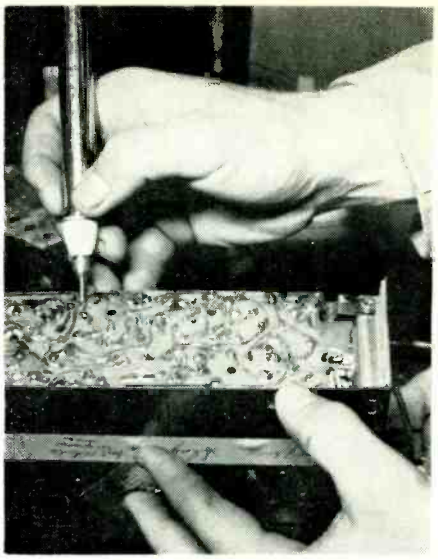


Fig. 2—**Completely-dead** Motorola TM327 had all transistors in audio output section bad, plus an open af detector (not shown). High supply voltage was suspect.



Pocket noise generator is handy for spotting bad stages in widely used PC boards

With an in-circuit beta transistor test, the first i.f. transistor appeared open. It is best to remove the suspected transistor and test it out of the circuit. Also, always test the new transistor before installing it.

After replacing the i.f. transistor, a loud rushing noise was heard, indicating a defective converter section. The in-circuit beta transistor tester showed the oscillator was open.

When replacing rf, i.f. and converter transistors a touch up of receiver alignment may be necessary. Also, it is possible to have more than one transistor defective in a solid-state auto radio chassis. Always record the various transistor replacements on the schematic diagram. These same defective transistors will crop up in other sets of the same chassis.

6—Intermittent i.f.

A Ford model 8TBLT came into the shop with intermittent reception. The intermittent would appear as a low distorted signal. In addition, when a local broadcast station was tuned in, reception was real mushy and distorted. An audio signal generator was used to check for distortion in the audio circuits. Many times a leaky output transistor, burned bias resistors, or an open avc diode will cause distortion.

The audio section was normal and the avc diode had continuity. Undoubtedly, the intermittent and distortion were produced by some common component. When the intermittent condition acted up, the low signal was traced to the second i.f. circuit. The second i.f. transistor and all voltage measurements were normal. When the second i.f. transformer was moved, the intermittent acted up.

Using an FET-vom we checked

the resistance of the second i.f. transformer. Many times, only the actual working windings of the i.f. transformers are checked for continuity and the unconnected terminals are not measured. In this case, the coil winding of the secondary had a poor connection where it was tied to the small capacitor across the winding (Fig. 3).

Most defective i.f. transformers, such as this one, can be removed from the circuit board and repaired. Use a suction-bulb type soldering iron to release the transformer terminals from the circuit board. On large transformer terminals use a large soldering iron to remove the molten solder. Wiggle and rock the i.f. transformer as heat is applied to the terminal pins. Be careful not to "pop off" circuit board wiring or break off a small terminal pin.

After the defective i.f. transformer was disassembled, two terminals were found unsoldered.

7—Bumpy Ford

In a Ford model 6TPO the music would come and go when the auto hit a bump. Naturally, the radio played normally when connected at the service bench. Most intermittent bumpy conditions are caused by a defective circuit board, intermittent i.f. transformers, or broken connections.

This intermittent was traced to the audio portion of the auto receiver. By prodding and pushing on the audio circuit board the intermittent was traced to the volume control board (Fig. 4). The whole volume control board was resoldered.

8—Dead-dog Rambler

A Rambler model 5BA came into the shop completely dead. The audio portion checked good. When the rf generator probe was placed on the first i.f. transistor base terminal the signal was normal. The trouble was either the set's convertor or rf stage. While attempting to connect the signal generator to the convertor base terminal, a .01 μF-capacitor lead to ground was found broken off (Fig. 5).

The same .01-μF capacitor has been found broken loose in several other solid-state auto radios. Do not overlook them for possible dead radio troubles.

9—Mushy and distorted

A distorted Ford radio model 8TBTLM was brought into the shop. Local broadcast stations were real mushy. At times, the radio appeared intermittent. When the volume became low excessive distortion was present.

While moving the wires going to

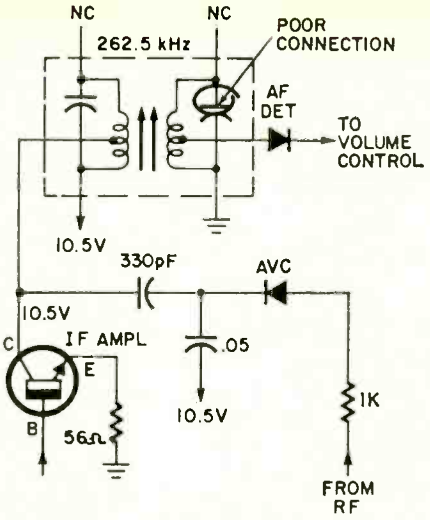


Fig. 3—Intermittent i.f. was traced to unsoldered terminals on i.f. transformer.

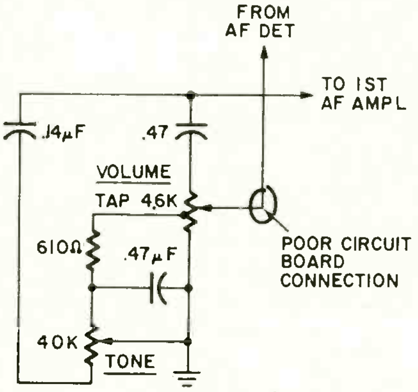
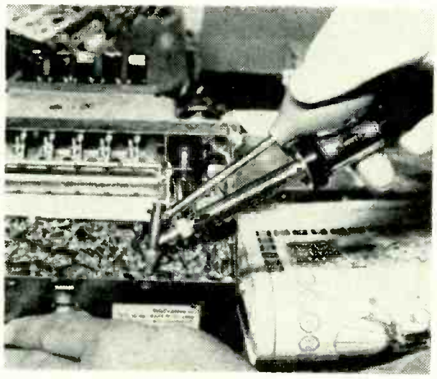


Fig. 4—Audio section of Ford 6TPO failed due to connection at volume control.



Suction-type soldering iron greatly simplifies task of removing PC-board parts.

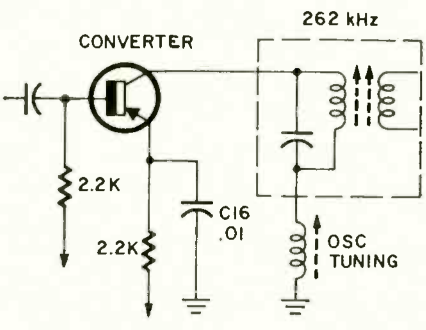


Fig. 5—Bypass capacitor C16 had broken loose, and radio came into shop dead.

the plastic-covered output transistor, the radio began to act up. In this particular output transistor the connecting wires are soldered into the transistor shell. The plastic case must be removed to see the open-face-type output transistor.

Voltage measurements were made at power transistor leads when distortion was present. The collector voltage had increased to 12.6 volts, base to 9 volts and the emitter voltage was at zero. When radio oper-

High leakage in power output transistors is spotted quickly on this beta tester.

ation was normal, the collector voltage was 10, base measured 10, and the emitter voltage was 1 volt. Always replace this special-type transistor with the manufacturer's replacement.

10—Very low hum

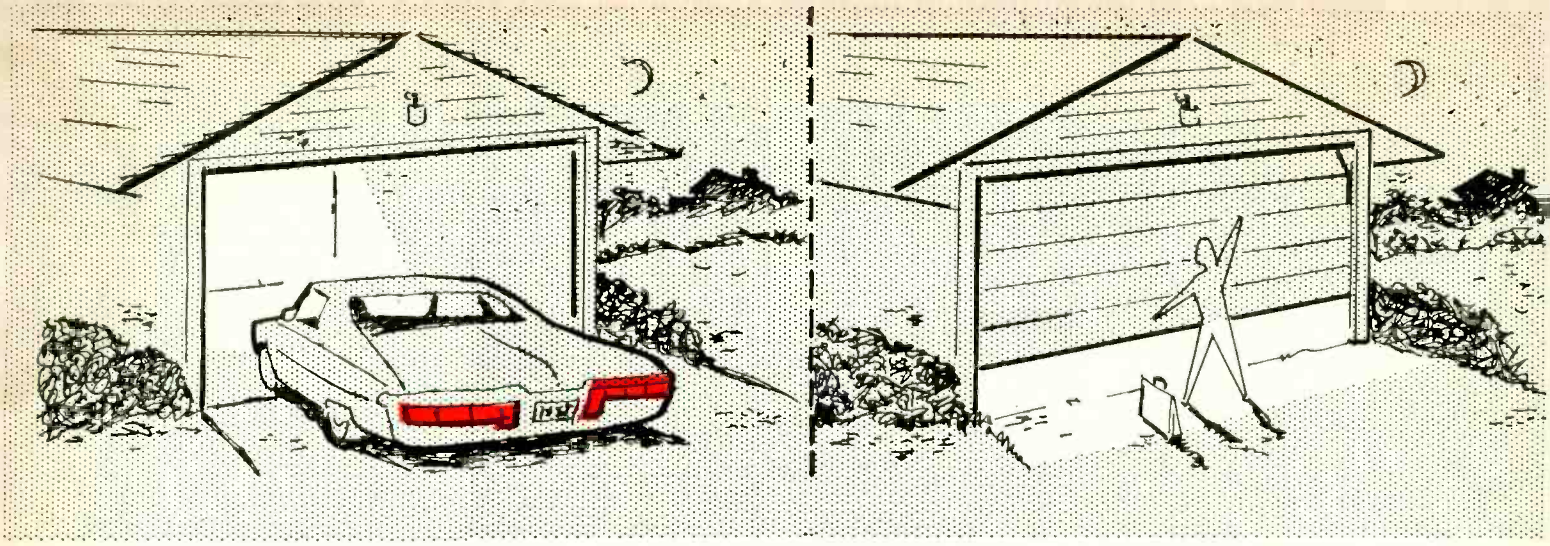
A Motorola model 414 came into the shop with a very low hum and no audio. When the radio was turned off and on, only a faint sound could be heard in the speaker. From these indications the output transistor must be defective. The SP891W output transistor was removed from the chassis and tested in a beta transistor tester. This transistor was open.

Always remember when testing output transistors that low gain and high leakage readings are normal. When replacing power output transistors apply silicon grease on the transistor and heat sink. Make sure the small plastic insulator is in place before bolting the transistor back on.

Final tips

Before removing a radio from a car make sure the fuse and antenna are good. The suspected fuse and antenna can be checked with an ohmmeter. A new antenna can be plugged into the antenna jack for a quick antenna check up. If the antenna cable is broken, replace it.

Check the pilot light before buttoning up the auto radio. **R-E**



BUILD! Lights-On Reminder

by R. M. MARSTON

THIS LIGHTS-ARE-ON REMINDER AUTOMATICALLY SOUNDS an alarm if you leave your car lights on after turning off the ignition. Two basic versions of the unit are described here. The first uses a bell or buzzer as the alarm. The second version uses an electronic alarm generator to generate a high-pitched audio signal.

Buzzer alarm

The negative-ground version of the basic lights-are-on reminder using a 12-volt buzzer or bell as the alarm generator is in Fig. 1. Operation is simple. Assume that S1 is in the NORMAL position. If lights and ignition are both on, points **X** and **Y** are at the same potential, so zero current flows through the alarm unit and it is off.

Again, if both the lights and ignition are off, points **X** and **Y** are both held at ground potential (via LP1 and R1, respectively), so the alarm is again off.

On the other hand, if the ignition is on and the lights are off, point **Y** will be at 12 volts positive and point **X** will be at ground potential. Diode D1 is reverse-biased under this condition, so the alarm is once more off and no warning is given.

Finally, suppose that the ignition is off and the lights are on. Under this condition 12 volts positive is at point **X**, and point **Y** is held at ground potential via R1. Diode D1 is now forward-biased so the alarm operates, indicating that the lights have been left on after the ignition has been turned off. Should you decide to leave parking lights on for the night, move S1 to the PARK position to turn off the alarm.

When the ignition is turned on again in the morning, the alarm will operate, warning you to switch S1 back to the NORMAL position.

The positive-ground version of the unit, shown in Fig. 2, is identical to the circuit described above, except that the polarities of D1 and the supply leads are reversed. In both versions of the unit, D1 can be any silicon rectifier having a current rating greater than that of the alarm unit.

Electronic version

When the car lights are left on, using the electronic version of the unit, a loud and fairly high-frequency reminder tone is generated as soon as the ignition is turned off. If the lights are left on (for night parking) the volume and frequency of the alarm decay to zero over a period of about 15 seconds.

The alarm thus turns itself off automatically after a limited time, and eliminates the need for the manually operated switch (S1) of the negative-ground units.

The full circuit of the electronic unit is shown in Fig. 3. Diode D1 serves the same function as the diode used in the earlier units, and the remainder of the circuit acts as the alarm generator.

The generator, a modification of a complementary astable multivibrator, uses an 8-ohm speaker as part of its Q2 collector load. The circuit operates only when it is connected to supplies of the polarities shown, and these connections occur only when the cars light switch is left on with the ignition turned off.

When connected as shown, the operating frequency and the volume of the unit are determied by the values of R3–R4 and C1, and by the voltage at the junction of R3 and C2. When the R3–C2 junction is at zero volts, volume and frequency are high. Volume and frequency decrease as the R3–C2 junction is made more positive, and fall to zero as the junction voltage nears the positive supply potential.

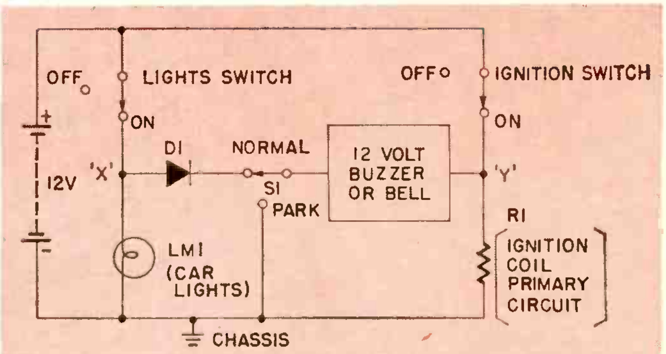


Fig. 1—Negative-ground circuit for lights-are-on reminder works with most cars. X and Y are normally at ground (B—).

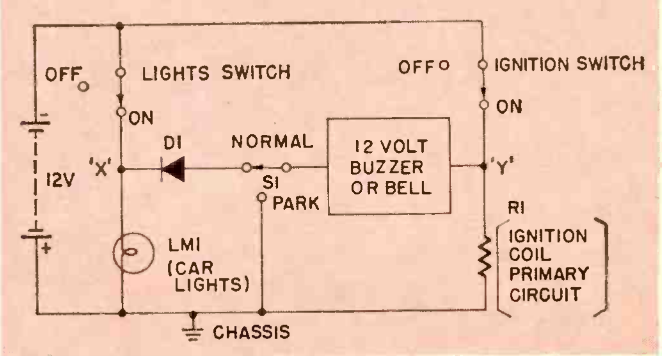
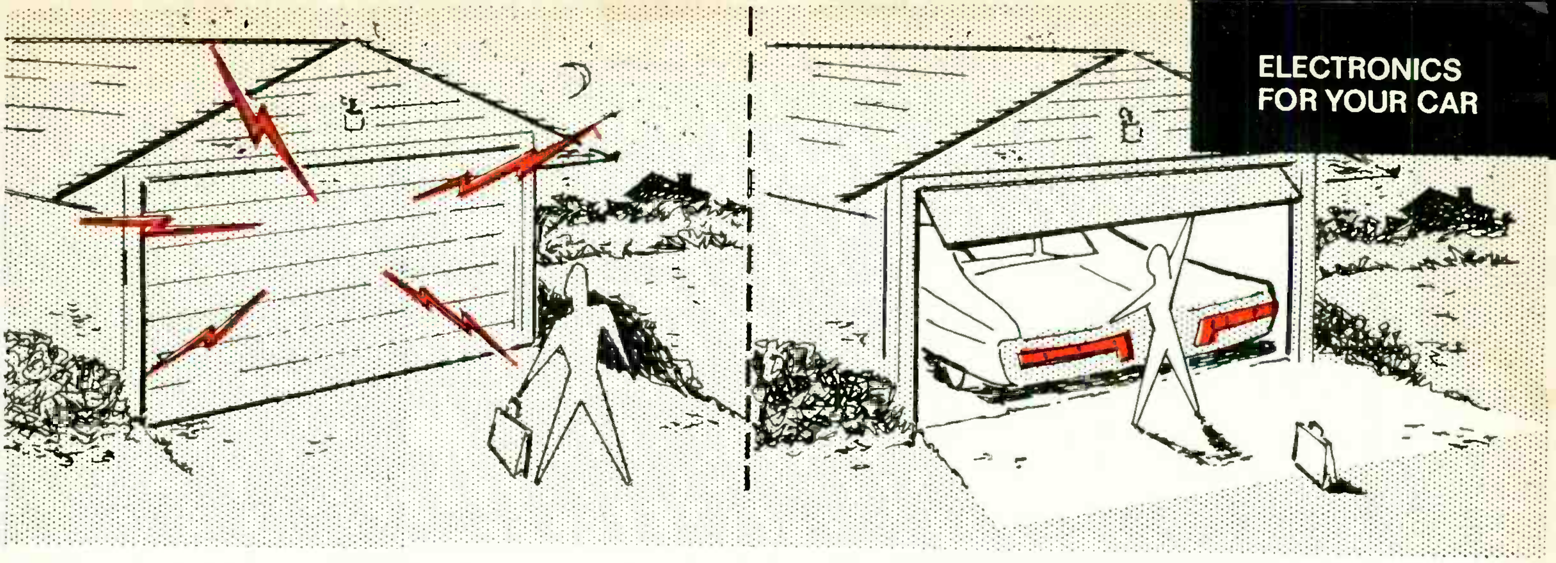


Fig. 2—Positive-ground version requires a polarity reversal of diode D1 and the 12-volt supply leads from Fig. 1 circuit.

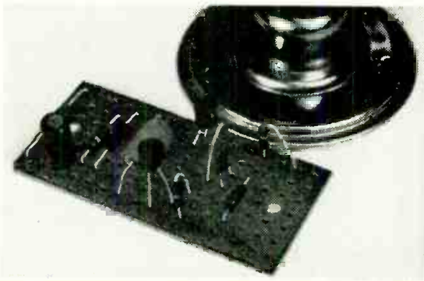


Forget to throw a switch and your car battery can be dead when you're in a hurry. These circuits won't let you forget!

Now, in Fig. 3, R3 and the base–emitter junction of Q1 are wired in series with C2 and act as a simple C2-charging network. When the supplies are initially connected to the circuit (via the ignition and light switches), therefore, C1 is fully discharged. So the R3–C2 junction is at zero volts, and the unit operates initially at high frequency and volume. Capacitor C2 then starts to charge via R3 and the base–emitter junction of Q1. As it does so, the R3–C2 junction voltage rises exponentially toward the positive line voltage, and causes the volume and frequency to decrease. After about 15 seconds, the R3–C2 junction voltage reaches a value that cuts off oscillation, and the unit turns off. The circuit then passes a total current of only 1 mA, via R6. When the supply is removed from the circuit (by operating the light or ignition switches), C2 discharges rapidly via D2 and R6, and the unit is then ready to operate again as a lights-are-on reminder.

The reminder alarm should operate briefly, starting at a fairly high frequency and decaying to zero in about 15 seconds. The decay period can be lengthened, if required, by increasing the value of C2. If extra volume is needed, use a higher-impedance speaker and decrease the value of R5 so the total collector load of Q2 is 22–27 ohms.

At right is the Veroboard construction used for electronic version. Fig. 4 below is the same-size board layout, showing letter-number coded holes or copper side (top) and component placement.



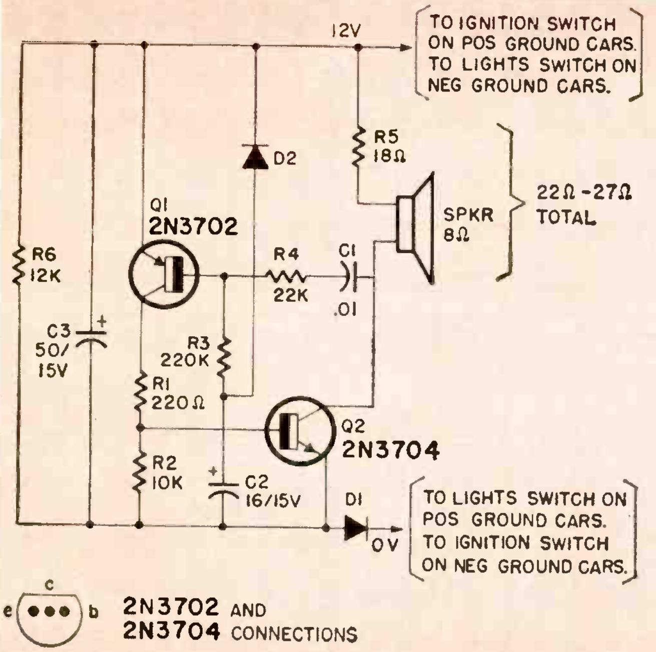
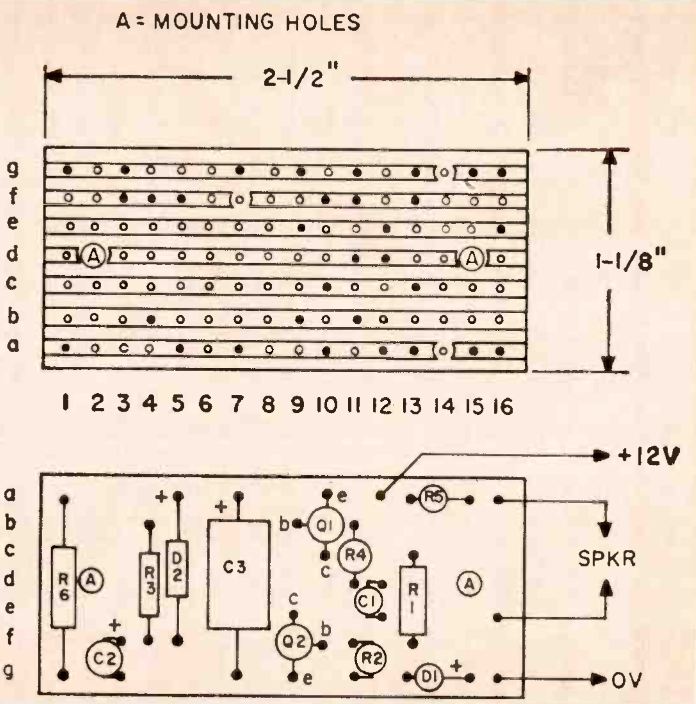


Fig. 3—Multivibrator modification added to basic lights-on circuit generates decaying high-freqquency audio signal.

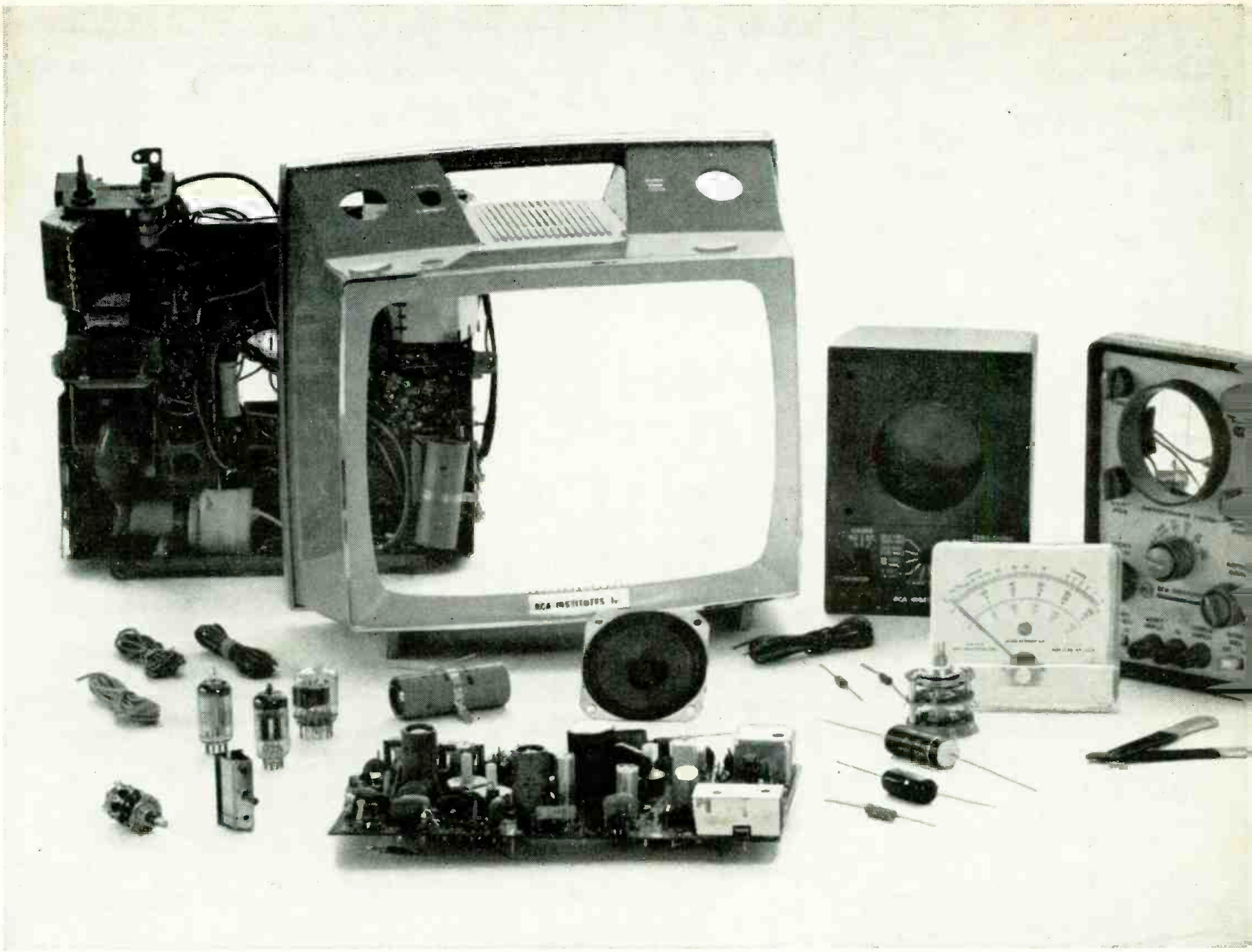


The electronic version of the unit is wired on a 2½ x 1⅛-inch piece of perforated Veroboard with 0.15-inch hole spacing. Construction details of this panel are in Fig. 4.

When the panel is complete, wire it to the 8-ohm speaker and the car's ignition and light switches, to conform to Fig. 3. Now, with the ignition switch off, turn the car lights on.

Now try various combinations of light and ignition switch modes (lights and ignition on, lights and ignition off, lights off and ignition on, etc.). Check to see that the unit operates only if the lights are on and the ignition is off.

The unit is then complete and ready for use, and can be permanently installed in the vehicle. It can be used in vehicles with electronic ignition systems. **R-E**



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Please clip out and mail to: Larry Steckler, Managing Editor, RADIO-ELECTRONICS, 200 Park Avenue South, New York, N. Y. 10003.

EQUIPMENT REPORT

Telvac SC-4 Transistor Tester

For manufacturer's literature, circle No. 61 on Reader Service Card.

The Telvac SC-4 Transistor Tester is a hand-held "probe" type. It's particularly handy for quick-check tests of the "GO-NO GO" type, with the transistor in-circuit. It will check any common transistor for cutoff and conduction ability, which is what we usually want to know. Diodes of any type can be tested in-circuit too.

This unit has a small built-in transistor amplifier with assorted diodes. A pilot light indicates the condition of the transistor, by lighting or staying off. A polarity-reversing switch across the built-in 3-volt battery sets the tester up for transistors of either sex, npn or pnp.

There is no on-off switch, this is done by the test pushbutton. The SC-4 is ready to go at all times. Actual current drain is very low. Battery life should be good. A miniature alkaline battery, with snap-on terminals, is housed in the back of the handle.

There are few test limitations on the SC-4. Transistors should have more than 1,000 ohms across the emitter-base junction, for silicon transistors, and more than 600 ohms for germaniums. When testing diodes in-circuit, the external circuit resistance must be more than 1,000 ohms.

Actual operation is about as simple as you can get. The SC-4 is in a probe type body, 1¼ inches in diameter, 9 inches long and weighs only 6 ounces, with battery. The pushbutton switch is mounted on one side and the indicator lamp, in a red dome-shaped housing, on the other. Normal brightness of the indicator lamp is high enough so that it can be easily seen even though it may be on the underside, out of direct view.

Contact to the transistor terminals is made by three spring-loaded and very sharp pins on the business end. These are arranged in the "E-B-C" basing, and set for a TO-5 spacing. The sharp pins are replaceable, should one be broken off. The pin-holders are hollow and a broken pin can be pried out with the tip of a knife-blade. They're just a little smaller than the old steel phono needles, but a good deal sharper.

To use the SC-4, set the selector switch for the right polarity, pnp or npn. (No damage will be done if it's reversed.) Then set the sharp pins on the transistor terminals and push to penetrate the sealing coating, etc. Note the condition of the pilot light indicator. If it is lit, the transistor has an emitter-to-collector short. If it's not lit, the transitor is ok—it is cut off.

Next push the button. If the transistor can conduct current, the indicator lights. Test over. If the indicator does not light in *either* position, you're not making good contact to the transistor. To check the SC-4's battery and operation, simply short the emitter or base pin to the collector pin. Regardless of switch position, pushbutton, etc., the indicator should light.

In the first test position, button not pushed, a small voltage is applied to the transistor through the internal circuits so it should be cut off. If it is, the indicator won't light. With the button pushed, it should conduct, lighting the indicator lamp.

Diodes can be tested either in or out of circuit. A special diode test adapter can be plugged onto the 3-pin head. A row of sockets, spaced 0.1 inch apart can be set up with plug-in spring-loaded pins. This lets you check diodes with any terminal spacing from 0.1 inch up to 0.8 inch, in steps of 0.1 inch.

For out-of-circuit testing of transistors, an adapter is provided which plugs onto the 3-pin head. Three test leads with miniature clips are used to make the connections. This harness can also be used for in-circuit testing of any transistor with a basing dimensions other than that of the TO-5 test-head.

The "one-hand—pushbutton operation" of this instrument can be used to good advantage in several ways. This simplicity makes it handy for use by untrained production-line personnel, and also very useful for the skilled test-engineers. For quick-checks at quality-control stations, general troubleshooting and similar applications, it could also be very convenient.

In the service shop, the ease and safety of operation could allow the use of novice technicians for preliminary testing of entertainment type equipment. This would save the time of the highly skilled technicians, and money. With the low operating voltage used, there is no danger of damaging the equipment.

The unit can be used with either the right or left hand with equal ease. The button can be pushed with thumb or forefinger. A useful addition to the growing line of "pushbutton technology".—*Jack Darr* **R-E**

NEW BOOKS

HOW TO USE GRID-DIP OSCILLATORS, by Rufus P. Turner. Revised Second Edition, Hayden Book Co. Inc., 116 W. 14 St., New York, N. Y. 10011. 5⅜" x 8¼", 128 pp. Softcover, $2.95.

Contains complete operating data on the uses of the grid-dip oscillator in radio, television, and electronics. Text concentrates on practical applications which have been proven by experience. Intended for student, technician, hobbiest or the engineer.

Presents step-by-step instructions on how to measure inductance, test and align TV, radio and FM receivers, how to get more out of a transmitter, how to find the resonant frequency of an antenna or check for antenna matching.

ELECTRONICS REFERENCE DATABOOK, by Norman H. Crowhurst. TAB Books, Blue Ridge Summit, Pa., 17214. 5½" x 8¾", 232 pp. $7.95 hardcover. $4.95 softcover.

This new reference book contains a collection of tables, formulas, graphs and equations and tells how to use them. Ten sections include Basic Electronics, Attenuators & Equalizers. Filter Design, Semiconductors and Tubes and Feedback.

HOW TO SELECT AND INSTALL ANTENNAS, by Lon Cantor. Hayden Book Co. Inc., 116 W. 14 St., N. Y., N. Y. 10011. 5⅜" x 8¼", 112 pp. Softcover, $3.95.

A practical guide covering the mechanical as well as the electronic side of antenna selection and installation. Offers reliable up-to-date information on color, black-and-white TV, and FM stereo antennas and complete home master antenna systems. Covers 82-channel installations and concentrates on what is actually practiced today. Includes enough theory to enable reader to solve virtually any reception problem.

ELECTRICAL PRINCIPLES OF ELECTRONICS, Second Edition. By Angelo C. Gillie. McGraw-Hill Book Company, 330 W. 42 St., New York, N. Y. 10036. 6¼" x 9¼", 732 pp. Hardbound, $11.50.

Broad-based text is divided into three major sections—Characteristics Of DC Circuits; Characteristics Of Sinusoidal Circuits; and Characteristics Of Complex Waveform Circuits. Added emphasis has been placed on applications to both the power-oriented and electronics oriented technologies. Only prerequisite is high school algebra. **R-E**

COMING NEXT MONTH

In May your stereo FM tuner may be outdated. According to author Ken Buegel, the cover-story tuner project you'll see next month uses special rf transistors and crystal filters.

(continued from page 48)

outputs determine which memory situation cell shall have new information written into it.

PLAY NO.	ADDRESS OF MEMORY CELL USED	MEMORY READ	BASED ON PLAY NO.	P's PREDICTION	H's PLAY	H's W/L RESULT	MEMORY WRITE	SUCCESS	NET GAMES WON BY H.	REMARKS
1	?	R	0	T	H	W	?	R	1	
2	?	R	0	H	H	L	S	R	0	
3	WSL	R	0	H	H	L	S	R	−1	
4	LSL	R	0	T	H	W	S	R	0	
5	LSW	R	0	H	H	L	S	R	−1	
6	WSL	S	3	H	H	L	S	+	−2	
7	LSL	S	4	H	H	L	S	+	−3	
8	LSL	S	7	H	T	W	R	−	−2	H changes strategy
9	LCW	R	0	H	T	W	S	R	−1	to play tails.
10	WSW	R	0	H	T	W	S	R	0	
11	WSW	S	10	T	T	L	S	+	−1	
12	WSL	S	6	T	T	L	S	+	−2	
13	LSL	R	8	H	T	W	S	R	−1	
14	LSW	S	5	T	T	L	S	+	−2	
15	WSL	S	12	T	T	L	S	+	−3	
16	LSL	S	13	T	H	W	R	−	−2	H changes strategy
17	LCW	S	9	H	H	L	S	+	−3	to all Heads.
18	WSL	S	15	H	H	L	S	+	−4	
19	LSL	S	13	H	H	L	S	+	−5	
20	LSL	S	19	H	T	W	R	−	−4	H begins strategy
21	LCW	S	17	T	H	W	R	−	−3	of alternate H & T.
22	WCW	R	0	H	T	W	C	R	−2	
23	WCW	C	22	H	H	L	C	+	−3	
24	WCL	R	0	H	T	W	C	R	−2	
25	LCW	R	21	H	H	L	C	R	−3	
26	WCL	C	24	T	T	L	C	+	−4	
27	LCL	R	0	H	T	W	S	R	−3	H decides
28	LSW	S	14	T	T	L	S	+	−4	to play all T's.
29	WSL	S	18	T	T	L	S	+	−5	
30	LSL	R	20	T	H	W	C	R	−4	H switches
31	LCW	C	25	T	H	W	R	−	−3	to all H's.
32	WSW	S	11	H	H	L	S	+	−4	
33	WSL	S	29	H	H	L	S	+	−5	
34	LSL	C	30	T	T	L	C	+	−6	H switches to
35	LCL	S	27	T	H	W	R	−	−5	a strategy of changing
36	LCW	R	31	T	H	W	S	R	−4	if he loses, playing
37	WSW	S	32	H	H	L	S	+	−5	same if he wins.
38	WSL	S	33	H	T	W	R	−	−4	
39	LCW	S	36	T	T	L	S	+	−5	
40	WSL	R	38	H	H	L	C	R	−6	
41	LCL	R	35	T	T	L	C	R	−7	
42	LCL	C	41	H	T	W	R	−	−6	H switches to strategy
43	LSW	S	28	T	H	W	R	−	−5	of changing if he wins,
44	WCW	C	23	T	T	L	C	+	−6	playing same if he
45	WCL	C	26	H	T	W	R	−	−5	loses.
46	LSW	R	43	T	H	W	C	R	−4	
47	WCW	C	44	T	T	L	C	+	−5	
48	WCL	R	45	T	T	L	S	R	−6	
49	LSL	C	34	H	T	W	R	−	−5	
50	LSW	C	46	H	H	L	C	+	−6	

C—Change, H—Heads, T—Tails
L—(Lose), S—(Play Same), W—Win, R—Random,
21 +, 11 —, 18 Random

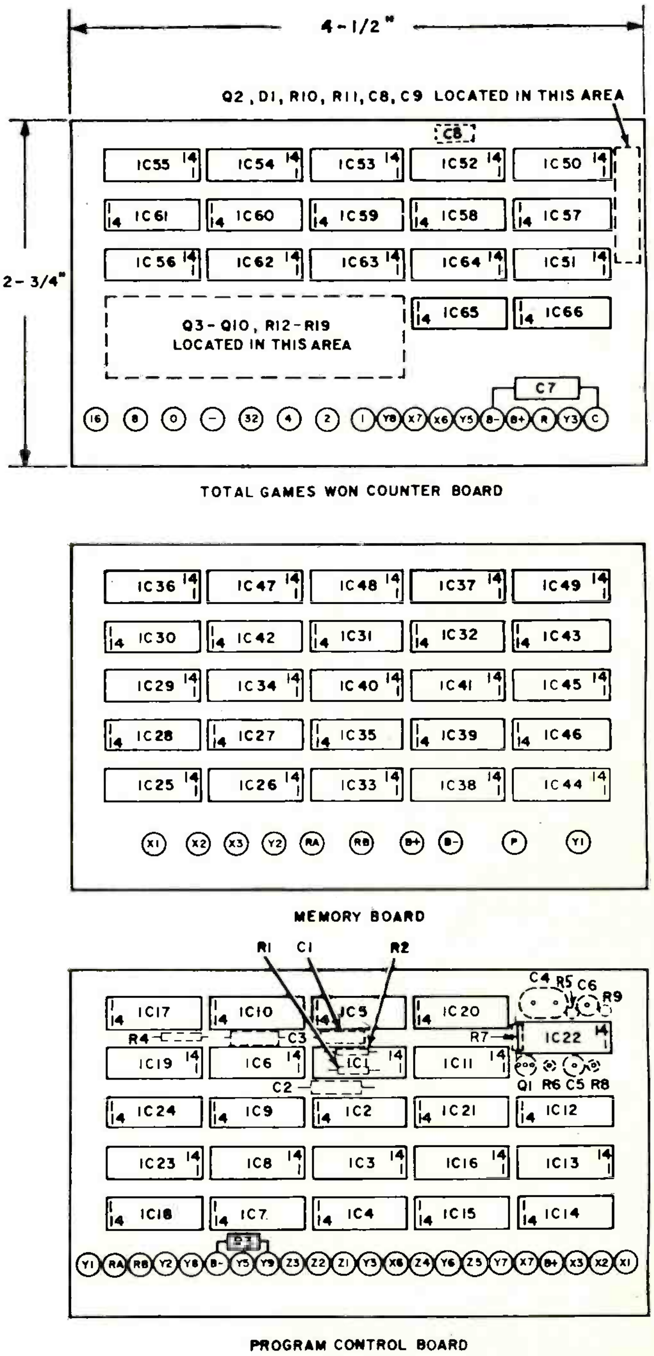
Memory: The memory consists of eight two-stage shift registers. If the two F/F's in a cell are storing 0–0, this corresponds to storing an S; if 1–1, a C; and if 0–1 or 1–0, an R. All the left-hand stages are continuously sampling the output of the Same/Change logic, but which cell receives the shift pulses that cause the cell contents to change is determined by the Shift-Pulse steering unit. Similarly, both stages of a cell corresponding to the address in the Memory Address go through the output selector to the Memory Input and Machine Play logics.

Memory Input Logic: This unit assures that a single game will change the contents of a cell holding on R to an S or a C. If a shift register holds 0–1 (R), shifting in a single 1 would result in the register holding 1–0 (still R), as the 0 would shift from the left to the right stage. Thus *two* shift pulses are applied in this case, as well as in the case where it is desired to change 1–0 to 0–0.

Machine Play Logic: This unit uses outputs from the memory, from the first stage of the H Play register, and from a Random Play flip-flop, to compute the machine's next play. If the memory holds an R, the Random Play F/F, which is continually changing state at over 100 times per second, is connected to this unit's output. The state that happens to be present at the end of the display illumi-

(continued on page 75)

Fig. 6—Arrangement of the 66 IC's and other components on three perf boards. This permits most compact circuit layout.



"SYNCRO SLIDE" Adds Sound To Your Slide Show

Low-cost silicon controlled switch advances slide projector from taped sync pulses on a stereo channel

By PHILIP BLAIRE

MUCH THAT'S GOOD IN A GOOD SLIDE show is in the showing. Use a little showmanship and your friends will greet your slide shows with real enthusiasm rather than dutiful politeness.

The Syncro-Slide will help you with the showmanship. For less than $10 this handy little solid-state device lets your stereo tape recorder control your solenoid-actuated slide projector.

The Syncro-Slide is designed around a very sensitive but inexpensive silicon controlled switch (General Electric 3N84) and a dc relay. The SCS, when used in an ac circuit like this one, conducts only when the anode and cathode are forward-biased and a positive voltage is applied to the cathode gate.* The high gate-firing sensitivity of the 3N84 eliminates the need for amplifying control signal. The rectifying characteristic of the SCS eliminates the need for a dc power supply. With those two circuits gone, the Syncro-Slide is about as simple and cheap to build as anyone could wish.

Fig. 1 is a diagram of the Syncro-Slide circuit. An ac signal of 0.6 volt applied to input jack J1 is rectified by D1, filtered by C1 and applied through R1 to the cathode gate of the SCS. This positive voltage turns the SCS on. Once on, the SCS rectifies the ac voltage supplied by T1. The resulting direct current actuates the relay, which in turn triggers

(turn page)

the slide projector. When the positive voltage is removed from the cathode gate, the SCS will turn off as the supply voltage from T swings through zero.

C2 smooths the pulsating dc flowing through the relay and prevents chatter. D2 surpresses inductive transients that could damage the SCS. These transients occur when the magnetic field around the relay coil collapses.

Resistors R2 and R3 forms a voltage-dividing network which is interrupted by switch S. When S is closed, a 1-volt 60-Hz signal appears at J1 and D1. This signal is used for recording sync tones on the tape recorder. It also triggers the SCS into conduction.

A double-pole relay may be substituted for the single pole unit shown. A neon light connected via the extra contacts to the 117-volt line will flash each time the relay closes.

A 3-volt Zener diode can be placed in the gate circuit. It will protect the SCS gate from overloads caused by excessive signal levels or leaking B+ from the tape recorder. The maximum allowable gate signal is 5 volts.

One more addition you may want to consider for your Syncro-Slide: a low-power lamp dimmer for controlling room illumination.

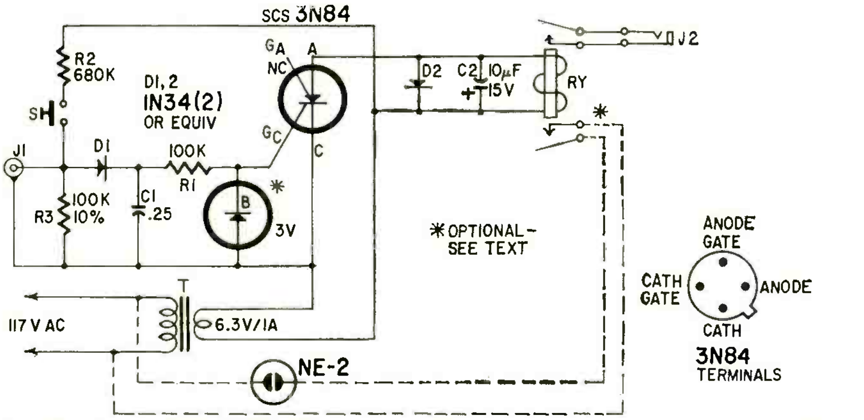


Fig. 1—Highly sensitive 3N84 silicon controlled switch is triggered by 60-Hz signal programmed on tape and applied through J1. Relay RY advances projector.

The circuit shown was laid out on Veroboard. The Veroboard and transformer were mounted in the bottom of a plastic meter case. J1, J2 and the ac line cord are on the back of the case.

You can get the parts for your Syncro-Slide either at a local supply house or through the larger mail-order houses. A 6-volt relay and transformer are used for the unit described here, but 12- or 24-volt devices can also be used. Simply change the value of R2 to obtain the proper relay voltage.

Assemble the circuit except for J1, J2 and the SCS. With S closed you should obtain 1 volt ac ±0.25 volt across R3, and 1 volt dc ± 0.25 volt across C1. This positive voltage should drop immediately to zero when S is opened. If it drops slowly or not at all, shunt C1 with a 1-meg resistor.

Now install the SCS. The anode-gate lead is not used and can be cut off. The SCS is extremely sensitive to heat. Solder it in carefully using a heat sink, or use a transistor socket instead and avoid soldering.

Measure the circuit resistance from the anode to the cathode of the SCS. Reverse the ohmmeter leads and measure again. The resistance in one direction should approximate the relay coil resistance; in the other direction the resistance should approximate the resistance of D2 when it is forward-biased. The SCS will have little effect on resistance readings unless it is shorted inside the unit.

With S closed, measure the dc voltage across the relay. If this voltage exceeds the rating of the relay, insert a series of dropping resistor. If there is no voltage, check the polarity of D2.

Install the Veroboard circuit and T in the plastic meter case. Install J1 and J2. Insert S in the top plate and install the top plate. Your Syncro-Slide is now ready to go to work for you.

To prepare a control tape, record a commentary about your slides on channel 1 of your tape recorder. Use the Syncro-Slide to record sync tones on channel 2 at points where you want the slides to change.

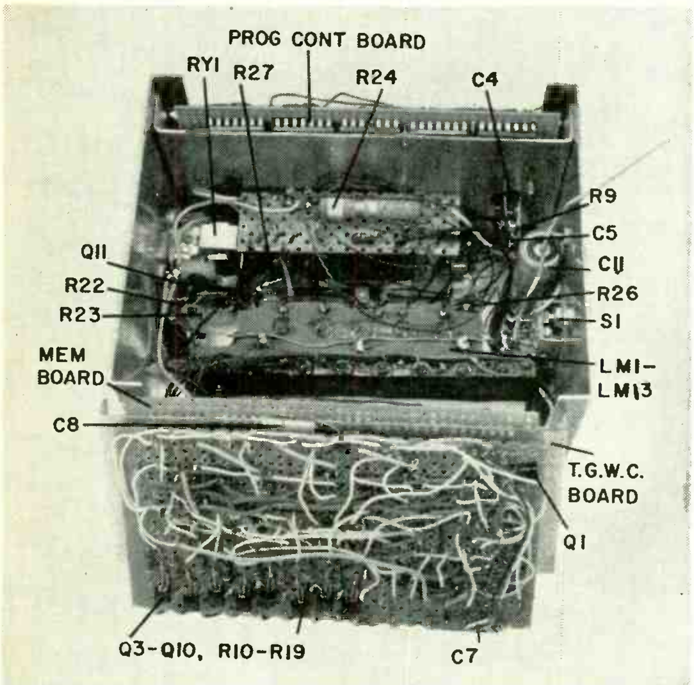
Once your control tape is made, you are ready for completely automatic showing. Connect J2 to your automatic slide projector; connect J1 to the channel-2 output of your tape recorder. As the tape plays, you will hear your commentary from channel 1. Slides change on each tone from channel 2.

With your best slides (*only* your best, please!) arranged in an interesting sequence and accompanied by a tape of fast-moving commentary, appropriate background music and subtle sound effects, your audience will sit up and take notice! **R-E**

(continued from page 72)

nation period is stored in the Machine Play register F/F as the machine's next play.

Display Control: This unit illuminates the displays upon receipt of a trigger pulse, and turns them off after an interval of about 1 sec. The purpose is to minimize battery drain. It deactivates the PLAY PUSHBUTTON during the in-



Follow this wiring procedure: Cut and tin wires, forming hooks at both ends. Tin IC pin; crimp wire to pin. Touch with iron to flow solder; inspect joint. Jumper all IC commons with No. 32 bare wire; run B+ and B– leads to all IC's. Interconnect boards.

terval, and sends a trigger pulse to the Machine Play register F/F at the end of the interval.

With the functions of the individual blocks in mind, the sequence of events that occur when the play button is released can be described. The initial conditions are:

(1) The H PLAY selector switch holds the human's current choice of play.

(2) The M Play register holds the computer's play.

(3) The W/L logic output is the result of the game that is about to be played.

(4) The Memory Address register holds the previous two W/L results and the S/C results of the human's two *previous* plays. This is the cell "address" corresponding to the game situation for which the human has just selected a play.

(5) The Random Play F/F is running.

When the PLAY BUTTON is pressed and released, the programer resets and then generates five pulses in sequence, applying each to different units. The pulse times are labeled t_0 through t_4. What happens at each pulse time is detailed next.

(t_0): The human's current play is shifted into the H-Play register and the Same/Change logic output now tells whether he played the same as the last time or changed. Also, if the total is zero, the sign F/F in the Count Up/Down logic is set according to the output of the W/L logic. After t_0, this unit has set the counter interconnections to count in the proper direction. No other registers have changed.

(t_1), (t_2): At this time, the human's current "same/change" response is to be written into the cell corresponding to the game situation prevailing when he selected his play. If the cell already holds an R, the t_1 pulse is applied as a shift pulse to the cell selected by the Shift-Pulse steering unit. Regardless of what happens at t_1, the same/change response is shifted into the cell (again, perhaps) at t_2.

(t_3): A shift pulse is applied to all stages of the Memory-Address register. This causes it to update to correspond to the situation when the human will select his *next* play. As a result the Machine Play logic output is determined by the human's current play and the contents of the memory cell corresponding to the *next* situation. The output is applied to the Machine-Play register, but is not set into that register till later.

The Display control is triggered to the ON state and the displays are illuminated for about 1 sec, starting from t_3.

(t_4): The leading edge of the t_4 pulse removes a count-inhibit voltage from the counter and the trailing edge causes the counter to count up or down as selected at t_0. The reason for normally inhibiting the counter is to prevent it from erroneously "counting" when the Count Up/Down interconnections are being shifted at t_0. Shortly after the end of the t_4 pulse, the count-inhibit voltage is restored.

(t_3 + 1 second): At this time the Display Control returns automatically to its OFF state, causing the Machine Play F/F to assume the instantaneous state of the output of the Machine Play logic and reactivating the PLAY pushbutton.

Three NiCd cells provide energy for about 2 hours of operation. A transformer, bridge rectifier, smoothing capacitor and current-control resistor supply charging current at a low rate that can be continued indefinitely with-

(continued on page 83)

NEW TUBES AND SEMICONDUCTORS

NEW LOW-NOISE FET's

A series of general-purpose low-noise FET amplifiers for use in high-gain audio and video amplifiers, multiplexers and analog and video switches has been introduced by National Semiconductor Corp. These devices, the 2N3069, 2N3070, 2N-3821 and 2N3822, have a low noise figure of 0.1 dB (typical) and 20 nV per root hertz at 100 Hz. Leakage is only 20 pA (typical) and gain is 2000 to 4000 (typical).

Prices range from $1.85 to $4.00 in quantities of 100 to 999 at all stocking distributors.

NEW IC FOR DSB AND SSB APPLICATIONS

The primary function of the new MC1596 IC is as a monolithic balanced modulator/demodulator for double-sideband suppressed-carrier communications systems. Its output voltage is the product of an input signal voltage and carrier, thus making the unit also useful in suppressed-carrier, and amplitude-modulation and frequency-doubling applications. The MC1596 can be used as a product detector for SSB, synchronous detector for AM and phase detector for FM. It features adjustable gain, excellent carrier suppression (60 dB typical at 500 kHz), carrier feedthrough or 40 μV rms (typical) at 1 kHz and a common-mode signal rejection ratio of 85 dB. Sealed in a long-lead TO-100 metal can, the Motorola MC1596 has a temperature range of −55 to +125°C and sells for $4.80 in 100-up quantities.

NEW POWER TRANSISTOR FOR TV

The D40N is a new 300-volt video output transistor with a free-air rating of 1.33 watts at 50°C ambient and 6.25 watts at 25°C tab temperature. Other features of this General Electric device include direct interchangeability with TO-5 can devices, a glass passivated pellet, 3 pF maximum collector capacitance at 20 volts. Applications include color and b-w TV video output, TV horizontal sweep drivers, portable TV audio output, high-voltage transistor regulator and video display drivers for oscilloscopes. **R-E**

DID YOU MISS?
Why risk speeding tickets? Build an excess-speed alarm. Check page 35.

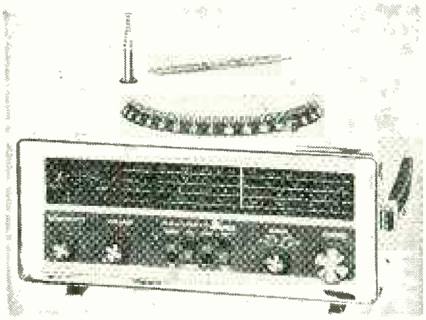
NEW PRODUCTS

More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card at the left and circle the numbers of the new products on which you would like further information. Detach and mail the postage-paid card.

AUTOMATIC TURNTABLE MODULE, *X-10,* prewired and equipped with a stereo ceramic cartridge (containing a diamond stylus). Three speeds (33, 45 and 78 rpm) for 12", 10" and 7" records. 2 interchangeable spindles supplied for auto/manual playing. Also includes a single-lever cuing and pause control and a low-mass tubular tone arm. $52.50.—**Garrard, Div. British Industries Co.,** Westbury, N.Y.

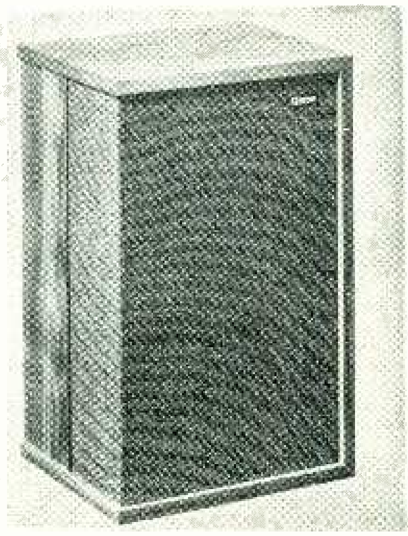
Circle 46 on reader service card

RDF, *Mariner Model MR-18,* kit form, features 6½" compass-rose to be set to boat's magnetic heading and low-impedance rod antenna turned to null on built-in Tune-Null meter for direction finding. Built-in sensing circuit and antenna eliminate 180° ambiguity. Automatic noise limiter, and 4-MHz capability. Receiver has front-panel switch that puts product detector into circuit for receiving SSB, CW and AM. Tunes continuously from 180 kHz to 11.5 MHz in 4 bands. Four ceramic filters in i.f. strip eliminate i.f. alignment. Uses FET's in mixer, oscillator and product detector for stability. Operates from rechargeable nickel-cadmium battery (included) running up to 10 hours on full charge. Built-in charging circuit permits charging from 120 or 240 Vac or 13.5 Vdc. Snap-on mounting base and snap-out circuit boards. 3 x 5" weather-resistant speaker gives 300 mW of sound. Has headphone jack. 6½ x 11⅜ x 8⅝". White wrinkle finish with marine blue, black and chrome accents. $124.95. Heath Co., Benton Harbor, Mich. 49022



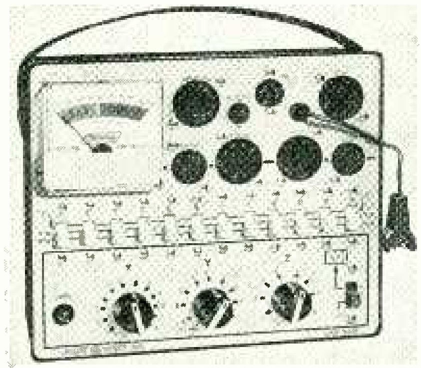
Circle 47 on reader service card

TWO-WAY SPEAKER, *Angle Mount, Model S-996.* Angle mounting permits use of 10" woofer. LC type crossover matches 4" cone-type tweeter. Response: 40–20,000 Hz. Power capacity: to 35 watts music power. 17½ x 10¾ x 8¾". 8 ohms. $79.98. **Olson Electronics, Inc.,** 260 So. Forge St., Akron, Ohio 44308



Circle 48 on reader service card

MINIATURE TUBE TESTER KIT, *model 990,* features full cathode conductance test, complete set of latest sockets, open-circuit meter switch selector. Tube setup data kept permanently up to date. Fits into tube caddy. One-year warranty. High-impact instrument case. 6½" x 3½". 4½ lb. Easy assembly with wiring instructions. $21.95. Factory-wired, $34.95. **Mercury Electronics,** 315 Roslyn Road, Mineola, N. Y. 11501

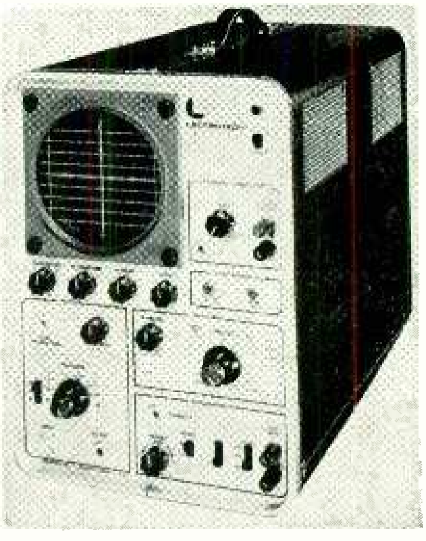


Circle 49 on reader service card

GOOSENECK MIKE, *HK-113,* omnidirectional, is designed for maximum intelligibility. Can be wired for remote control. Main applications are service counter, voice recording, public address and paging. Works into low-and high-impedance amplifiers. Fits into any mike stand. $42. **RCA/Electronic Components,** Commercial Engineering, 415 S. 5th St., Harrison, N. J. 07029

Circle 50 on reader service card

LECTROTECH OSCILLOSCOPE, *Model TO-50 5.* 10 MHz bandwidth; dc amplifiers eliminate pattern bounce, permit viewing ac and dc simultaneously; calibrated vertical attentuator and horizontal time base; automatic sync mode; TV sync selector. Vectorscope input for color TV servicing. External horizontal amplifier; 60-Hz horizontal sweep with



phasing control; edge-lit calibrated scale. Compatible with all sweep generators. Solid-state (tube-protected input). 14⅛ x 10¼ x 16½"; 23 lb.—**LECTROTECH, INC.**, Chicago, Ill.

Circle 51 on reader service card

RECEIVER, *LR-100*, 50-watt solid-state AM/FM stereo. Circuitry: 33 transistors, 25 diodes, 2 thermistors; Response: 20-20,000 Hz ±1dB; power bandwidth 35-30,000 Hz; HD, 0.1% @ 1 watt. FM

useable sensitivity 2.5 μV. Capture ratio 5 dB. Distinctively styled front panel and simulated walnut-grain vinyl-clad metal case. 14½" x 4½" x 10½". $129.95—**LAFAYETTE RADIO ELECTRONICS**, Syosset, N.Y.

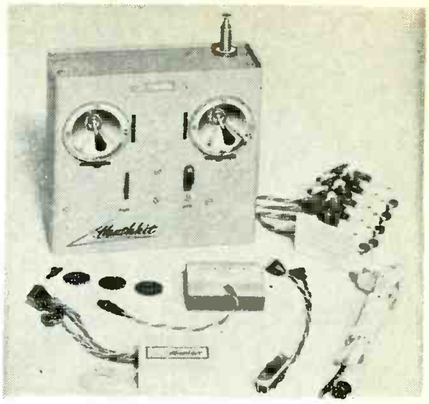
Circle 52 on reader service card

CHANGER/TURNTABLE, *Miracord 750*, is identical to *Model 50H* except that the *750* has a special 4-pole induction motor instead of Papst hysteresis-

synchronous motor and different trim. $139.50.—**BENJAMIN ELECTRONIC SOUND CO.**, Farmingdale, N.Y.

Circle 53 on reader service card

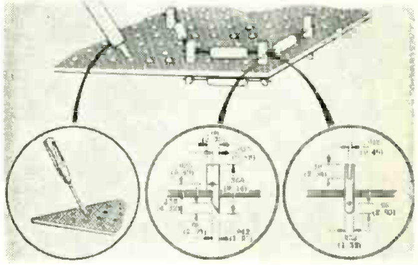
RADIO CONTROL SYSTEM, *Model GD-19*, designed to control model planes, boats and cars, includes transmitter, receiver, 4 servos and rechargeable battery packs for transmitter and receiver. Can be ordered on 5 frequencies in 27-, 53- or 72-MHz bands. Servo travel can be reversed at appropriate control potentiometer. Mode changes made quickly. Transmitter battery is charged by built-in circuit. Pilot lamp on bottom of transmitter indicates charging circuit is on. Comes with preassembled and factory-aligned rf section. Has 3 ceramic filters in i.f. for high selectivity, extra reliability, and elimination of i.f. alignment. Receiver circuitry is unaffected by noise or temperature change and is in an almost indestructible nylon case. Receiver battery is rechargeable nickel-cadmium type. Heath military-type flat terminal blocks used to lessen weight. Plug conversion kit for using new receiver with previous *Heathkit*



GD-47 is available. Variable-capacitor servos have 2 linear outputs (one with vertical tabs) plus rotary output. 2.3 oz. 25/32 x 2 x 27/32". System flying weight, 16 oz. *Kit GD-19*, $219.95. Transmitter, battery and charging cord only, *Model GDA-19-1*, $86.50. Receiver, *Model GDA-19-2*, $49.95. Receiver battery pack, *Model GDA-19-3*, $9.95. Servo, *Model GDA-19-4*, $21.50. Plug conversion kit, *Model GDA-47-6*, $2.95. **Heath Co.**, Benton Harbor, Mich. 49022

Circle 54 on reader service card

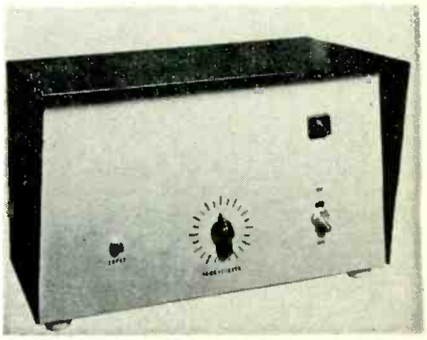
TERMINAL PIN designed for miniature circuitry; holds up to 5 leads in 3 possible directions. Inserted into 0.052" diameter holes due to its spring form;



pins may be reused by pulling out of board. Made from phosphorous bronze with bright tin finish. Walter O'Donnell, **Vero Electronics, Inc.**, 176 Central Avenue, Farmingdale, N.Y. 11735

Circle 55 on reader service card

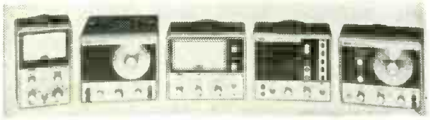
HIGH-POWERED COLOR ORGAN. Silicon circuitry. Triac power output stages and active R-C filters for high channel separation. The 4-channel unit can operate 600 watts of lighting on each channel, continuous duty. Steel cabinet, walnut wood-grain front panel. Rear apron has 8 ac outlets, 2 per channel,



for ease in distributing the lighting load. Channels protected by a fuse. May be operated by connecting across any loudspeaker. A microphone accessory unit is also available. $100.—**Edison Instruments Inc.**, Rahway, N.J.

Circle 56 on reader service card

FIVE NEW TEST INSTRUMENTS include signal generator, *Model 150*, FET voltmeters, *Models 240 and 242;* rf signal generator, *Model 330*, and FET sine/quare-wave generator, *Model 379*, all solid-state. *Model 150* aids in troubleshooting AM, FM and TV receivers, hi-fi and PA systems. Two separate probes test radio and af circuits. Performance judged from 8-ohm speaker or visually from built-in meter. Can make substitution tests for amplifier, output transformer and loudspeaker. *Models 240* and *242* have high-impedance out-



put, can test vacuum-tube and semiconductor circuits. One probe, 7 nonskip ranges in 10-dB steps. Operates from ac line and battery. *Model 242* has large 6½-in. meter. *Model 330* (rf) covers 100 kHz to 54 MHz, all on fundamentals. Can align AM/FM radio, TV and communications gear. All modulated and unmodulated rf and audio signals available with good waveforms. Calibrated front-panel control adjusts modulation up to 100%. *Model 379* gives simultaneous sine and square-wave outputs ranging from 20 Hz to 2 MHz. Uses FET transistor in low-distortion Sulzer feedback circuit to give output signals for testing response of finest hi-fi systems. Square-wave rise time is better than 0.1 μsec. Distortion rated at less than 0.25%. Kit or wired form available for all units. **EICO Electronic Instrument Co., Inc.**, 283 Malta St., Brooklyn, N. Y. 11207

Circle 57 on reader service card

STEREO TAPE DECKS, *Mark II, III* and *IV*. 3 operating speeds—7½, 3¾ and 1⅞ ips; inputs for microphone and auxiliary; outputs for line and headphones. Vertical and horizontal positions; reel capacity 7". Record indicator light for channel, built-in tape cleaner, automatic tape lifters, automatic stop, stereo headphone jack for listening and monitoring, flutter filter and dynamic muting. *Mark II* has frequency response range of 20 to 23,000 Hz at 7½ ips; retails at less than $230. *Mark III* has overall frequency response to 27,000 cycles, under $260. *Mark IV* (shown) with dual capstan mechanism, under $300.—**Concord Electronic Corp.**, Los Angeles.

Circle 58 on reader service card

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

New address for Castle Tuner Service—The Eastern division of Castle TV Tuner Service is moving from Long Island City to Richmond Hill. The new premises are set up to do thorough overhauls on all makes of TV tuners, for the Eastern section of the United States. A large stock of custom and universal replacement tuners will also be available. The new address is 130-05 89th Road, Jamaica, New York 11418. **Castle Tuner**'s main plant at 5710 Northwestern Ave., Chicago, Ill. 60645 continues to provide similar service for the rest of the United States.

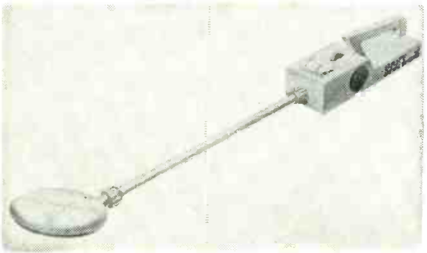
14 SPEAKER SYSTEM, *LWE IV*. High-efficiency, four-way, nonresonant system, features inverse feedback electronic suspension and room gain control, for use in auditoriums, halls, amphitheaters, discotheques, etc. Transducer com-

Circle 107 on reader service card

plement consists of four 15" woofers, four 8" mid-base, four 6" mid-range and two 5" horn-type tweeters. Frequency response: 20–20,000 Hz ±3 dB with crossovers at 150 Hz 1,000 Hz and 4,000 Hz. Impedance: 4 ohms. Capacity: 200 watts rms with 100 watts rms

per channel minimal power requirement. Electronic network generates negative-feedback error voltages when speaker does not follow amplifier output and controls speaker cone to eliminate low-frequency distortion. Network tends to cancel effect of frequency-sensitive network at high frequencies. Control panel carries high-frequency high and low mid-frequency controls, phase switch, aux amplifier jack, main input connector for stereo, and room gain control. 51½ x 36¼ x 20". 250 lb. *Instant kit*, unfinished cabinet, without grille, $725. *LWE IV*, walnut cabinet with wood fret grille, $950. Marketing Dept., **LWE Div., Acoustron Corp.**, 2418 Bartlett St., Houston, Tex. 77006

METAL DETECTOR, *Goldseye,* finds coins, relics, gold, silver, copper and other metals through dirt, sand, rock, wood, water, etc. Features earphones and loudspeaker. Fully transistorized, operating 20 hours on 9-volt radio bat-



tery. 2 lb. *Model XL*, $29.95. *Model XXL*, including view meter, $39.95. Super power-coil to double penetration depth of both models, $12.95. Enclose $5 for C.O.D. **Dart Electronics,** PO Box 361, Huntsville, Tex. 77340 **R-E**

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 79 and circle the numbers of the items you want. Then detach and mail the card. No postage required!

SPEAKER SYSTEMS BROCHURE, *"The Sound of Excellence,"* features "electronic suspension" speakers that provide transient repose, eliminate resonance, increases efficiency 5% to 10%, reduce distortion almost completely, and adapt to any good-quality tube or solid-state amplifier or receiver. Describes "instant kits," offering 30% savings, consisting of sound components mounted on baffle board, completely wired in unfinished wood enclosure. User adds finish and grille cloth. **LWE,** Div. of **Acoustron Corp.,** 2418 Bartlett St., Houston, Tex. 77006

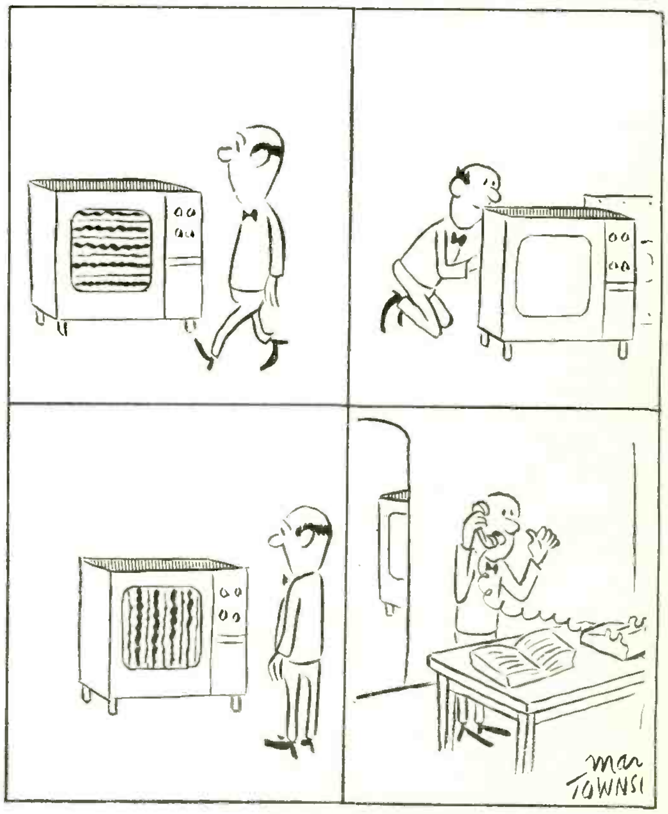
Circle 59 on reader service card

ELECTRO-VOICE BROCHURES describe speaker systems *(form 1262)* and component speakers *(form 1263)*. Speaker systems include bookshelf. console and outdoor units, amplifiers, FM tuners and AM/FM receivers. Component speaker brochure helps in building your own system—listing vhf horn/drivers, mid-range horn and driver, building block and stepup kits, crossovers, mixer transfofrmer, level control, 8" to 15" coaxial and 3-way speakers, super bass driver, and music instrument speaker. Plus speaker selection chart. **Electro-Voice, Inc.,** 600 Cecil St., Buchanan, Mich. 49107 **R-E**

Circle 60 on reader service card

R-E ON FILM

Two sources of filmed back issues of RADIO-ELECTRONICS are now available. Please write the companies for further information. Microfilm editions are available from University Microfilms, A Xerox Company, Ann Arbor, Mich. 48106. Beginning with the January, 1969, issue, Microfiche editions are available from NCR Microcard Editions, Industrial Products Division, 901 26th St., N.W., Washington, D.C. 20037.

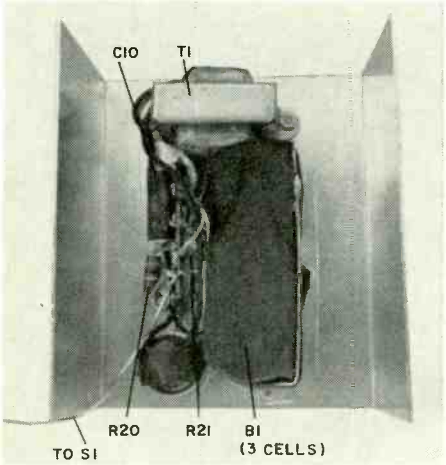


(continued from page 75)

out harm to the cells (see Fig. 5). Attaching the ac line cord starts charging automatically. About 24 hours of charging is required to charge fully.

When NiCd cells are series-connected, they are subject to irreversible damage should any one cell voltage go to zero so that the other two cells tend to reverse-charge it. To prevent this, a circuit is included to turn off the unit automatically if the total battery voltage drops below about 3.3. When the power switch is turned on, relay RY1 is pulled in by a transient pulse of current flowing into C11. As soon as the relay closes, voltage is applied through Zener diode D2, and the collector current of Q11 holds the relay closed. However, should the battery voltage drop too low, Q11 will turn off, removing the load from the battery except for the leakage current through C11. The circuit has been arranged to permit the use of a compact, inexpensive, yet sensitive, relay that is constructed with a grounded armature. To obtain operation at close to 3.3 volts, it may be necessary to select the resistor in series with the Zener diode (R23), and to decrease the normally open armature spacing to increase relay sensitivity.

Unbased lamps were mounted in a wood block with thermoplastic cement to avoid the cost and space of sockets. The lamps are rated at 4.5 volts, so should last indefinitely. The logic elements are dual in-line plastic IC's. They are mounted by inserting their leads through paper-base Bakelite circuit boards perforated on 0.1-inch centers. The circuit boards are clamped at several places to aluminum mounting plates. Clamping is by wire loops passed through plates and boards, drawn snug and soldered. The aluminum plate carries away the heat generated by the IC's and conveys it to the case. Cabling permits the boards to be slid out of the case for troubleshooting.



Notice battery circuit is completed only when two case halves are joined. Position batteries so they will fit into the second half of the case.

Board wiring was done with about 100 feet of No. 32 stranded vinyl-covered wire. Each of the more than 1000 joints was carefully inspected for proper solder flow, absense of strain, etc. Careful and accurate wiring is a must on this type of project because of the difficulty of finding wiring errors and the danger of damaging the IC's.

Logic wiring diagrams of the three circuit boards are shown in Fig. 2-4. The remainder of the circuitry installed in the case was included in Fig. 5. Positioning of IC's 1-66 is shown in Fig. 6.

The total parts cost in early 1968 was $150, about half of which was for the integrated circuits. This includes everything except miscellaneous mounting hardware.

All gates are NOR gates. The logic elements are Motorola MC700P series RTL dual in-line plastic units. Harness connections to other boards and to the box-mounted circuitry are denoted by circled symbols. Like symbols on the various diagrams are connected together. B+ and B− connections to the IC's are not shown. **R-E**

PEAKED AMPLIFIER FOR SINGLE-SIGNAL C-W

by I. QUEEN

EDITORIAL ASSOCIATE

Need more CW selectivity from your receiver? This simple accessory makes poor receivers great and great ones better

IF YOU ARE AN ARDENT CW DX-ER ON the ham bands or a Novice, you know that even the best ham-band and communications receivers seem lacking when the going gets really rough. The peaked audio amplifier described drastically reduces QRM and QRN, and improves your chances of complete copy of those weak signals squeezed between two "powerhouses." It has a big advantage over similar devices that simply amplify the desired signal more than adjacent ones. This circuit attenuates interference while providing plenty of gain for the signal you want.

The degenerative-type selective amplifier I built was based on patent No. 3,116,460, issued to Charles H. Nowlin of Cambridge, Mass.

Tube V1-a (Fig. 1), a cathode follower, is connected to the common terminal of a twin-T network connected in a degenerative feedback loop between the cathode of V1-b and the grid of V2. Some of the signal from V1-a is fed through V2, where it is amplified and fed to V1-b, another cathode follower.

The output of V1-b is 180° out of phase with the input of V2. The twin-T has a very high impedance—and zero transmission—at its design frequency, so there is no degeneration and full gain is realized. At all other frequencies, the impedance is lower and some signal is fed back from V1-b to V2. The resulting negative feedback reduces circuit gain at all frequencies except at resonance. The further the unwanted frequency is from the tuned frequency, the greater is its attenuation. Fig. 2 compares the response of the amplifier with that of more conventional peaked circuits.

The component values for the twin-T are derived from the formula

$$f = \frac{1}{2\pi RC}$$

where f is the frequency in Hz, R is in megohms and C is in μF. You can select values for R or C and f and determine the unknown from

$$R = \frac{1}{2\pi fC} \text{ or } C = \frac{1}{2\pi fR}$$

I selected 600 Hz as the easiest tone to copy over prolonged periods and then used 470 pF for C and 470,000 ohms for R. Shunt arms R/2 and 2C were selected on a bridge from several 240K and 0.001-μF units.

I found that if R/2 is too small a value, the circuit breaks into oscillations, so I added R10 to cancel this effect. This was fortunate because I could then use R10 to control selectivity and oscillations.

Actually, I shunted R/2 with various high-resistance resistors until, with R10 at zero resistance and a 1.3-megohm shunt resistor, the circuit would just break into oscillations. As you back away from the point of oscillation—by increasing R10—selectivity decreases.

This amplifier really shines when used with a poor CW receiver but its performance is still amazing when it is used with a top-notch ham-band receiver with 500-Hz selectivity. Being continuously variable, it is better than the simpler crystal filters.

Too much selectivity causes "ringing," and dots and dashes tend to run together. Therefore, you will have to reduce selectivity when copying high-speed CW.

There is enough gain to permit you to bypass some or all of the audio stages in the receiver. I have added two output jacks. J3 is used for phones, and J2 is a phono jack used to feed the output back into the receiver's audio circuits. If you connect the amplifier between the set's volume control and first af amplifier, keep the control turned down near minimum.

The amplifier needs only 6 volts at 600 mA and 250–300 volts dc at about 20 mA. This can be tapped off the receiver's power supply or supplied by a simple utility power supply.

R-E

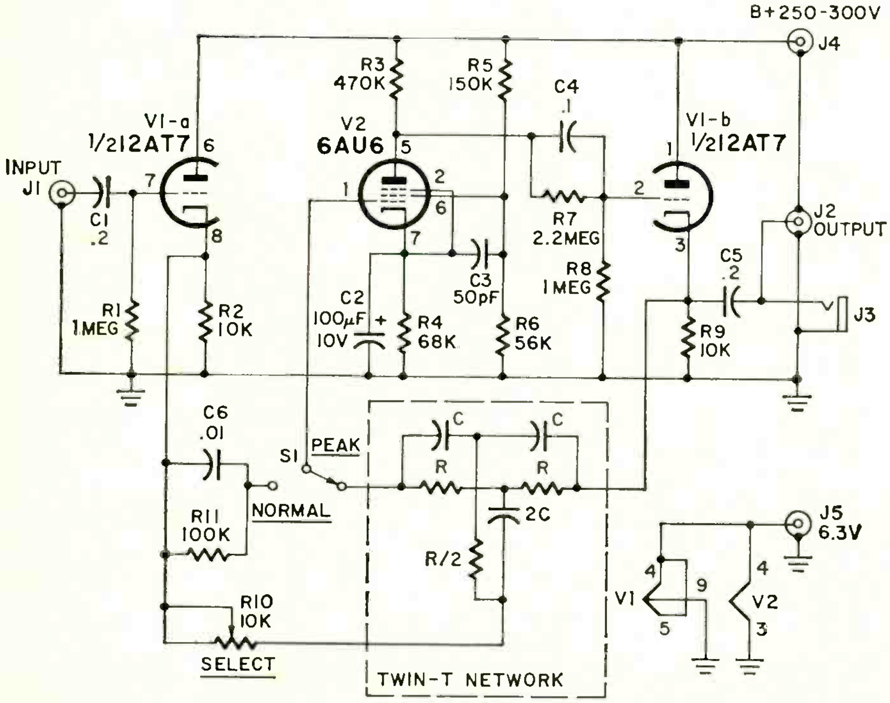
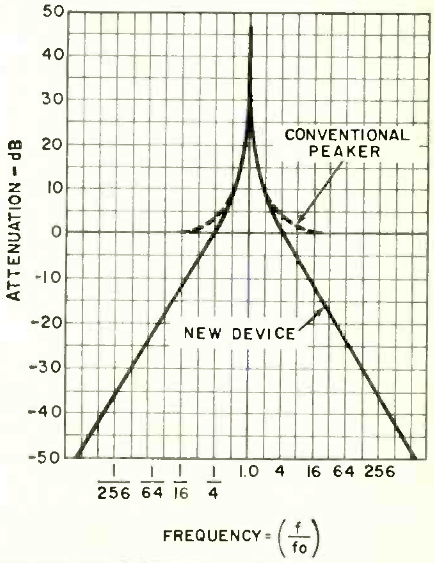


Fig. 1 (left)—Twin-T network in degenerative feedback loop attenuates all signals except those at resonant frequency. Fig. 2 (below)—Greater off-frequency attenuation is possible with the Twin-T degenerative amplifier in Fig. 1.



Exciting New Kit Ideas from Heath

New Heathkit 100-Watt AM/FM/FM-Stereo Receiver

World's finest medium power stereo receiver . . . designed in the tradition of the famous Heathkit AR-15. All Solid-State . . . 65 transistors, 42 diodes plus 4 integrated circuits containing another 56 transistors and 24 diodes. 100 watts music power output at 8 ohms — 7 to 60,000 Hz response. Less than 0.25% distortion at full output. Direct coupled outputs protected by dissipation-limiting circuitry. Massive power supply. Four individually heat sinked output transistors. Linear motion bass, treble, balances and volume controls. Push-button selected inputs. Outputs for 2 separate stereo speaker systems. Center speaker capability. Stereo headphone jack. Assembled, aligned FET FM tuner has 1.8 uV sensitivity. Two tuning meters. Computer designed 9-pole L-C filter plus 3 IC's in IF gives ideally shaped bandpass with greater than 70 dB selectivity and eliminates alignment. IC multiplex section. Three FET's in AM tuner. AM rod antenna swivels for best pickup. Kit Exclusive: Modular Plug-In Circuit Boards . . . easy to build & service. Kit Exclusive: Built-In Test Circuitry lets you assemble, test and service your AR-29 without external test equipment. The AR-29 will please even the most discriminating stereo listener.

Kit AR-29, (less cabinet), 33 lbs....................................**$285.00***
AE-19, Assembled oiled pecan cabinet, 10 lbs........................**$19.95***

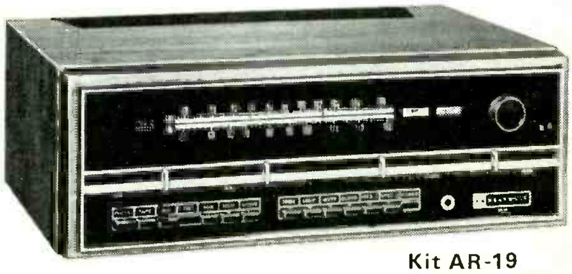
Kit AR-29
$285.00*

New Heathkit 60-Watt AM/FM/FM Stereo Receiver

The AR-19 circuitry reflects many of the advanced concepts of the AR-29. It uses 108 transistors and 45 diodes including those in 5 integrated circuits. It delivers 60 watts music power at 8 ohms. At any power level, Harmonic and IM Distortion is less than 0.25%. Frequency response ranges from 6 to 35,000 Hz. Direct coupled outputs are protected by dissipation-limiting circuitry. A massive power supply includes a section of electronically regulated power. The assembled, aligned FET FM tuner has 2.0 uV sensitivity.

A preassembled and factory aligned FM IF circuit board gives 35 dB selectivity. The multiplex IC circuit provides inherent SCA rejection. It features two switched noise muting circuits; linear motion controls for bass, treble, volume and balance; input level controls; outputs for 2 separate stereo speaker systems; center speaker capability; two tuning meters; stereo indicator light; front panel stereo headphone jack. The Modular Plug-in Circuit Board design speeds assembly. Built-in Test Circuitry aids assembly, simplifies servicing. "Black Magic" panel lighting, black lower panel, chrome accents. Compare it with any model in its price range . . . the AR-19 will prove itself the better buy.

Kit AR-19, (less cabinet), 29 lbs....................................**$225.00***
Assembled AE-19, cabinet, 10 lbs.....................................**$19.95***



Kit AR-19
$225.00*

New Heathkit Deluxe 18-Watt Solid-State Stereo Phono

Looks and sounds like it should cost much more. Here's why: 16-transistor, 8-diode circuit delivers 9 watts music power per channel to each 4½" high-compliance speaker. Speaker cabinets swing out or lift off . . . can be placed up to 10' apart for better stereo. Has Maestro's best automatic, 4-speed changer — 16, 33-1/3, 45 & 78 rpm. It plays 6 records, shuts off automatically. Ceramic stereo cartridge with diamond/sapphire stylus. Has volume, balance & tone controls. Changer, cabinet & speaker enclosures come factory built . . . you build just one circuit board . . . one evening project. Wood cabinet has yellow-gold & brown durable plastic coated covering. This is a portable stereo you can take pride in.

Kit GD-109, 38 lbs..**$74.95***

Kit GD-109
$74.95*

New Heathkit 80-10 Meter 2 KW Linear Amplifier

Incomparable performance and value. The new SB-220 has 2000 watts PEP input on SSB & 1000 watts on CW and RTTY. Uses a pair of Eimac 3-500Z's. Pretuned broad band pi input coils. Requires only 100 watts PEP drive. Solid-state power supply operates from 120 or 240 VAC. Circuit breaker protected. Safety interlocked cover. Zener diode regulated operating bias. Double shielded for max. TVI protection. Quiet fan — fast, high volume air flow. Also includes ALC to prevent over-driving. Two meters: one monitors plate current; the other is switched for relative power, plate voltage and grid current. Styled to match Heath SB series. Assembles in about 15 hours.

Kit SB-220, 55 lbs...**$349.95***

Kit SB-220
$349.95*

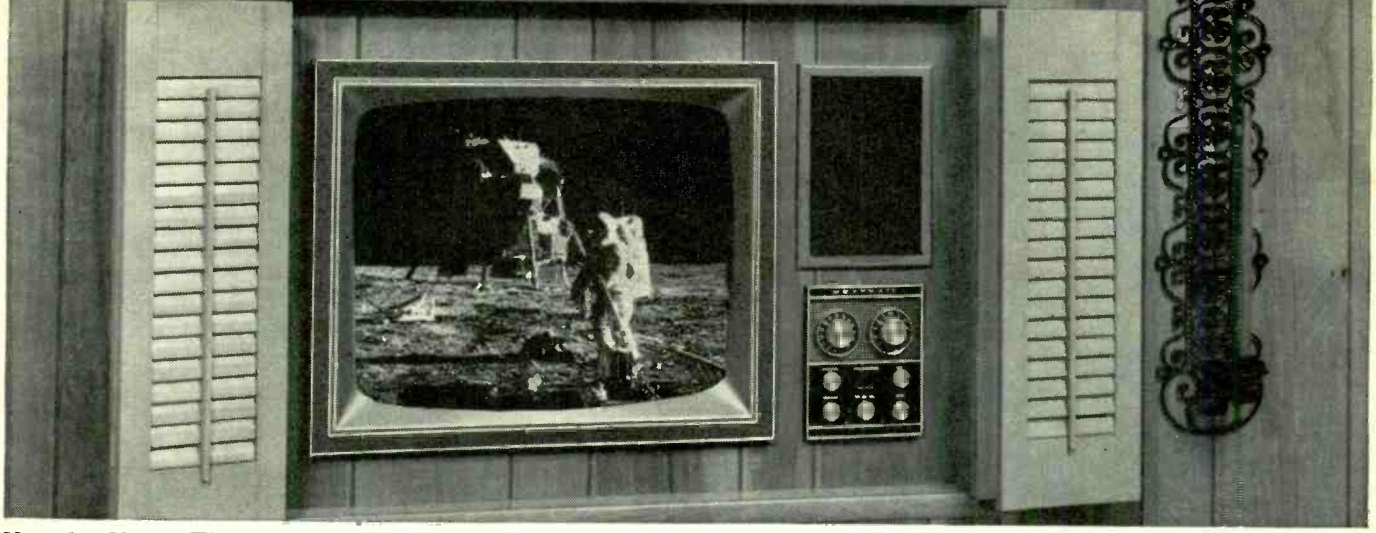
New Heathkit Portable Fish-Spotter

Costs half as much as comparable performers. Probes to 200 ft. Spots individual fish and schools . . . can also be used as depth sounder. Manual explains typical dial readings. Transducer mounts anywhere on suction cup bracket. Adjustable Sensitivity Control. Exclusive Heath Noise-Reject Control stops motor ignition noise. Runs for 80 hrs. on two 6 VDC lantern batteries (not included). Stop guessing — fish electronically.

Kit MI-29, 9 lbs...**$84.95***

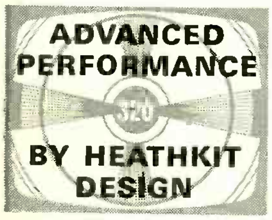
Kit MI-29
$84.95*

NEW IMPROVED 1970 HEATHKIT® COLOR TV
New Lower-Than-Ever Prices



Here's How The Color TV That Thousands Call Best Became Even Better and Lower In Price

Since the very first model was introduced, thousands of owners, electronic experts, and testing labs have praised the superior color picture quality and extra features of Heathkit ColorTV. Now Heath has made improvements that make the 1970 models even better.



Sharper, More Detailed Pictures. Latest design improvement in the circuitry of Heathkit Color TV video amplifiers has increased their bandpass capabilities. The result is an increase in the number of lines of resolution . . . greater than in any other brand of color TV we have tested. This improvement means you get sharper, more detailed pictures as shown by test pattern measurements. You not only get the superior *color* pictures Heathkit Color TV has always been noted for, but you also get sharper pictures.

New Brighter Tube. Now all Heathkit Color TV models include the new brighter picture tube you've read so much about. These new tubes produce noticeably brighter pictures with more life-like, natural colors and better contrast. (We also offer the RCA Hi-Lite Matrix tube as an extra-cost option for the Heath GR-681 and GR-295 kits.)

New Safety Features. As an added safety precaution, AC interlocks have been added to all Heathkit Color TV cabinets.

Now The Best Costs Less. How can Heath make improvements in its Color TV Models and still reduce the prices? We have passed on to you the savings which have accrued due to reduced picture tube prices. The result is your 1970 Heathkit Color TV will cost you $20 to $55 less depending upon which model you choose . . . proof that Heathkit Color TV is a better buy than ever.

All Heathkit Color TV's Have These Superior Features

• New brighter American brand rectangular color tube with bonded-face, etched anti-glare safety glass • Exclusive built-in self-servicing aids so you can adjust and maintain the set for best performance always • Automatic degaussing plus mobile degaussing coil • New broader video bandwidth for better resolution • 3-stage video IF • Improved retrace blanking • Gated automatic gain control for steady pictures • Automatic color control • Exclusive Magna-Shield surrounds picture tube for better color purity • Deluxe VHF tuner with "memory" fine tuning and precious metal contacts (models with automatic fine tuning also are available in all 3 picture tube sizes) • 2-speed UHF solid-state tuner • Completely shielded hi-voltage supply • Extra B+ boost for better definition • 2 hi-fi sound outputs for built-in speaker or your hi-fi system • 300 ohm & 75 ohm antenna inputs • Circuit breaker protection • Optional wireless remote control can be added anytime • Factory assembled and adjusted tuners, IF section, and hi-voltage supply • Exclusive 3-way installation capability — in a wall, custom cabinet or Heath cabinets

Choose Your Heathkit Color TV Now . . .
It's Better Than Ever in Performance . . . and A Better Buy Than Ever

New Lower-Than-Ever Prices On All Models

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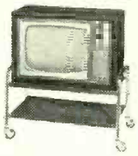

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Now only $359.95*

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Circle 111 on reader service card

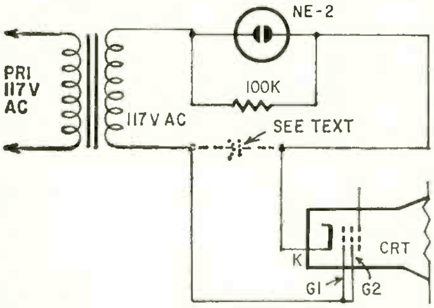
Service Clinic

By JACK DARR
SERVICE EDITOR

CRT tester modification

I have an oddball CRT tester that works pretty well, but I'd like to use a meter in place of the present neon bulb on the emission test. Can I do this?—B.T., Toms River, N. J.

With this circuit you've sent I don't see why not. You're applying 117 volts ac to the CRT cathode and G1/G2. The CRT thus forms a *diode rectifier*, loaded by the 100,000-ohm resistor. If it is able to supply enough emission, you develop enough dc voltage across the resistor to fire the neon. This voltage will be something like 65–75.

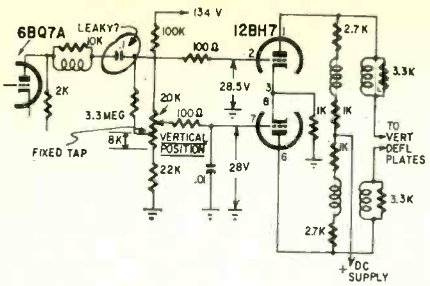


Therefore, you could connect a dc voltmeter across the 100,000-ohm resistor, and get a reading which would be directly proportional to the half-wave rectified output of the CRT (as a diode). You might get a better reading by adding a capacitor across the circuit to act as an "input filter." You'd have to calibrate the meter by testing a good CRT, and then by checking some weak ones. However, this will give you a better reading than the "light" or "not-lit" of a neon lamp.

Vertical positioning trouble in scope

I just built a kit scope. Now, I can't position the trace vertically, more than about 1½ inches from the top or the bottom of the CRT. All of the voltages in the circuit check, except for the pin-2 grid of the 12BH7. Book says 8.5 volts to ground, and I've got 28 volts. The company service department gave me no encouragement, but they insist that I should have 8.5 volts at this point, as the book says. What's going on?—A. W., Albany, Ga.

Believe them. After all, they *made* the thing! Seriously, you can see that this much difference in voltage between these two tubes would cause a 'difference' in the steady-state state dc plate voltages, and a shift of the spot position. Looking at this circuit, I'd say that by taking out all tubes, you could measure voltages across that voltage divider (which is all that resistor string is) and tell where your trouble is really



located. I'd tend to suspect a slight leakage (say about 20 volts worth) through that 0.1-μf coupling capacitor from the 6BQ7 plate.

Remote CB station

I'd like to mount my CB antenna on a building 500 feet from the house. How can I do this without losing too much power?—J. C., Ridott, Ill.

I'm afraid this isn't possible. With only 5 watts of rf power, you'd lose it all a quarter of the way along the cable.

Due to high attenuation of coaxial cable, after about 50′ losses become prohibitive. Even then, you must use expensive, low-loss coax to get anything at all. There's only one practical way to do this. Mount the CB station on the roof of the building at the base of the antenna. Then run audio and control lines down to the control point.

I'd check with the FCC before doing this, though. I can't find anything in the rules about remotely controlled stations, but it's best to make sure.

5M-K9 rectifier

I have a Sony 103 with a 5M-K9 tube in it. It's out and I can't find a replacement anywhere. Any information? —P. G., Okla.

This is an ordinary rectifier. Seems to be about the same as a 6X4, etc. For best results, replace it with a pair of small silicon-diode reactifiers, something like a 600-volt PIV type at 0.5 amp. Solder from plate to cathode on the tube socket, observing polarity. Just for luck, check the plate voltage output. It might be a bit higher than before since these rectifiers have a very small drop.

Loss of scope sync

My Precision ES-550B scope won't sync on the 2500-16K position. Rest of the ranges work okay.—R. E. H., Mansfield, Ohio.

Since the rest of your sweep ranges are working, the trouble must be something in either the selector switch or a coupling capacitor in that circuit. Check C31 since this capacitor sets the sweep speed for the highest frequency range.

Try spray cleaning the switch and the tube sockets. Also check the 6BH6 and 12AU7 sync amplifiers.

Precision ES-500 scope distortion

I've got an ES-500 Precision scope, and can't find a schematic. The scope shows the positive half-cycles of a sine-wave pattern, but not the negative. Vertical amplifier trouble?—H. N., Birmingham, Ala.

You can find a wiring diagram in John F. Rider's *Encyclopedia on Cathode Ray Oscilloscopes* (First Edition), pages 912–13. Your scope is probably an early version, since it shows two of the deflection plates tied together and a single-ended vertical amplifier. The ES-500A's all use push-pull deflection.

Your trouble sounds like very bad clipping or an open circuit in one of the vertical amplifier stages. Check for "balance" of all stages (between the two halves of each push-pull stage). Check bias voltages especially.

Also, check coupling capacitors very carefully, and replace any with the slightest leakage. **R-E**

Circle 115 on reader service card

COMING NEXT MONTH

MAY 1970

■ **Build R-E's No Compromise Stereo Tuner**
Top quality FM stereo tuner uses forward agc transistors in the front end for superior performance when handling very weak signals. Crystal filters in the i.f. strip for optimum performance. Three printed circuit boards to simplify assembly. A tuner you'll be proud to build.

■ **Build Computer Logic Circuits**
Contributing Editor Matt Mandl lets you find out for yourself how computer logic circuits work. He's set up a series of logic circuits you can build with discrete components, and then there's a set of experiments that clearly illustrate how they operate.

■ **Build One Of These**
Electronic flash tester makes quick work of checking out electronic strobe units
Horizontal efficiency tester speeds servicing TV horizontal sweep circuits
Pulsed light darkroom timer is handy for timing enlargements in your darkroom

■ **Plus these special features**
Photography 1970
Kwik-Fix™ Transistor Agc Circuits
Tools Report

TRY THIS ONE

A COPPER WIRE TABLE ON YOUR SLIDE RULE

Most engineers are never far from a slide rule, but a copper wire table can sometimes be hard to find when needed. Resistance, diameter, and circular millage of copper wire can be obtained within 5% from a slide rule. The copper wire table is set up roughly according to the following equation.

$$\text{Wire Gage} = 10(1 + \log_{10} R) \text{ where}$$
$$R = \text{Resistance in ohms per 1000 ft. at } 20°C$$
$$= 10(\log_{10} 100{,}000/\text{Cir Mil})$$
$$\text{Diameter Mills} = \sqrt{\text{Cir Mil}}$$

In practical usage, one simply remembers that No. 10 wire is 10,000 circular mils and 1 ohm per 1000 ft at 20°C.

The remaining table closely approximates the following system.

Wire Size (AWG)	*Circular Mils*	*1000 Ohms per ft. @ 20° C*	*Diameter (in.)*
No. 10	10,000	1	.1
No. 20	1,000	10	.0316
No. 30	100	100	.01
No. 40	10	1,000	.00316
Etc.			

Using any slide rule with D(C) DI(CI) and an L scale, take the example of No. 27 wire.

Set 7 on the L scale; the D scale then indicates 5. From above we know the resistance is greater than 10Ω and less than 100Ω or, 50Ω/1000′ at 20°C. The wire table gives 51.47.

To obtain the circular millage, look at the CI or DI scale which indicates 2. No. 27 is greater than 100 circular mils and less than 1,000 circular mils; therefore, is 200 circular mils. The wire table gives 201.5 circular mils.

The system breaks down for wire sizes larger than zero but this is not a serious handicap.—*R. J. Kerr*

GUITAR STAND HOLDS RECORDER FOR EASY WORK

Recorders with front speakers often sound richer if upended on a suitable rack or stand so that sound will be baffled against the table top. In such a position the controls are usually more convenient and the signal-strength meter, or light, can be more readily observed.

If you don't want to go to the trouble of building an easel-like rack, one that will serve can be purchased for around $5. It is the now-familiar guitar stand. It will hold most portable recorders securely in an effective operating position. The recorder will run cooler, and mechanical hum from the motor will be reduced to a minimum level of audibility.

Add a piece of pegboard to the center upright for storing extra tape reels. By using two pegs the reels can be stored in pairs without changing the position of the tape so that a specific program can be instantly continued at a more convenient time. There will be no tangle. Several pairs of reels can be racked conveniently.

The part of this easel rack that served as the guitar neck rest can be used for holding the microphone or patch cord. It is also ideal for racking headsets.—*Glen F. Stillwell*

CLEAN AND DEMAGNETIZE TAPE HEADS

Magnetic heads on a tape recorder should be kept demagnetized. Magnetized heads will put a permanent hiss on the tape and erase some of the highs. Buy a head demagnetizer. Instructions are provided with the tool.

Clean the heads frequently with a cotton-tipped swab dipped in alcohol (or a special cleaning solvent recommended by the tape recorder manufacturer.)

Top-grade tape is essental for good sound. It is difficult to tell good tape from bad by looking at it. However, inferior unrecorded tape is usually noisy when played with the recorder at maximum volume.—*Glen F. Stillwell*

PILOT LIGHT FOR AC/BATTERY RECORDERS

Many of the newer tape recorders are ac- or battery-powered, so sometimes there is no ON indicator. Meters are used instead of signal-strength lights. Because of this a recorder is often left on. To avoid this when the recorder is used at home with the ac line, plug the recorder into a special multiple receptacle controlled by a toggle switch. This receptacle is plugged into the power line and a miniature night light is plugged into it along with the recorder line cord. The night light serves as a pilot lamp.

Triple receptacles are available at any electrical hardware counter. The toggle switch can be added by splicing it into one lead from the receptacle. This is a series connection.—*Glen F. Stillwell*

R-E

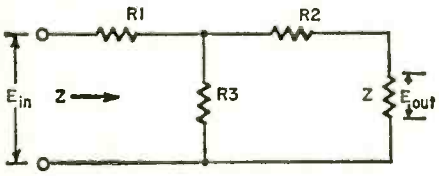
Circle 27 on reader service card

NOTEWORTHY CIRCUITS

THE L-T PAD

Here is an attenuator circuit that looks like a T, but acts like an L. The extra resistor is not included for the benefit of resistor manufacturers, but actually eliminates as many as three resistors.

A precision L-pad usually re-



quires four precision resistors and two 5% or 10% types. This is because the values are dictated by the fact that only two resistors are used in the design. It is a rare occasion when one is available, and paralleling two precision resistors with one 5% is usually necessary to get the value of one resistor precisely.

An L-T pad however has no set values, and can be designed for "real" resistors. Three precision and one 5% will, almost always, do the job.

To find R1 and R3 pick, at random, a value for R2, and solve for R3, using the formula $R3 = \dfrac{Z + R2}{\dfrac{E_{in}}{E_{out}} - 1}$

Try various values for R2 until R3 comes out to an available value. Solve for R1 using $R1 = Z - R3\left(1 - \dfrac{E_z}{E_{in}}\right)$.

If R1 is not available you must find a new value for R3 using the first formula. If the calculated value of R1 is not exactly that of an available precision resistor, you may use the next higher available precision value and parallel with a 5% type. The 5% resistor should be at least 10 times the value of R1.

Since a number of calculations must be made, it is advisable to use a slide rule. Inexpensive ones (with instructions) run about $2.00.

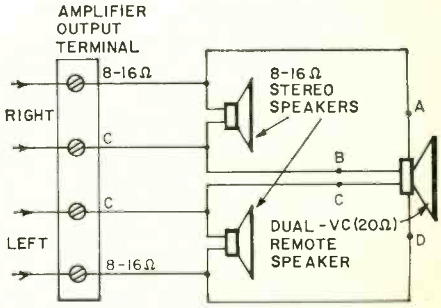
As a final check compute the attenuation

$$\frac{ZR3}{(R1 + R3)(Z + R2) + R1R3}$$

and the network impedance $R1 + \dfrac{R3(R2 + Z)}{R2 + R3 + Z}$. If they don't come close enough to what you require, you can usually make some minor adjustment in R1 that will get you closer.
—*Robert Russell*

DUAL VOICE-COIL SPEAKER SOLVES STEREO EXTENSION PROBLEM

How many times have you been asked by a stereo customer to install an extension speaker to his den or outdoor patio? Most customers want this to be an inexpensive project and do not want two speakers nor care for the stereo sound effect.



Should you tap the remote across one speaker of the stereo system this may unbalance the output and, in addition, you do not get the total sound from the extension speaker.

Try the following setup as a solution to the problem: Use one of the dual-voice coil speakers that were designed for multi-impedance matching of transistor auto radios. Quam makes a 5"x7" speaker model 57A2MT or equivalent that mounts nicely in an 8" speaker baffle. These speakers have two voice coils of 20 ohms (impedance) each.

One of the voice coils is connected to the right channel stereo speaker and the other one to the left channel output (see diagram). This hook-up will not effect the operation of the master stereo unit such as causing any cross talk or distortion.

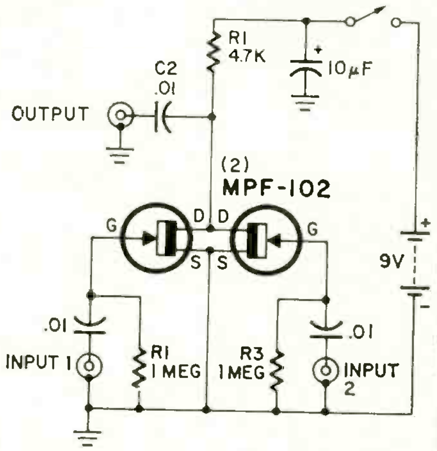
These speakers will match the common transformer-output type amplifiers from 8 to 16 ohms. They also work equally well for the direct feed (output transformerless) transistor amplifier of from 20 to 40 ohm output impedance.

The only precaution is to have proper phasing of the two coils. To do this, listen to the sound output while you reverse the leads to terminals A-B or C-D until maximum output is obtained.

This set-up produces good quality sound output and cuts the cost in half for the installation.—*R. L. Goodman*

SIMPLE UTILITY MIXER

Here's an interesting mixer circuit. With it you can effectively combine signals from audio to high-frequency rf. Also, as a special bonus, this circuit will provide some gain at a low noise figure. The inputs can be of almost any level or impedance while the output (low-Z) will drive most tuned circuits or transistors.



Basically, the device–I call it the Utili-Mix–consists of two similar FET amplifier stages with a common load resistor (R2). Each FET develops a signal across this resistor, a form of cancellation takes place, and a difference signal results.

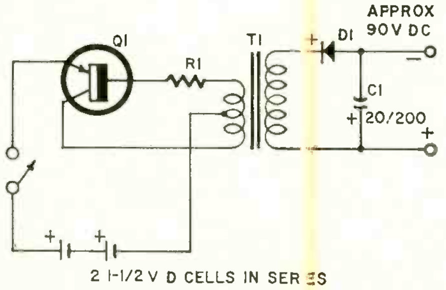
Construction of the mixer is up to you. However, I found that the parts went nicely into Radio Shack's No. 270-230 3¼" x 2⅛" x 1⅛" utility case. The wiring layout isn't too critical, but try to keep all leads as short as possible.

If you want more gain, try reducing R2 to 2,200-ohms. Also, use a larger battery for B1. These modifications will not affect mixing ability.—*Gary McClellan* **R-E**

90 VOLT BATTERY SUBSTITUTE

Here is a small one-transistor experimental type dc-dc converter which can be used to substitute for a 90-volt battery in experiments with low-current devices such as neon glow-lamp oscillators, etc.

T1 can be universal audio output transformer with the voice coil output used as a primary or it can be a center-tapped 6.3 volt filament transformer. Almost any pnp power transistor can be used. R1 must be determined experimentally in order to make the circuit oscillate. Its value is somewhere between 100 and 1000 ohms.



Rectifier D1 was originally a small selenium type; but you can substitute a silicon type, or better still, a full-wave bridge. The capacitor is a 20 μF, 200 volt electrolytic. Of course you can use a larger value depending on the amount of filtering you need. The device is powered by two flashlight batteries.

I used this gadget to power a neon binary counting demonstrator. I'm sure you will find several uses for this handy device and save money on those expensive 45 and 90 volt batteries.—*George Devenconzi*

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READER QUESTIONS

Tape recorder bias

I've got a funny one. A Revere T700D tape recorder will play any pre-recorder tape nicely: plenty of volume, good tone, etc. But, anything I record is badly distorted and very weak. I replaced the tape heads, but no help. The set won't erase, either.—J. N., Bronx, N. Y.

Let's eliminate a few things. If you can play tapes, the amplifier and play head are okay. If you can't erase and can't record clearly, this should be a *bias* problem. Both of these functions would be upset if you had little or no bias on the recording head.

Check the 6K6 bias oscillator, preferably by replacement. Check for the presence of high-frequency bias voltage on the recording head with a scope or even an ac vtvm. The bias should read about 40 volts rms at 38 kHz. You can easily tell which is the bias lead since the signal lead is shielded and the bias lead isn't.

Check the switching. Quite often, one contact on a play–record switch will miss in RECORD position. Spray it well with contact cleaner.

Vtvm calibration

I have a Knight-Kit 83Y125 vtvm, and I'm having problems with calibration on dc volts and on the ohmmeter.—S. M., Frankfort, Ky.

Look for something common to both functions in the meter circuits. How about the 12AU7 tube? This is the standard meter-between-cathodes circuit used in many vtvm's, and the tube must have equal emission in each half.

The slightest grid emission in this tube can upset the balance. Check the tube on a good grid-emission tester or try a new one. New tubes should be aged for at least 24 hours with heater voltage applied and just a little plate voltage. Or you can plug the tube into the meter and leave it on.

You should have about +150 volts on the plates of the 12AU7 and about −50 volts to the cathodes. If the rectifier is a selenium type, it could be weak. Silicon types break down completely, but do not weaken. Check the dc supply voltage. Measure rms ac voltage across the transformer secondary, then read dc voltage output which should be about 1.2 times rms voltage. **R-E**

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