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Radio-Electronics

60c ■ OCT. 1968

IND

GERNSBACK

SPECIAL ISSUE
STEREO & TAPE RECORDERS

CHANGERS–What's really new

FM TUNERS–FET & IC breakout

CASSETTES–New shape of tape?

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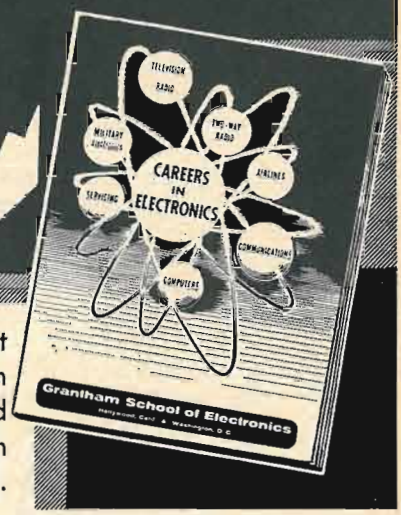

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LOOKING AHEAD

By DAVID LACHENBRUCH
CONTRIBUTING EDITOR

Off-color TV

A multifaceted, full-scale engineering investigation is now under way in an attempt to remedy the major weakness of American color TV—those annoying variations of color intensity and hue from station to station, camera to camera, scene to scene and program to program.

The study will examine the role played in color changes by station equipment, maintenance, film processing, broadcast standards, measurement techniques, receiver design, servicing, antennas—to cite just a part of the inquiry's scope. The end result could be new instrumentation, equipment, procedures—or even FCC standards.

The inquiry is being conducted by an ad hoc engineering committee composed of representatives of virtually every organization with an interest in television: Society of Motion Picture and Television Engineers, Institute of Electrical and Electronic Engineers, Electronic Industries Association, National Association of Broadcasters and National Community Television Association, with the FCC represented on an "observer" basis.

'Hands-off' color sets

The widespread use of automatic frequency control in 1969-model receivers eliminates one of the three critical color tuning procedures. Set manufacturers now are exploring methods of eliminating the other two—color intensity (chroma) and hue or tint adjustment.

Manufacturers' previous investigations of possible automatic chroma and hue controls have reached a dead end as a result of the seeming color inconsistencies in the transmitted pictures. The all-industry ad hoc investigation of color changes (above) is understood to have been undertaken at least partly at the instigation of receiver makers determined to further automate color tuning and controls. The outcome and implementation of the new study will be a major factor in the development of "automatic" color sets.

Fast-growing CATV

Television-by-cable may or may not be the wave of the future—but at present it's growing faster than ever. An analysis of CATV's growth last year shows that the number of systems increased by nearly 15% to 1984, while the number of homes served by cable rose 26% to 2,675,251—that's 4.7% of all US television-equipped homes, an increase of 3.9% in one year. Wyoming is the state with the greatest CATV saturation—28.5% of all homes get their programs by cable. Vermont and Montana are next, with 27% and 23.8%, respectively.

Importance of imports

While the demand for black-and-white TV sets continues to be surprisingly strong in the "color age" (sales were up 2.5% from last year in the first half of 1968), a sharply rising percentage is now foreign-made. Predictions are being heard that monochrome TV will follow the transistor radio in becoming largely an import market with the vast majority of receivers being manufactured outside the U.S.

In the first half of this year, more than 25% of all monochrome TV sets sold in the United States were made overseas. Most of these imported sets, however, bore American set makers' brand names—either built to their specs by outside firms or, in some cases, made in their own plants in the Far East. The vast majority of imported TV sets still come from Japan—the source of 557,298 receivers in the first 6 months of 1968. At the same time, 53,403 came in from Taiwan (Formosa) and a couple of hundred from Hong Kong. Aside from Canada, no other country ships any quantity of TV sets to the United States.

Imported black-and-white sets, while still largely in the small-screen area, are gradually increasing in size. The 12" receiver is gaining in popularity, while the novelty-sized tinyvision sets are declining.

TV newspaper readout

Newspapers may soon be added to the services presented on CATV systems. UMC Facsimile Corp., controlled by Universal Marion Corp., is testing via cable TV a system which it claims can transmit a full-size newspaper page per minute on a standard FM station's subcarrier—or faster if a full FM channel is used at night while the station is off the air.

Its "variable velocity scanning" system saves time and bandwidth by eliminating redundancies in the transmitted signal. Portions of the newspaper page—such as the white spaces around the type—which do not contain printed information are processed at a rate much faster than information-containing portions. Under UMC's plan, a large metropolitan newspaper would be transmitted by FM subcarrier and stored on a standard reel of magnetic audio tape for later playback at 7 ips on a vacant CATV channel.

A more elaborate system would employ the tape recorder-player in the viewer's home. "Playing" the newspaper index first, the viewer would decide which pages he wanted to read on his TV screen, then use the fast-forward button to locate them. At night, the tape would be erased automatically and the next morning's paper recorded.

Meanwhile, a new data conversion technique is being used by Bell Labs to transmit newspaper page facsimilies over telephone lines (photo). In experiments a page has been transmitted in 6 minutes. Each page is attached to the drum of a revolving facsimile scanner. Scanner signals are fed into a data conversion terminal for conversion to binary pulse. These encoded pulses are then transmitted over T-1 carrier telephone line at rates of 1.5 million bits sper second. **R-E**

Radio-Electronics

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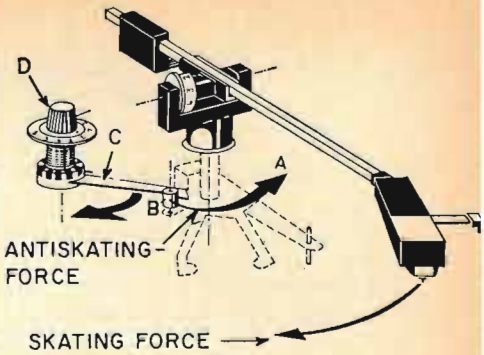
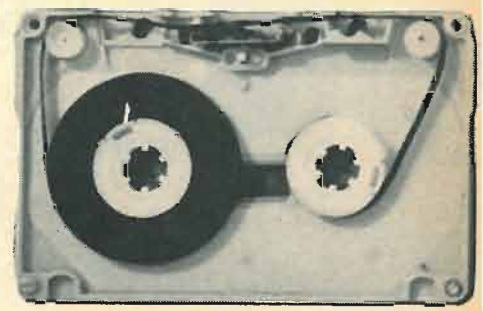


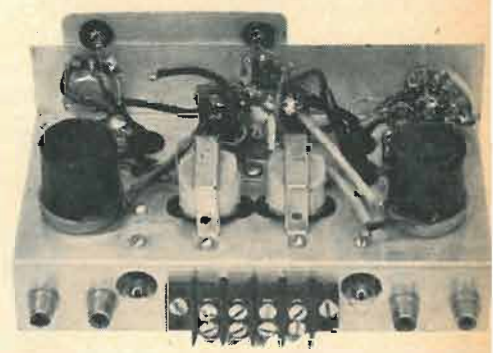
Record changers and casette recorders. They may look the same, but what's under the hood has changed. Here's 13 pages of the latest happenings in Stereo & Tape Recorders.

starts on page 32

STEREO AND TAPE RECORDING



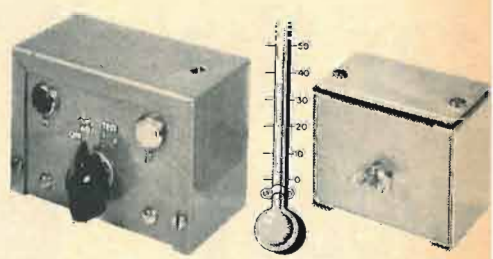
BUILD ONE OF THESE



Do-it-yourself Compandor makes your records sound like you were sitting in the concert hall.

see page 52

HOW TO FIX IT



see page 56

Make winter driving safer this year. The Road Icing Alarm (above) tells you when roads may be icy.

GENERAL ELECTRONICS

DEPARTMENTS

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NEWS BRIEFS

HOW WE WILL USE "PAPER POWER"

A wafer-thin, "energy-paper" cell announced by Norelco offers a new source of portable electric power. The unique cell, weighing less than 1/10 ounce, has been used to power a prototype Norelco shaver. It can provide about 1 watt for 6 to 7 minutes.

Cells are moistened before use.

Disposable power cell is moistened before use, activating chemically treated fibers. Metallic plate on the shaver's lid serves as top layer in cell "sandwich" and must be replaced periodically. Top layer is equivalent to zinc can in conventional cell.

Because of the chemicals used and low internal resistance due to cell thickness (1 mm), they have a power density 5 times that of a normal dry cell.

This makes the cells especially useful for brief, high-output applications. For example, a number of cells were joined together to start a car with a rundown battery.

Complete cells have four sandwiched layers, although a three-layer cell is used when one sheet is built into the device to be powered. The top layer, which corresponds to the zinc can in conventional dry cells, is a zinc or magnesium sheet that acts as an electron donor. A dry paper sheet treated with common salt is beneath the donor sheet. The third layer consists of paper fiber impregnated with potassium persulphate and powdered carbon. A conducting foil completes the "sandwich." The addition of water to the salt-treated layer forms an electrolytic solution.

Cost of the basic materials for an energy-paper cell and the capacity per cubic cm are about the same as for

(continued on page 6)

Here's a new, complete ICS course in TV Servicing that costs less than $100.

With the first two texts, you can repair 70 percent of all TV troubles.

You need no previous experience to take this complete, practical course in TV Repairing.

You don't even have to know a vacuum tube from a resistor. Yet in a matter of months, you can be doing troubleshooting on color sets!

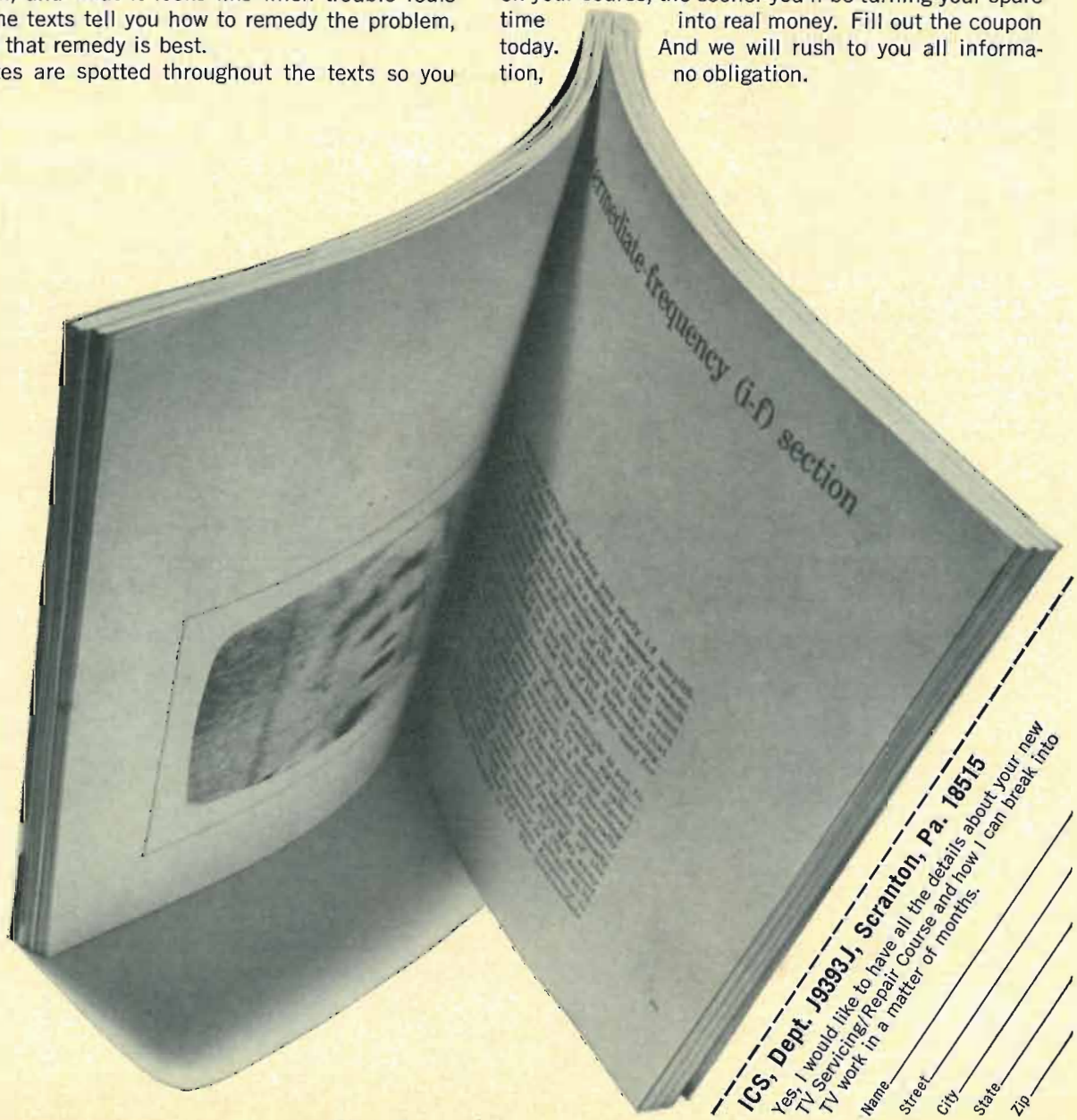
Course consists of 6 texts to bring you along quickly and easily. 936 pages of concise, easy-to-follow instruction, plus 329 detailed illustrations. You also receive a dictionary of TV terms geared directly to course material so you'll understand even the most technical terms. The dictionary will come in handy even after you've finished your course.

Instruction is simple, very easy to grasp. Photos show you what a TV screen looks like when everything is normal, and what it looks like when trouble fouls it up. The texts tell you how to remedy the problem, and why that remedy is best.

Quizzes are spotted throughout the texts so you can check your progress. At the end of the course, you take a final examination. Then you get the coveted ICS® diploma, plus membership in the ICS TV Repairman Association.

By the time you've finished the course, you should be able to handle tough, multiple TV problems, on color sets as well as black and white.

This new TV Servicing and Repair Course has been approved by National Electronic Associations for use in their Apprenticeship program. Because of its completeness, practicality and price, it is the talk of the industry. The cost is less than $100—just slightly over ½ the price of any comparable course on the market today. Remember, the sooner you get started on your course, the sooner you'll be turning your spare time into real money. Fill out the coupon today. And we will rush to you all information, no obligation.



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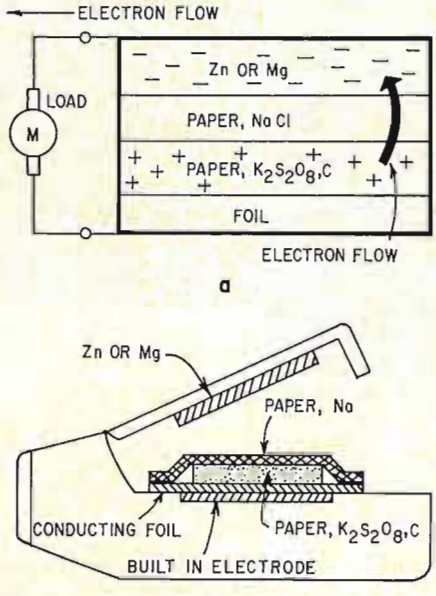
convenional everyday-type dry cells.

The cells, developed at the Philips Research labs in Holland, were introduced by North American Philips Co., who says it has no current plans to mass-produce them.



Four-layered cell (a) has zinc or magnesium sheet covering a dry, salt-treated paper sheet. Next layer is paper impregnated with potassium persulphate and powdered carbon. Bottom layer is conducting foil. Shaver (b) can use a three-layer cell. Top layer is built into shaver.

'CHIRP' TESTS HEARING

Electronic chirping from this new Neo-meter developed by Zenith helps determine hearing difficulties within hours of birth. Four pushbuttons, marked for precisely calibrated sound levels, control signals that resemble the chirp of a bird. Held 12" from a baby's ear, infant response is observed

(continued on page 14)

Radio-Electronics

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As a Radar representative, you could make *$1,200* a month if you sold only one system each week. Most of our dealers make much more. Two sales a week would net you *$28,000* a year; five a week, *$46,000 a year.*
We make the finest solid state microwave burglar alarm system available; one that's easy to install and easy to service...for both home & business.
We're presently expanding our organization of dealer representatives. We'll train you, provide you with leads and offer continuing counsel. You can operate full-time or part-time. Later, you may want to expand and organize your own sales staff.
But for now, let's get better acquainted. Fill out the coupon. In a few days, you'll receive complete details about how you can live a life of crime-and make it pay, *handsomely.*

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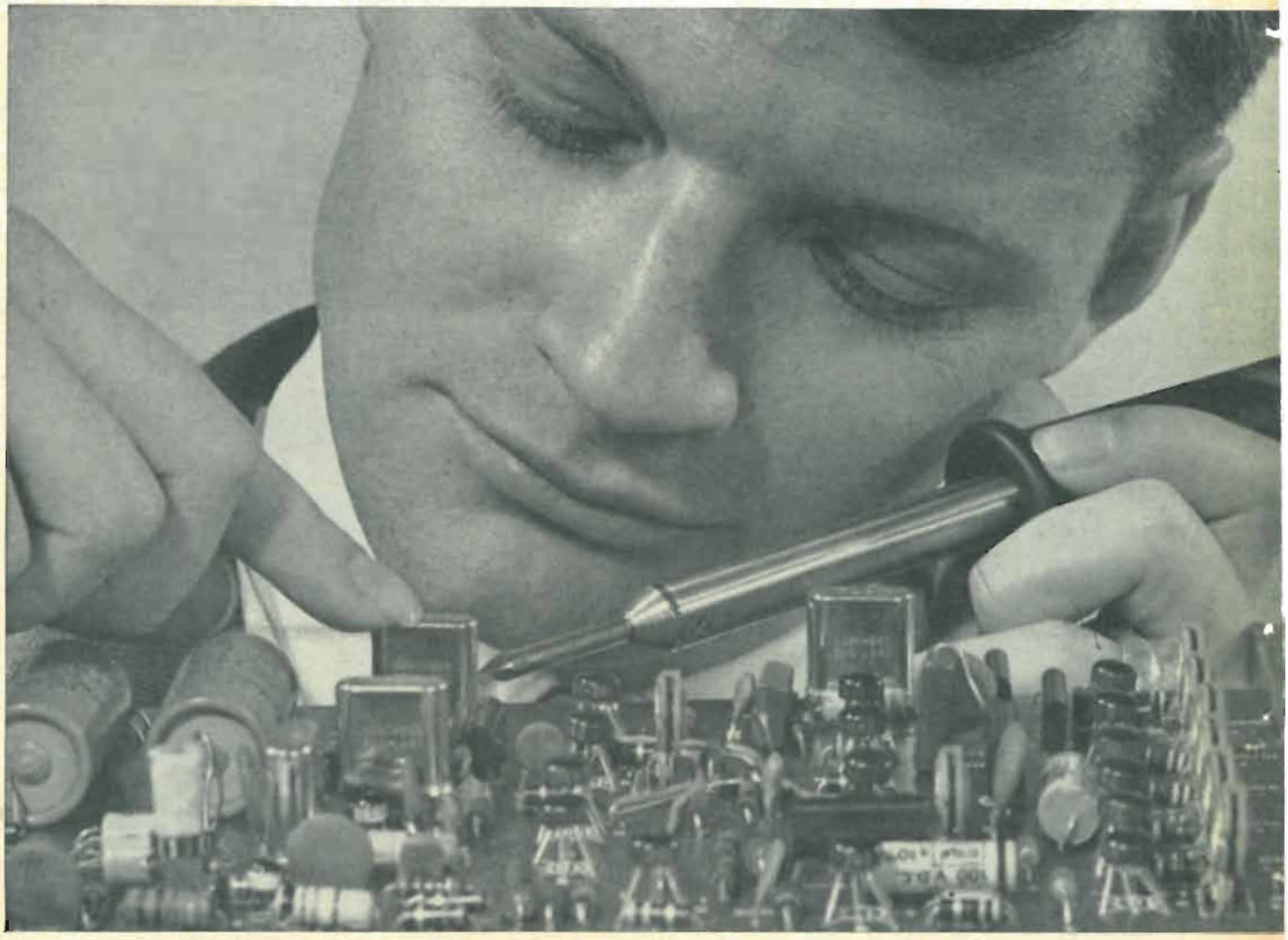

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NRI Communications training programs will qualify you for a First Class Commercial Radiotelephone License issued by the FCC. If you fail to pass the FCC examinations for this license after successfully completing an NRI Communications course we will, on request, refund in full the tuition you have paid. This agreement is valid for the period of your active student membership and *for six months* after completion of your training. No school offers a more liberal FCC License agreement.

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There is a model scientfically designed and engineered for your area.

Check this chart for the FINCO "Signal Customized" Antenna best suited for your area.

STRENGTH OF UHF SIGNAL AT RECEIVING ANTENNA LOCATION ▼	Strength of VHF Signal at Receiving Antenna Location				
	NO VHF ▼	VHF SIGNAL STRONG ▼	VHF SIGNAL MODERATE ▼	VHF SIGNAL WEAK ▼	VHF SIGNAL VERY WEAK ▼
NO UHF →		CS-V3 $11.50	CS-V5 $18.50 CS-V7 $25.95	CS-V10 $37.95	CS-V15 $50.95 CS-V18 $59.50
UHF SIGNAL STRONG →	CS-U1 $10.50	CS-A1 $19.95	CS-B1 $31.50	CS-C1 $45.95	CS-C1 $45.95
UHF SIGNAL WEAK →	CS-U2 $15.95	CS-A2 $23.95	CS-B2 $41.95	CS-C2 $54.50	CS-D3 $73.50
UHF SIGNAL VERY WEAK →	CS-U3 $22.95	CS-A3 $32.50	CS-B3 $52.50	CS-C3 $62.95	CS-D3 $73.50

All Prices Subject to Change

NOTE: In addition to the regular 300 ohm models (above), each model is available in a 75 ohm coaxial cable downlead where this type of installation is preferable. These models, designated "XCS", each come complete with a compact behind-the-set 75 ohm to 300 ohm balun-splitter to match the antenna system to the proper set terminals.

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(continued from page 6)

by a nurse or trained volunteer. Early detection of hearing defects allows doctors to aid in the development of normal speech.

TECHNICIAN TEST

The National Electronic Association reports a 50% failure rate for its new electronic technician certification test (see News Briefs, September). The test was written by technician members of NEA, and covers electronic theory and practical troubleshooting.

SUPERMAGNETS

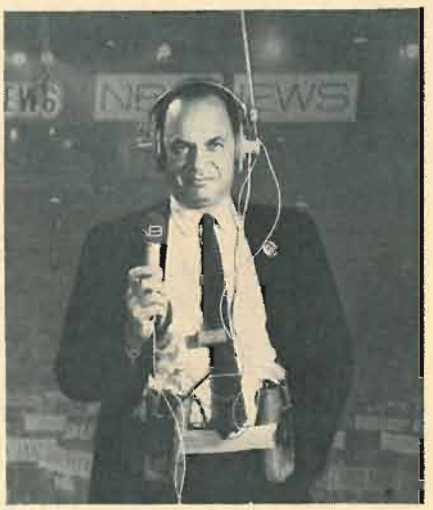
New permanent-magnet materials with very high resistance to demagnetization make it possible to cast extremely small magnets in shapes different from conventional magnets. Solid cobalt, copper, iron and a rare earth element—either cerium or samarium—are placed in disc-shaped molds in a copper hearth and fused by an arc furnace. Coercive forces as high as 28,700 oersteds have been obtained in Bell Labs magnets.

CB ON A NEEDLE

High atop Seattle's well-known Space Needle, Jim French, a disc jockey for AM station KIRO, beams traffic reports to area listeners during his 6 to 10 a.m. show. Instead of depending entirely on reports from helicopters, which are sometimes restricted by rain, fog and snow, KIRO makes use of a CB network and reports from some 40 work-bound motorists. The station operates an Amphenol 650 with a vertically polarized coaxial antenna mounted near the Needle's spire. The station's unique elevation assures a 20-mile radius coverage, but QRM is described as "unbelievable" at times.

RADIO MICROPHONE

A wireless and portable radio broadcast microphone was used during the national political conventions by ABC and NBC news. Transmitter, receiver



and batteries are worn on a belt and weigh only 3¼ lbs. Transmitters operate between 942 and 952 MHz at about 200 mW. Reception is simultaneous with transmission, and a "tie clip" is the transmitter on-off switch. Units are made by Airborne Instruments Laboratory, a Cutler-Hammer division. **R-E**

Disc jockey Jim French reports accident radioed to station KIRO by Seattle area motorist equipped with channel 9 CB rig. AM station is nearly 600 feet above city.

Scott's new LR-88 receiver takes the

out of kit building

Building a kit used to be something you couldn't do with ladies and children present, but Scott's new LR-88 AM/FM stereo receiver kit has changed all that. First, there's the instruction manual. In clear and simple language, it leads you, step-by-step, through every stage of the assembly process. And each stage is illustrated . . . full-size, full-color. Next, there's Scott's ingenious new Kit-Pak®. The parts for each assembly stage are in individual compartments, keyed to the instructions. All wires are color-coded, and pre-cut and pre-stripped to the proper sizes. Difficult or critical sections are pre-wired, pre-aligned, pre-tested, and factory-mounted on printed circuit boards. Is soldering your bugaboo? Scott has provided push-on solderless connectors for the hard-to-get-at spots.

About thirty painless hours after you've started, you've completed one great receiver. The LR-88 is the 100-Watt kit brother to Scott's finest factory-wired beauties. It includes the famous Scott silverplated Field Effect Transistor front end, Integrated Circuit IF strip, all-silicon output circuitry . . . in fact, all the goodies that would cost you over a hundred dollars more if Scott did all the assembling. Performance? Just check the specs below . . . and you'll be amazed at how great a receiver sounds after you've built it yourself. Treat yourself to a weekend of fun and years of enjoyment . . . see the Scott LR-88 at your dealer's today.

LR-88 Control Features: Dual Bass and Treble; Loudness; Balance; Volume compensation; Tape monitor; Mono/stereo control; Noise filter; Interstation muting; Dual speaker switches; Stereo microphone inputs; Front panel headphone output; Input selector; Signal strength meter; Zero-center meter; Stereo threshold control; Remote speaker mono/stereo control; Tuning control; Stereo indicator light.

LR-88 Specifications: Music Power rating (IHF), 100 Watts @ 4 Ohms; Usable sensitivity, 2.0 μV; Harmonic distortion, 0.6%; Frequency response, 15-25,000 Hz ± 1.5 dB; Cross modulation rejection, 80 dB; Selectivity, 45 dB, Capture ratio, 2.5 dB; Signal/noise ratio, 65 dB; Price, $334.95.

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Correspondence

PAUSE CONTROL WIPE-UP

I built the automatic windshield wiper-pause controller (July 1968) and soon discovered I couldn't get it to turn off. Since the wiper motor is actuated by supplying a ground return path (through S2 or S3), a positive 12 V appears at point A at all times, even with S2 and S3 open.

My solution was to insert a diode in the line between S1 and the junction of R4 and D1, with its anode at S1. It prevents current at point A from reaching the emitter of the unijunction through R1 and R2.

NEIL H. FORREST
Crownsville, Md.

The automatic wiper-pause control worked too well on my 1968 Camaro. I couldn't turn it off. My solution was to simply eliminate D1, since the path through the motor supplies enough voltage at the anode.

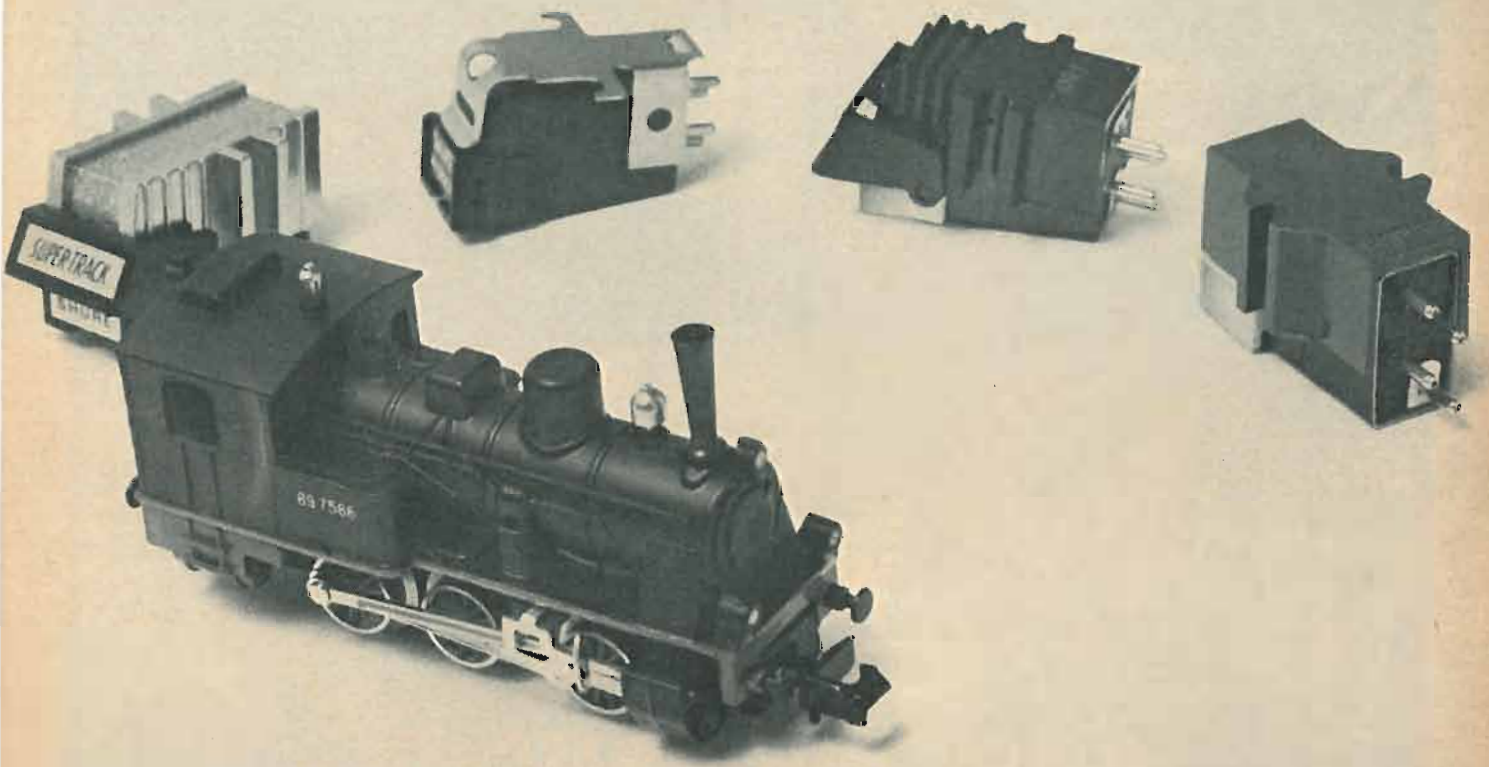
ARTHUR ASKEY
Chicago, Ill.

The author reports that it is the current flowing through R3 that triggers the SCR. While the steps mentioned above do work, he suggests altering the circuit so the wiper terminal of R2 connects to capacitor C1. The unijunction is then connected to the same reference point regardless of the position of R2.

BEYOND HEARING

Periodically, there is some editorial sound-off on the necessary bandwidth for amplifiers and whether this should go beyond the "range of hearing." Since my aural nerve is defective, these investigations are no longer practical for me. However, I would call your attention to remarks that have been made by Drs. Fletcher and Munson with regard to inaudible sounds that had distinct effect on the auditor. I would also mention that during the 20's, I believe, the French pipe-organ builder, Cavaillé-Coll, conducted various experiments, primarily related to timbre. I believe he used 21 partials, which would take him pretty

(*continued on page 22*)



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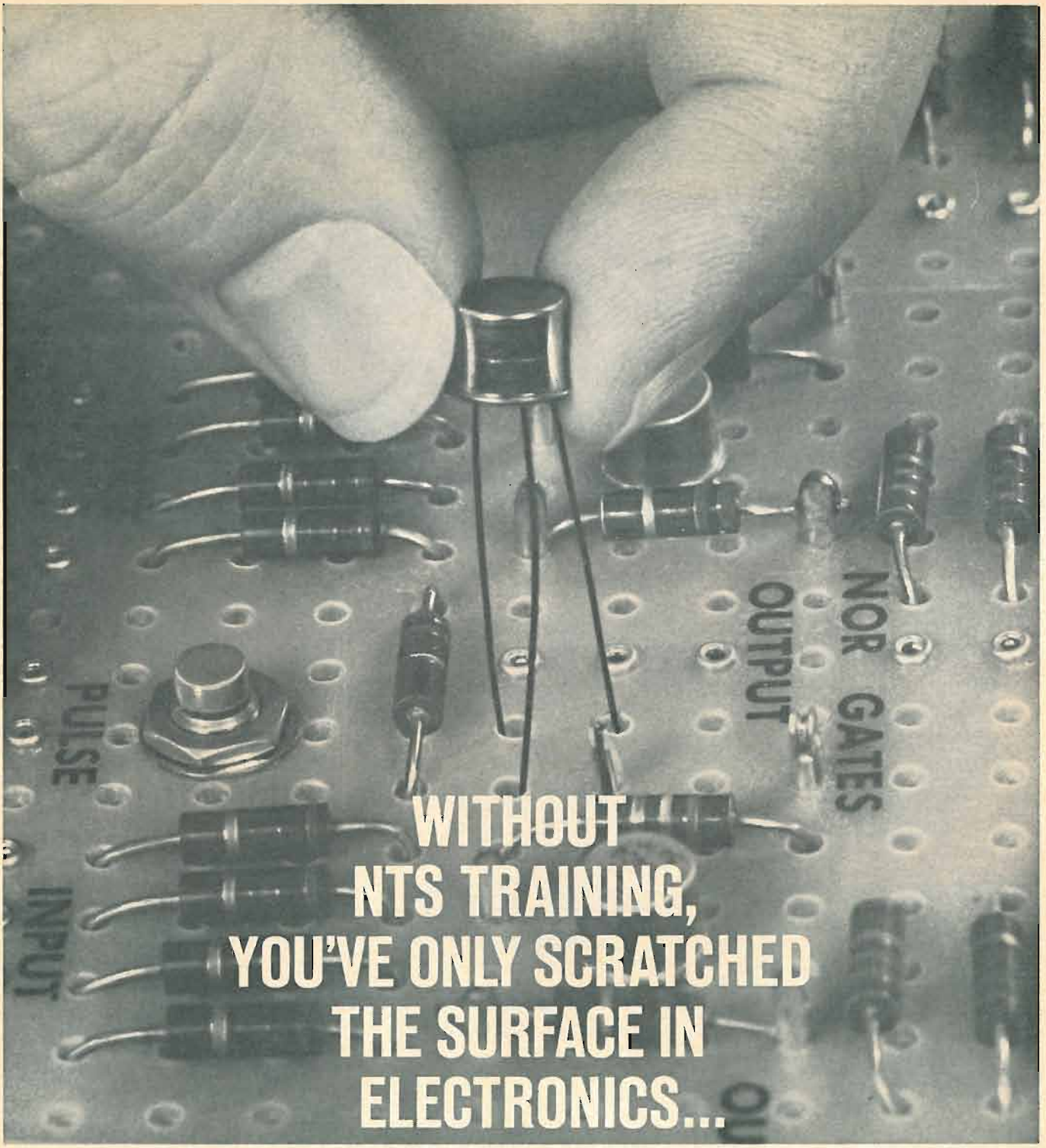

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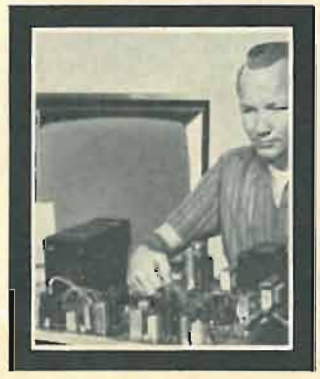

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(continued from page 16)

high, even if the fundamental frequency was low.

JOSEPH G. BRADLEY, JR.
New York, N. Y.

There have been many pros and cons on this subject over the years. Let's stir it up again. How about some of our readers telling us about their opinions and experiences.

ANOTHER WAY TO DO IT

I enjoyed the article "Computerize your Car's Lighting System" in the August 1968 issue. However, if a new car is in the horizon, I have a suggestion. Fiber optics is now offered on all models of Chevrolet except the Chevy II and Corvair and is standard equipment on the Corvette. Optional systems are offered on the Thunderbird and Continental Mark III.

Basically, this system "pipes light" directly from each headlight, parking light, license light and two tail lamps to readouts mounted on the front fenders and on the rear deck. This system is not electronic in nature and is completely passive, and thus not subject to transistor, resistor, or diode failure. It will also indicate which lamp has failed and will tell if two failures have occurred.

T. H. HORRELL
Design Engineer
Packard Electric Division
General Motors Corporation
Warren, Ohio

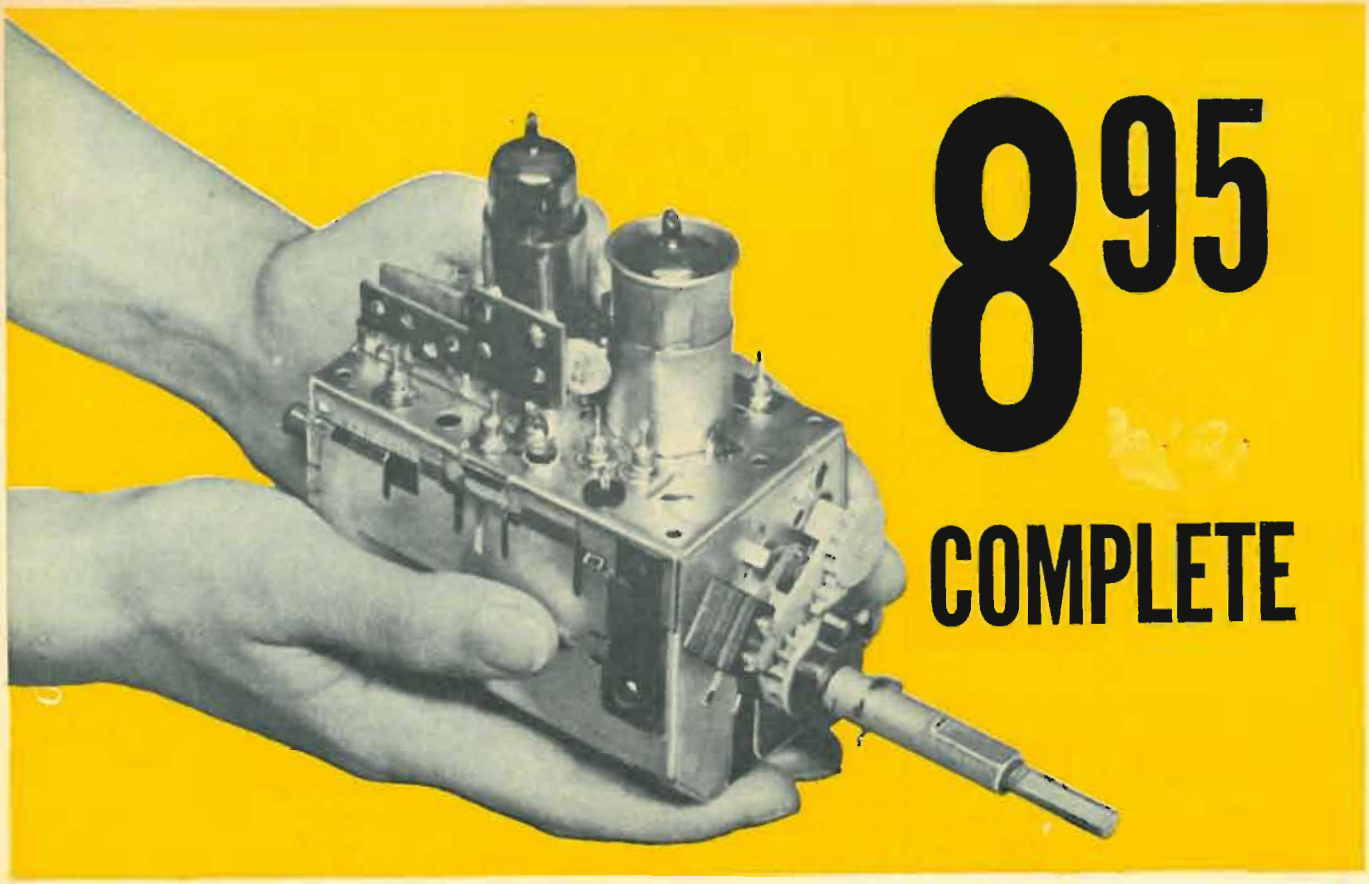
HALL-EFFECT INDUCTOR

The Hall-effect applications mentioned in the article "Hall Effect in Solid" (July 1968) are the most common ones, but one new application was developed by a research group headed by Shoei Katsoka, at Japan's Electrotechnical Laboratory in Tokyo. This new application is a solid-state inductor which may revolutionize many integrated-circuit designs.

Before its development, engineers had to rely upon external discrete coils when inductive reactances were needed in their circuits. The device may make it possible to include inductors as integral parts of IC chips along with other discrete components.

JOHN LAABS
No. Stonington, Conn.

We've already asked John to do a complete story for us on this new device. It will appear soon. **R-E**



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CR6XL	Parallel 6.3v	2½″	12″	41.25	45.75	10.45
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CR9XL	Series 450mA	2½″	12″	41.25	45.75	11.00

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Circle 19 on reader's service card

In the Shop . . . With Jack

By JACK DARR
SERVICE EDITOR

INPUT IMPEDANCE MATCHING

IMPEDANCE MATCHING IS MOST IMportant in output circuits, where we are dealing with *power*. A properly-matched load will get maximum power from the amplifier. But impedance matching is a two-ended thing; we have input impedances too.

However, input impedance is far from being as critical as output impedance. Why? Primarily because the inputs of most amplifiers are "dry circuits." There is voltage, but practically no current; hence, very small amounts of *power*. If we can get enough *voltage* out of our device—microphone, phono cartridge, etc.—to drive the amplifier to its rated power output, fine. Therefore, the actual impedance match is not nearly as critical as many think. There are exceptions, of course, and we'll see some of them.

The only time we do get into trouble is when the mismatch is so bad that it reduces the input signal voltage *too much*! Then, we have a "weak output." For example, a crystal phono cartridge has a very high impedance. Normally it uses a load resistor of about 4.7 megohms, to develop a high signal voltage across the input. If we connect a dynamic microphone directly across such an input, we won't hear too much output. There will be some, but not enough.

However, if we add a matching transformer to the mike, between its low voice-coil impedance and the input, so the output voltage is stepped-up a lot, we'll be back where we were. This is the kind of impedance matching that *is* necessary.

Standard impedances

There are actually only two "standard" impedances: "low," which is the 600-ohm balanced type used in all radio-TV broadcast audio equipment (Fig. 1), and "high," which, by a kind of gentleman's agreement, includes anything from 50,000 ohms on up.

There are others, but these aren't ordinarily considered as standardized. They can be anything, but will probably be about 2000 ohms or so.

The high-impedance group includes crystal and ceramic microphones and phono cartridges, and any other kind of device with a matching transformer which gives it an output impedance of 50,000 ohms or more. Velocity mikes, dynamics and similar types are all basically very low impedance, and need the matching transformers for high Z work. "Magnetic" phono cartridges are basically low Z devices, and are used in both versions.

As usual, there is a good reason for using each of these. The low-impedance, balanced-to-ground 600-ohm lines can run for long distances with little attenuation, and no undesirable effect on the *frequency* response. Because of the balanced circuit and the grounded center tap, they do not pick up hum and noise. So, this type

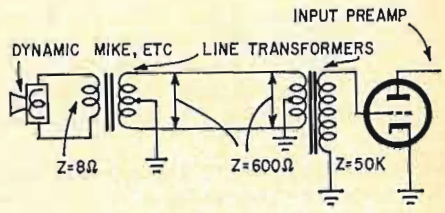

Fig. 1—Matching 600-ohm transformers are used for a balanced line between mike and input. This is standard impedance for radio and TV broadcast audio equipment.

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

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 200 Park Ave. S., New York 10003.

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is universally used in broadcast work, and for high fidelity recording work.

The high-impedance types are cheaper. However, they should be limited to comparatively short runs, especially when used with microphone and phono input cable. The inherent shunt capacitance of a long run of coaxial cable will cause a severe loss of high frequencies.

You can always identify the type by looking at the schematic. If the input goes directly to a tube grid or FET (Field Effect Transistor) base, with a very large load resistor, it's high-Z. If there is a center-tapped transformer across the input, it is not apt to be a 600-ohm balanced type.

Mismatch and frequency

Normally, even what looks like a horrible mismatch won't make a lot of difference in the quality of the output. If you wind up with enough signal voltage to drive the amplifier to its full output, okay. In an emergency, I have fed the 16-ohm output of a PA

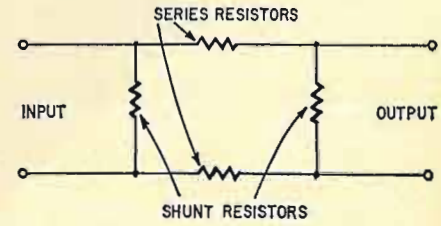

Fig. 2—Input overdrive can be cured with a simple H pad, which will not affect frequency. To reduce signal output, large series resistors and smaller shunt resistors are used in the network.

system into the 600-ohm balanced input of a radio-remote amplifier, and fed a low-impedance speaker line directly to the very high-impedance input of a tape recorder, and come out smelling like a rose.

There is only one thing you must beware of: in such cases—don't overdrive. A microphone may have a voltage output of something like 50 mV, a phono cartridge up around one volt. But a speaker line can get up around 15–20 volts, and you'll overdrive the sensitive input and cause a bad hum, clipping and so on. Transistor amplifiers seem to be especially sensitive to this kind of overload problem.

The cure, of course, is to cut down the input-signal voltage. Use simple non-inductive resistive H-pads across the circuit (Fig. 2). These are not frequency-sensitive since they use only resistors. Rule of thumb: to cut down voltage, make series resistors bigger and shunt resistors smaller. **R-E**

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SHOWN ABOVE: Left, 848A 30 watt CDP speaker, $89.00 list; or FC100 horn only, $53.50 list for use with any E-V convertible driver. Right, AC100 horn only, $92.00 list. Not illustrated, smaller 847 25 watt CDP speaker, $59.00 list. Normal trade discounts apply.

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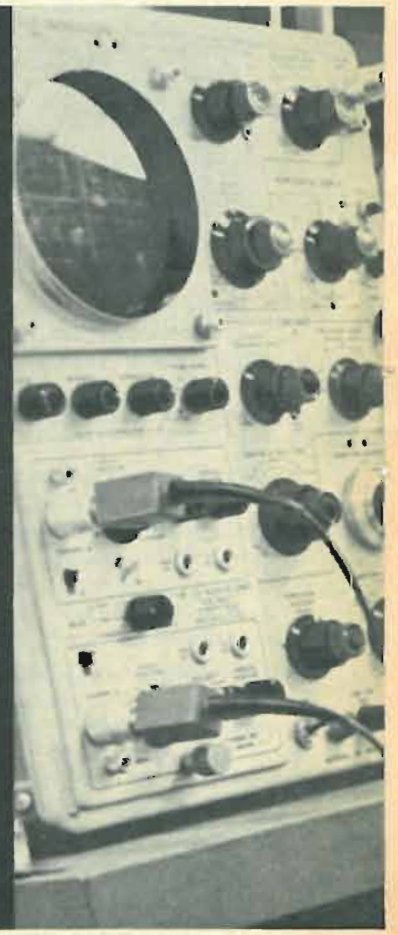

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RE-53

Circle 25 on reader's service card

What's Really New

Inside story on the new generation—changers that think they're turntables!

By CHARLES WURTSWORTH

MOST HI-FI COMPONENTS HAVE UNDERGONE SIGNIFICANT improvements that have touched off "second generation units." FM tuners have been fitted with front-end FET's and IC's in their midsections . . . amplifiers boast silicon transistors . . . loudspeakers capitalize on acoustic suspension.

Now it's the record changer's turn. Although current models employ no revolutionary concepts, it can be safely said the new changers are significantly improved over instruments of a few years ago.

A sign of what's happening is the changer's soaring reputation. Until recently, it was widely believed that highest fidelity was possible only with a single-play turntable fitted with a separate arm and cartridge. Mechanical simplicity and careful design could produce playback with extremely low levels of wow, rumble and flutter. Well-designed arms could help a cartridge trace grooves at low tracking force and error.

Record changers, on the other hand, often suffered from short, resonating tone arms and high arm pivot friction. Considerable arm pressure was needed to trip a changer into cycling at the end of a recording. The sheer mechanical complexity of a changer soaked up a considerable part of its price without contributing much to quality.

Finally, conventional changers reeled under the introduction of the stereo disc. With increased cartridge sensitivity in the vertical plane, where rumble is most troublesome, changer performance deteriorated even further.

Then came the turnabout. Despite its rejection by audio purists, the changer still offered a powerful appeal: operating convenience. Its faults were willingly accepted by many listeners for the pleasure of being able to load the instrument with more than a half-dozen discs and hear music played without further fuss. This may explain why manufacturers expended considerable effort to upgrade the changer to full hi-fi status.

Have they succeeded? The answer from a chorus of authorities and audiophiles is that the difference in quality between the manual turntable and changer has virtually disappeared.

The current crop of changers is the result of a number of painstaking refinements. Several examples show where they appear. If you examine the turntable platter on a current changer, you probably won't see a mere shell of metal. Chances are it's a heavy platter, possibly more than 7 pounds. Note the tone arm. Again, it's no longer a metal shell. It may be tubular metal or wood, with mechanical resonances carefully engineered out of the audible range. And it is extremely rigid yet lightweight.

In addition, the cartridge end is constructed with a

In Record Changers

precise offset to provide low tracking error. At the arm's anchored end, there is a low-friction pivot to complement high-compliance stereo cartridges. At that point you'll also see a counterbalance system far more sophisticated than on older changers. Instead of a coarse spring, new models have elaborate weights to permit balancing and adjusting an arm to recommended stylus force. Unlike earlier changers, arm balancing in new models virtually eliminates the need for leveling the instrument base during installation.

A new changer will probably have a trip mechanism that can trigger a change cycle when stylus force is less than a gram. (It once required some 8 grams or more.) The motor will be an induction or hysteresis-synchronous type (or a combination of both). Either type of motor in a well-designed changer has excellent speed accuracy. Some models add a "pitch" control, a vernier on turntable speed that allows a listener to match musical pitch to that of a live instrument.

Photo Credits: Above from left to right—Lesa Professional Six by Martel; Dual 1019 by United Audio; Lafayette Model 400; Allied Model 919; (left) McDonald model 600 by BSR; (below) Miracord Model 50H. All six are the latest changers around.

Another changer trend is to make some adjustments, formerly hidden from view, easily accessible to the listener. Instruction manuals now provide more comprehensive information on adjusting arm height (to clear a record stack) and setdown point. They reflect the belief that, if a system is capable of higher quality, critical adjustments should be easily available to maintain it.

Even the name "record changer" is shifting. Many models are designated "automatic turntables," which suggests a combination of single-play turntable and automatic changer. The new designation is mainly justified by supplying two spindles. One is the familiar, long type to stack records for the changing operation, the other is a stubby one. If the listener prefers single-play or manual operation, the short spindle is substituted in the turntable's center hole. Now single-play becomes as convenient as with a manual turntable.

Why bother with single-play? It's apparently the manufacturer's nod to the audio purist who associates high quality with the manual player. One benefit is that the short spindle, unlike the long one, can rotate *with* the record. This subjects a disk's center hole to virtually no wear or widening. Another benefit—the tone arm doesn't have to be handled in single-play operation, a tricky proposition with today's featherweight cartridges. The changing mechanism automatically positions the stylus in the lead groove. Also, the system shuts off automatically after the disc is through playing.

Many other features appear in recent changers. Let's look at several as they appear in specific models.

Anti-skating devices are one example. Skating is the tendency of the arm to thrust sidewise toward the center of the disc. (The force develops from the fact that the arm is offset, or bent, near the cartridge to help eliminate tracking error.) Since skating force tends to nudge the stylus against the inner wall of the groove, the result may be uneven record wear and distortion. This was hardly a problem with old changers since high pivot arm friction obliterated the light skating forces. But current cartridges track at a gram

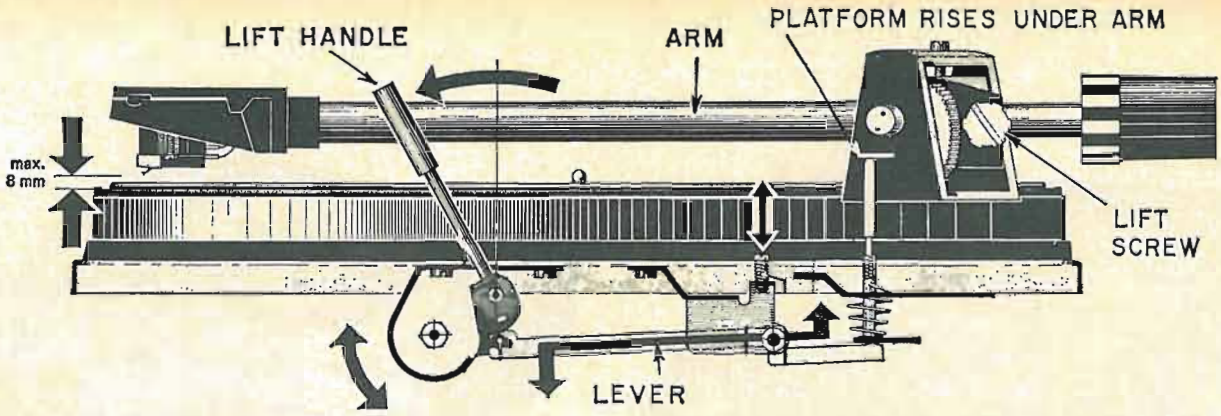


Fig. 2—Cueing devices permit manual lowering of the stylus. On Dual 1019, pressure on the lift handle is transmitted to a platform under the tone arm. This raises the stylus above the record surface, permitting scratch-free lateral tone arm movement.

or so, and skating force is more apparent.

The anti-skating mechanism is usually a spring or weight device. The arrangement on the Miracord 50 is in Fig. 1 (below). Skating force developed by the arm is shown by the lower directional arrow. The anti-skating device creates an opposing force whose direction is shown by arrow A.

To set up the system initially, the listener dials a number on the adjusting knob, marked D. This value will always be the same as the stylus force recommended by the cartridge manufacturer. (Anti-skating force is about 1/10 of this stylus force.) The listener's adjustment sets the tension of a rotary spring below the knob and its force is applied to lever C. The lever presses against bolt B on the tone-arm shaft. As the tone arm rides through its arc, it receives a continuous counterforce to offset any skating effect.

Another feature now widely used in automatic turntables is a cuing device to overcome the problem of handling a delicate tone arm and stylus. It's not a simple task to manipulate a tone arm that's tracking at a mere gram or less without risking a swipe of the stylus across the record grooves. The cuing device answers the problem of lowering the stylus on a particular band or groove.

To operate a typical cuing system, a lever is operated that raises the tone arm a fraction of an inch above the grooves. The tone arm can then be safely moved to any point over the record. Releasing the cuing lever allows the stylus to descend gently to the record surface.

The cuing feature of the Dual 1019 is shown in Fig. 2. When the lift handle is pulled by hand, the lever transmits the action back to the lift screw. This raises the platform, positioned just below the tone arm. After the listener has moved the tone arm over the desired point, the lift arm is pushed toward the rear of the changer. This disengages the lever from the lift screw and allows the arm to drop slowly to the record, its speed controlled by damping action of silicone grease.

This cuing system may also serve as a pause control. If the lift handle is pulled, the arm rises and hovers a fraction of an inch above the disc for the desired pause, then returns to the same groove after release.

The light tracking force of current cartridges has prompted many manufacturers to include a built-in stylus gauge on their record changers. Further, the gauge is usually coupled with a method for finely balancing the tone arm. This leads to a two-step adjustment when a changer is first set up in the home.

To illustrate how it's done, adjustments are shown in Fig. 3 for the Garrard Synchro-Lab 75. First step is balancing the arm. This is done by turning the counterbalance adjustment, a wheel that positions the large counterweight at the rear of the arm. When the arm is in perfect balance, the stylus-force dial is turned to the recommended stylus force (there are graduations from 0–5 grams). With this system, the arm becomes resistant to error in turntable level and mechanical disturbances.

Also note the bias compensator near the arm in Fig. 3. This is another designation for the anti-skating control de-

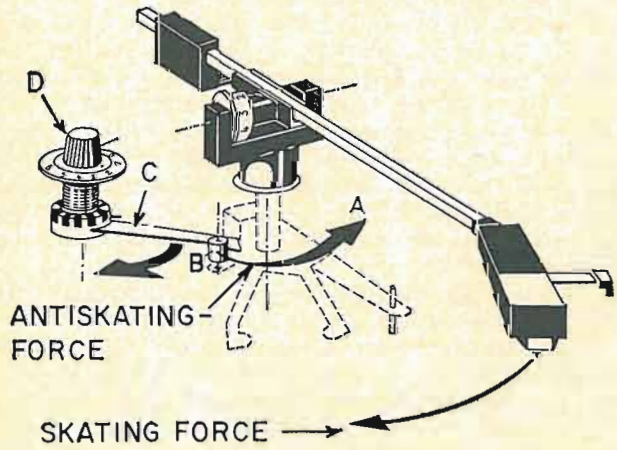


Fig. 1—Anti-skating mechanisms apply a constant counterforce (A) to the tone arm. On the Miracord 50, this force is about 1/10 that recommended for tracking and is set with knob D.

Fig. 3—Two tone arm adjustments on Garrard's Synchro-Lab 75 permit working with modern-day light-tracking-force cartridges.

scribed earlier. In this model, a movable weight is slid until a number, which corresponds to the stylus force, appears in a window. The Garrard Synchro-Lab, incidentally, utilizes a special drive motor that combines the principles of both induction and synchronous motors. The manufacturer states that the induction section permits the turntable to attain operating speed and high torque quickly, while the synchronous section provides accurate speed by locking onto line frequency.

An arm's counterweight system can become quite elaborate, as seen in the McDonald 600 arrangement in Fig. 4. The manufacturer (BSR) provides three weights that may be assembled to obtain basic adjustment ranges for different cartridges. Fig. 4-a shows the master weight A. It alone would counterbalance any of the lighter cartridges. To use an intermediate-weight cartridge, weights A and C are coupled together. The heaviest cartridges would use an A–B weight combination. Once the range is determined, the weights are mounted on the arm (Fig. 4-b) and slid back and forth until the arm is perfectly balanced. Once this is done, the desired stylus force is dialed on calibrated knob D.

All changer makers strive for precise record speeds, especially under changing line voltage and varying load on the turntable as it piles up records. Most automatics now have four-speed changers (16⅔, 33⅓, 45 and 78 rpm). A few are three-speed, eliminating 78 rpm.

Several manufacturers provide a vernier that permits the listener to vary rpm slightly. This feature is found on Dual, Lesa and Perpetuum-Ebner models. The range of variation is about 6%, or about a half-note. This would enable a solo-instrument player or serious listener to adjust musical pitch of the recorded material to that of a live instrument.

When the listener wishes to adjust speed to the nominal rating, he places a strobe disk (usually supplied) on the turntable and observes its reference markings. These markings appear to "freeze" when viewed under fluorescent illumination during correct rpm. One model, Lesa, contains a built-in strobe and indicator positioned next to the speed control knob.

Vernier action for this feature may be handled internally by a tapered motor-drive pulley. As the user operates the vernier speed control, he's actually moving the idler wheel against the tapered pulley to cause small changes in gear ratio on a given speed. Manufacturers claim this arrangement affects only disc rpm, not motor speed or power.

Disc-dropping mechanisms have also undergone considerable refinement. An objection in older changers was that discs were given rough treatment on the center hole due to pushoff action. An example of a superior system for gentler record changing is illustrated in Fig. 5. Note that a stack of records rests on a bottom support (actually, three such supports in a circular arrangement). A record is dropped as the bottom supports are drawn close to the spindle. The significant action, however, is that the holding supports simultaneously project outward to bear the weight of the records above. Thus a dropping record is separated from the pile and does not sustain stress from above. Also, sidewise pressure that wears the disc hole is eliminated.

New changers contain other innovations to insure high playback quality. Many have needle-point and ball bearings to reduce friction in tone-arm action. Special plastic jigs are supplied to clip on the cartridge and guide the installer to a precise cartridge overhang position for minimum tracking error.

At least one manufacturer goes so far as to provide a knob for adjusting the stylus vertical tracking angle. Nominally 15°, it is altered by a varying number of records stacked on the turntable. It's this kind of attention to small detail in the new equipment that's won over many an audiophile to the ranks of the automatic record changers. **R-E**

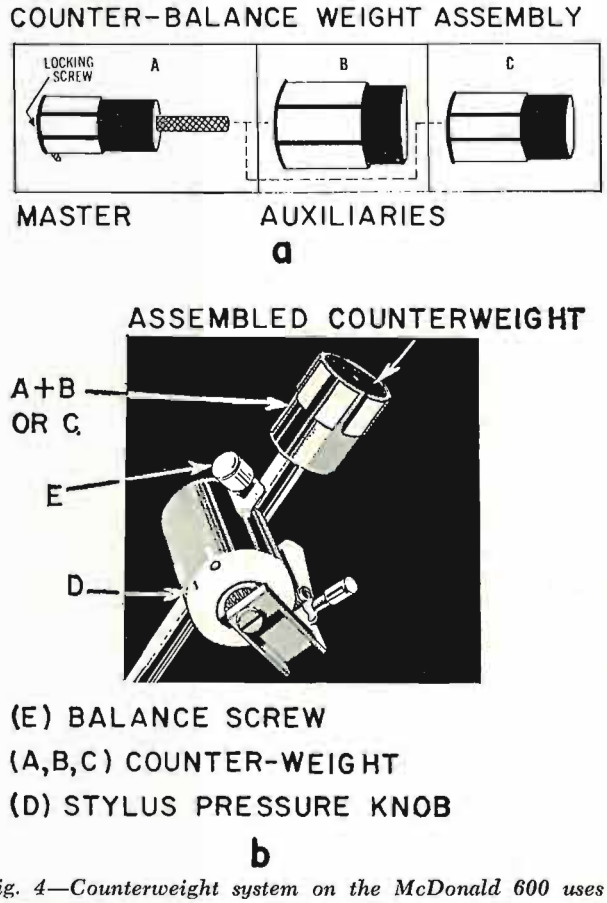
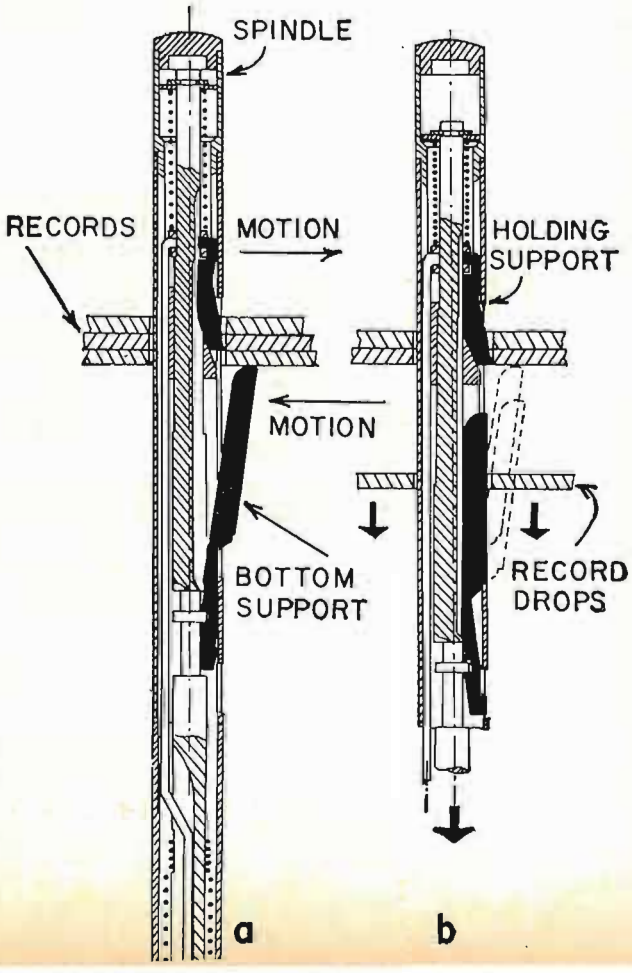


Fig. 4—Counterweight system on the McDonald 600 uses a master weight for lighter cartridges and one of two auxiliary weights plus the master weight to balance heavier cartridges.

Fig. 5—Elac disc-dropping spindle. During drop cycle, three bottom supports (drawn in a*), permit record to drop. Holding support arms move out* (b) *to support remaining records above.*



FM TUNERS-FET

New solid-state devices are revolutionizing today's FM tuner designs with multistage i.f. limiters, greater sensitivity and ultrasharp selectivity.

by PETER SUTHEIM

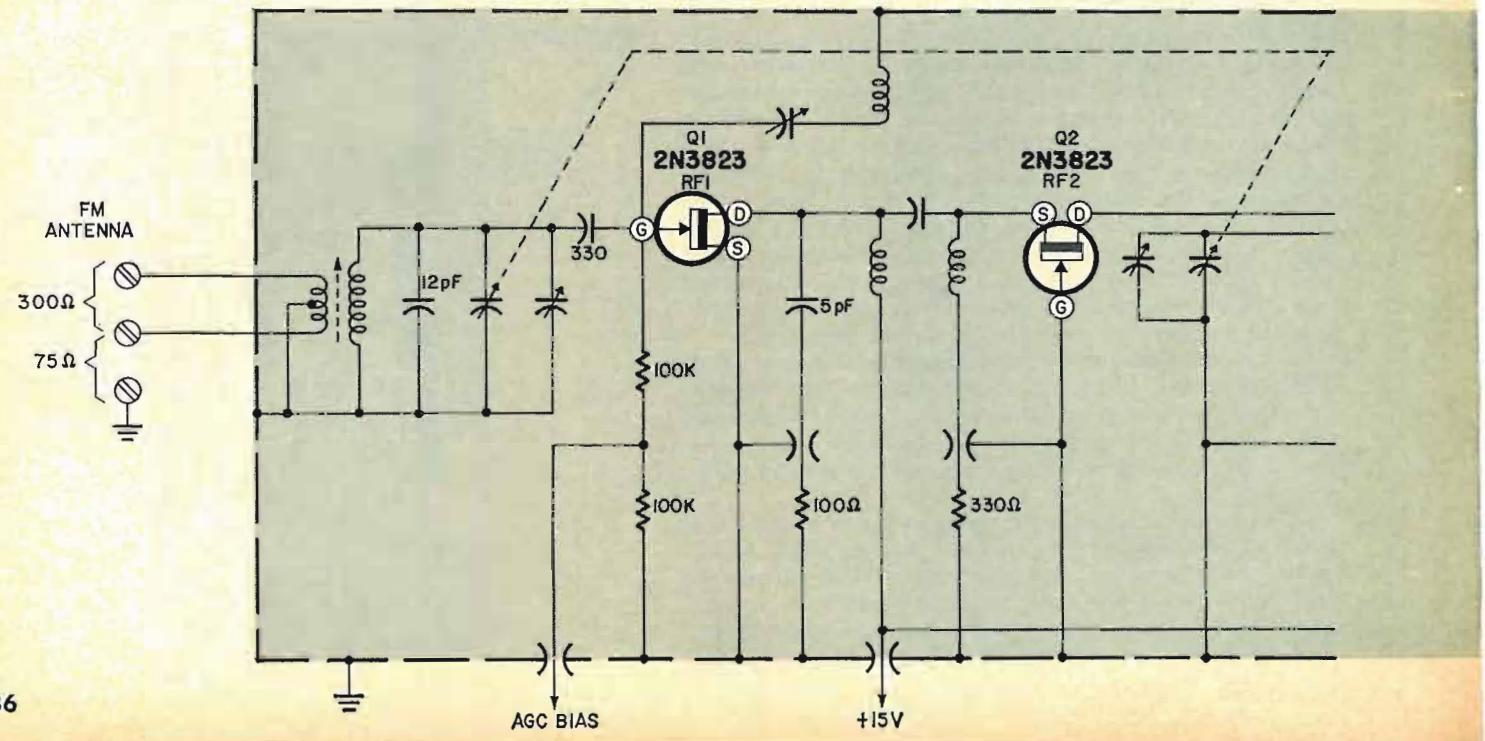
AS SO OFTEN HAPPENS IN MODERN TECHNOLOGY, A NEW demand and a revolutionary advance in the state of the art arrived almost hand in hand. The complex FM-stereo multiplex signal, with its critical bandwidth and phase requirements, made heavy demands on FM tuner circuitry. At about the same time, solid-state technology began to come up with new devices and circuits that allowed engineers to meet the demands. That isn't to say that good FM stereo tuners couldn't be built with tubes—many were—but simply that tuner design has taken a new turn in the past few years. A turn toward solid state.

Three kinds of fundamentally new devices appear in the more advanced FM tuner designs today: the field-effect transistor (FET), the integrated circuit (IC), and the solid-state ceramic (piezoelectric) filter.

The FET is quite different from the conventional transistor. Attempts to make conventional transistors work in FM front ends were disappointing. When they weren't noisy, they were very susceptible to signal overload, which caused cross-modulation and resulted in a powerful signal's appearing at several spots on the tuner's dial, sometimes right next to or on top of a weaker station—which happened to be the one you wanted to listen to. The cross-modulation (which is really exactly like the desirable amplitude modulation in a transmitter, and like intermodulation distortion in an amplifier) was caused by the nonlinearity of the transistor's base-emitter junction, which behaved like a diode.

In fact, it is a forward-biased diode, which represents a comparatively low resistance. To prevent that low resistance from loading down the rf tuned circuits excessively, the transistor's base had to be tapped down on the coil, and the consequent loss of gain had to be made up elsewhere. The loading would vary with signal strength and automatic gain control (agc) voltage, to make matters worse.

For that reason, many transistor FM tuners used tubes of one sort or another in their front ends (nuvistors, for example). But the FET, with its high and relatively stable input impedance, low input capacitance and square-law transfer characteristic, makes an ideal rf amplifier—even



AND IC BREAKOUT

better in many respects than tubes. The noise generated by an active device depends on its operating temperature, among other factors. A tube, therefore, which necessarily runs hot, generates significantly more noise than an FET, and the noise limits the maximum sensitivity of the tuner. Also, FET's don't seem to lose gain or become noisier as they age. Tubes do both.

FET for FM front ends

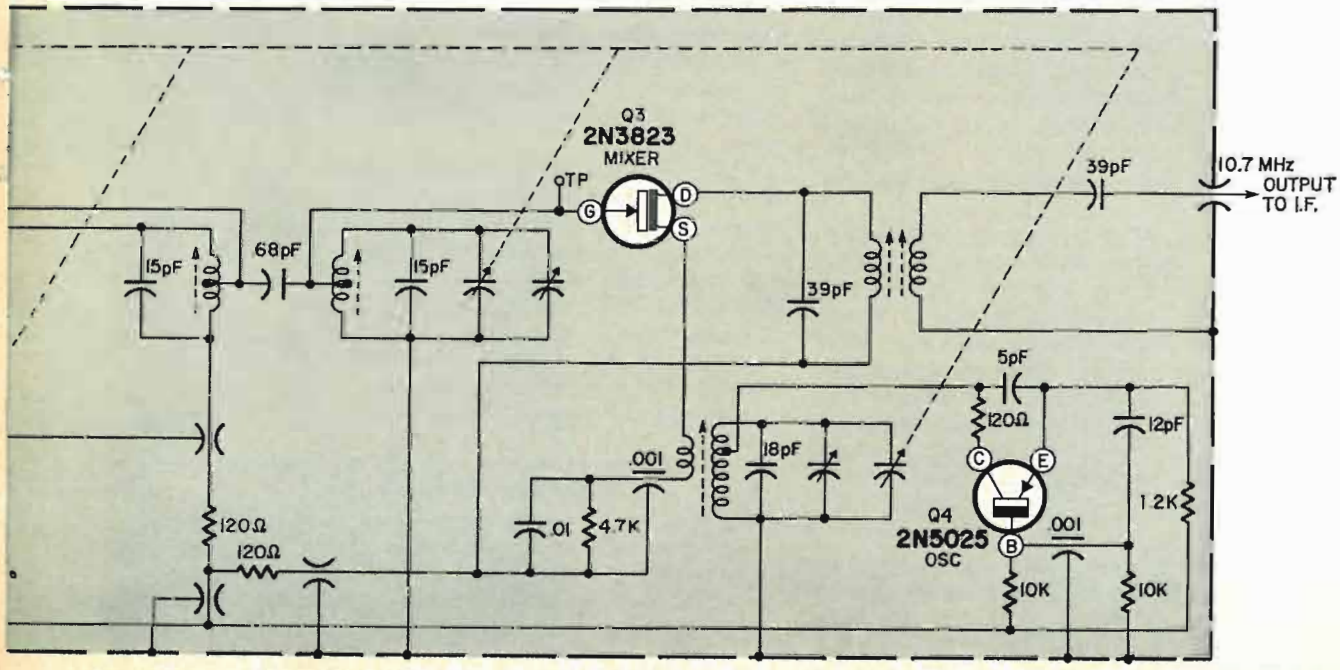
Now, almost all FM tuners use FET front ends, and the improvement is clear, both by listening comparison in a strong-signal area, and by measuring the spurious-response rejection, which is now often in the vicinity of 90 dB.

Integrated circuits, properly used, are responsible for far more in an FM tuner than compactness and lowered production costs. Just about the most effective and stable FM limiter is the emitter-coupled amplifier. With a matched pair of transistors, it is inherently symmetrical, a desirable thing in a limiter. But matched-pair transistors are expensive; they have to be matched after manufacture in a separate operation. Also, the idea of using two separate transistors, with biasing networks, in a single limiter stage is not too appealing, especially since a good FM tuner will have to have several limiter stages. If the transistors are not matched, the bias networks have to be adjustable, or resistors have to be selected during final testing to make the limiters symmetrical.

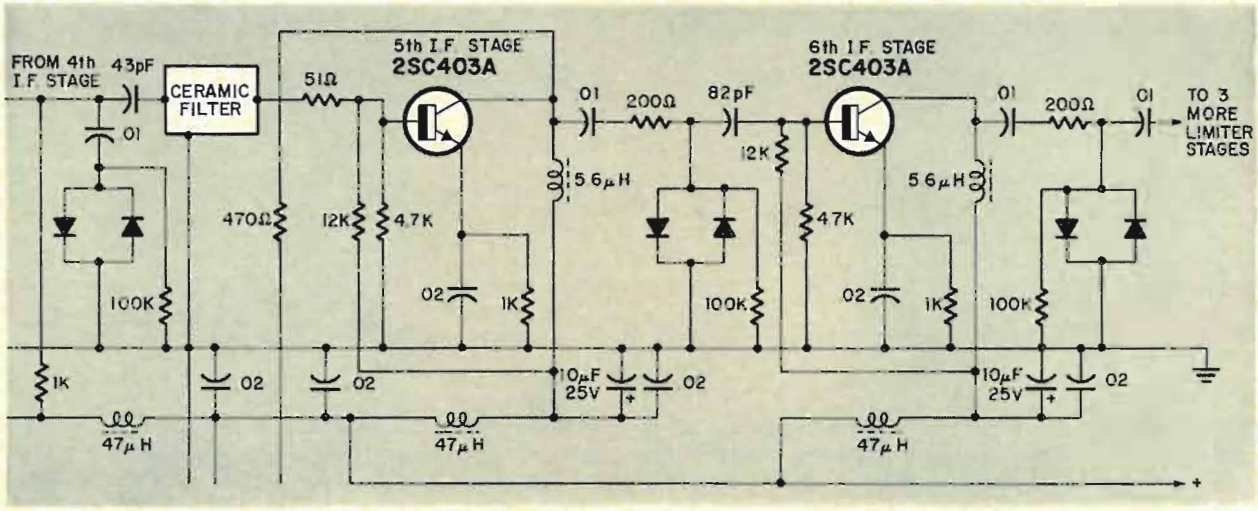
IC's can help

But with IC techniques, a complete emitter-coupled amplifier, with diode biasing networks, can be fabricated in a single chip of silicon. The two etched-in transistors are bound to be identical, within very small tolerances, and. being mounted on the same header and enclosed in the same case, temperature changes affect both of them by the same amount. So, excellent emitter-coupled amplifier-limiters are now feasible at low cost.

There's another more subtle advantage. The diode biasing networks etched into an IC have a very low internal impedance for signal currents, and thus don't need to be bypassed. This not only saves parts, but eliminates several troublesome time constants that interfered with limiting ac-



Typical of high-sensitivity FET front ends is this design from Heathkit, used in their AR-15 receiver and AJ-15 tuner. The oscillator (Q4) uses a conventional transistor, since an FET offers no particular benefit. Note that the first two stages, Q1 and Q2, form a cascode circuit, which was developed in the early 1950's for low-noise, tube-type TV front ends of that era.



Part of the i.f. strip of the Sony ST-5000FW tuner (above). Three of nine i.f. stages are shown. Piezoelectric ceramic filters are used at three points. (The last filter is shown.) Beginning with the 4th stage, each stage is followed by a pair of matched diodes connected back-to-back across the output of the stage. These are the limiters. Each diode clips the i.f. signal to a peak level of about 0.6 volt, according to its polarity. The following transistor stage amplifies the clipped signal, after which it is clipped again. By the time the 10.7-MHz signal reaches the detector, its amplitude is practically constant for any value of input signal above a certain very low threshold, and amplitude noise pulses are removed. This makes for a clean audio output.

tion or converted an amplitude noise pulse into a phase or frequency pulse, making it impossible to separate it from the signal.

In these ways IC's have made possible cheaper and more effective i.f. limiter circuits for FM tuners.

Crystal filters are here

The multitude of tuned transformers in FM tuners has always been a headache. They need to be aligned, which is a relatively time-consuming process, and thermal effects or mechanical shock can spoil the alignment. Their selectivity is limited by their winding resistance, which means either compromising somehow between optimum selectivity and optimum phase linearity and bandwidth, or else cascading a great many i.f. amplifier stages with a tuned transformer between each one. The more transformers you use, the more you have to align.

The development of extremely high-Q piezoelectric filters (either crystal or ceramic) for use at the relatively high frequency of 10.7 MHz has simplified FM-tuner i.f. strips very considerably, eliminating alignment except for the ratio-detector or discriminator transformer. With such filters, it is practical to design i.f. strips with practically perfect phase linearity over the required bandwidth (which is essential for minimum distortion, best capture ratio and good stereo separation), yet still to have the response drop off steeply outside the band, which makes for fine selectivity.

A maverick design

One curious design approach, which doesn't really fit in with any of the developments we've been talking about, is Marantz's use of a front end with no active devices at all—no rf gain. Together with the fixed-frequency filters in the i.f. stages, this trick reduces alignment to an all-time low for FM tuners. The Marantz receiver front end is also just about the quietest, since the mixing diodes contribute very little noise. The receiver is still highly sensitive, but all the gain comes in the i.f. stages rather than from the front end. And the diode mixer shows very little cross-modulation (spurious response is down 100 dB, according to the manufacturer's specifications).

This isn't exactly a new technique; it's been seen before in radar receivers and in uhf TV converters and front ends, but its application to high-fidelity FM tuner design is unique.

The accompanying partial schematics illustrate the use of these devices and circuits in a few current FM tuners and receivers.

A couple of other circuit developments are perhaps somewhat less spectacular but also relevant, and they too are products of semiconductor technology. We haven't the space to detail them here. Both were pioneered by Fisher. The first is a pulse-counter type of FM detector, in contrast to the more usual ratio detector or discriminator. One of the advantages claimed for this type of detector is better capture ratio—the ability of the tuner to discriminate in favor of the stronger of two signals on the same or nearby frequencies. This is particularly important in reducing the ill effects on stereo of multipath reception—the simultaneous pickup of signals both direct and reflected. Multipath reception causes severe distortion and loss of stereo separation.

The second was recently introduced in the Fisher 160-T, a low-cost FM stereo receiver. In the 160-T voltage-variable-capacitance diodes do the tuning, in place of the conventional variable capacitor. This permits stable, no-drift pushbutton selection of five pretuned channels, for your five favorite FM stations. The receiver can also be manually tuned to any station. This development is more a convenience than a major advance in the quality of FM reception, but it is interesting and so far unique among FM receivers on the market. **R-E**

Coming Next Month

A look at the no-gain Marantz 18 front end, and how it achieves a remarkable spurious-response rejection of 100 dB. Also, more on Heathkits' use of IC's and crystal filters in their AR-15 and AJ-15 tuner designs.

COMPUTERIZE YOUR CAR LIGHTS

Part III—Add "lights-on" reminder and lamp flasher to complete your lighting computer

By R. M. MARSTON

THE COMPUTERIZED LIGHTING SYSTEM described in Parts I and II of this series detects most lighting faults. There is, however, one remaining service that the "brain" can perform, and that's as a "switch-lights-off" reminder. Here's what the device should do.

To remind the driver to switch the lights off after a night drive, the dash-panel warning lamp should light when the car is parked and the ignition switch is turned off. The lamp should extinguish when the lights are switched off, indicating everything's all right.

It's possible, however, the driver knows the lights are still on, but wants them left that way for night parking. Then, the warning lamp should switch itself off after 50 seconds or so. A reminder system of this type can be built easily using the 5-transistor circuit shown in Fig. 7.

Normally, with both ignition and light switches on, the circuit condition is: The positive side of C2 is connected to the −12-volt line via the ignition switch, while the other side of the capacitor is connected to the −12-volt line via R69, the Q26 base network and the lights switch. Since there is zero charge on this capacitor, Q27 is cut off, as are Q25 and Q24. Lamp LP13 is also off. Capacitor C3 is fully charged, so Q28's base is effectively shorted to the −12-volt line via R72. Thus Q28 and Q27 are cut off.

Suppose now the ignition switch is turned off, but the lights are left on. As soon as the ignition switch is opened, the positive side of C2 is shorted to ground via R65. This capacitor begins to charge via R65-R69 and the base network of Q26 switching Q26 on in the process. The collector of Q26 is direct-coupled to Q25's base, and Q25's collector is direct-coupled to Q24's base; so, as soon as Q26 starts to conduct, both Q25 and Q26 are switched hard on, and LP13 lights.

Transistor Q26 has an input impedance of about 20,000 ohms, so C2 charges with a long time constant. When C2 is nearly charged to −12 volts, Q26 cuts off, as do Q25 and Q24, and the lamp goes off. With the component values shown, LP13 stays on for about a 50-sec maximum.

If the light switch is opened, the supply to the circuit and LP13 is immediately broken, and LP13 goes off at once. Turning the ignition on when the lights are off has no effect.

Finally, consider the circuit action if the lights are switched on but the ignition is off. In this case, as soon as the light switch is closed C3 starts to charge via Q28's base network, and Q28 is switched on. As Q28 switches on, it switches Q27 on also. The collector of Q27 is direct-coupled to Q26's base; so, when the light switch is on, Q27 is driven to saturation and effectively shorts Q26's base to the −12-volt line, insuring that Q26, Q25, Q24 and LP13 are cut off. Since Q26's base is effectively shorted to the −12-volt line, C2 charges rapidly via R65, R69 and Q27's collector.

Transistor Q28 is connected as an emitter follower and has an imput impedance of about 20,000 ohms. With the component values shown, Q27 stays saturated for about 4 seconds. But when Q27 is saturated, C2 charges to almost full −12 volts in about 2 seconds. Thus, by the time Q27 switches off, C2 is fully charged, so Q26 (and thus LP13) stays off at the end of this brief timing cycle. Therefore, LP13 switches on only at the moment the ignition switch is opened with the lights on.

Diode D38 provides a short discharge path for C2 when the ignition switch is turned on, and D39 and R73 give a short discharge path for C3 when the lights are switched off.

Q24: Any npn transistor with a current gain greater than 20 (greater than 40 in a 6-volt system) and $I_{c(max)}$ rating of 500 mA or greater. A germanium transistor is preferable, but not essential.

Q25: Any silicon pnp transistor with a current gain greater than 20.

Q26, Q27, Q28: Any npn silicon transistor with a current gain greater than 20.

D37: Any silicon or germanium rectifier with a forward-current rating greater than 300 mA.

D38, D39: Any general-purpose germanium diode will work here.

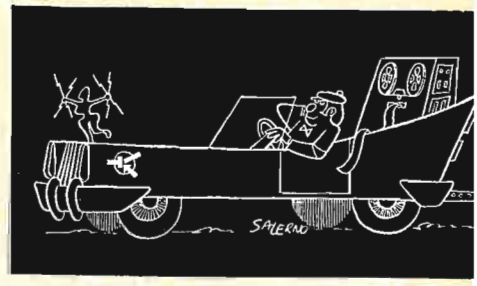
Most circuit component values are shown in the list in Fig. 7. Additional semiconductor selection data are shown here.

This "switch-lights-off" reminder circuit can be used either on its own or with the two computer circuits described in Parts I or II.

A flashing warning indicator

In the three units described so far, warning indicator LP13 has been a simple bulb that switches on when a fault is present. A glowing lamp is not particularly effective in attracting a driver's attention, however, and a superior system replaces LP13 with a unit that rapidly flashes a warning lamp on and off when triggered.

A suitable flashing circuit is shown in Fig. 8. The reader is urged to use this unit in place of LP13 in the earlier circuits. Besides giving a more effective warning, this unit allows a number of



changes to be made to the computer circuits described earlier: permitting transistors with an h_{FE} as low as 5 to be used in many cases, and the moderately expensive D25-D28, etc., 300-mA diodes to be replaced by general-purpose germanium types.

The circuit of Fig. 8 works this way: Dash-panel warning lamp LP13 is connected between ground and the collector of Q29; Q29's base is direct-coupled to the collector of Q30, and Q30's base is shorted to ground via R77. This section of the circuit is permanently wired across the 12-volt battery. Under normal conditions Q30 and Q29 are cut off, and LP13 is off.

Transistors Q31 and Q32 form a free-running multivibrator, operating at a frequency of about 1 Hz. This

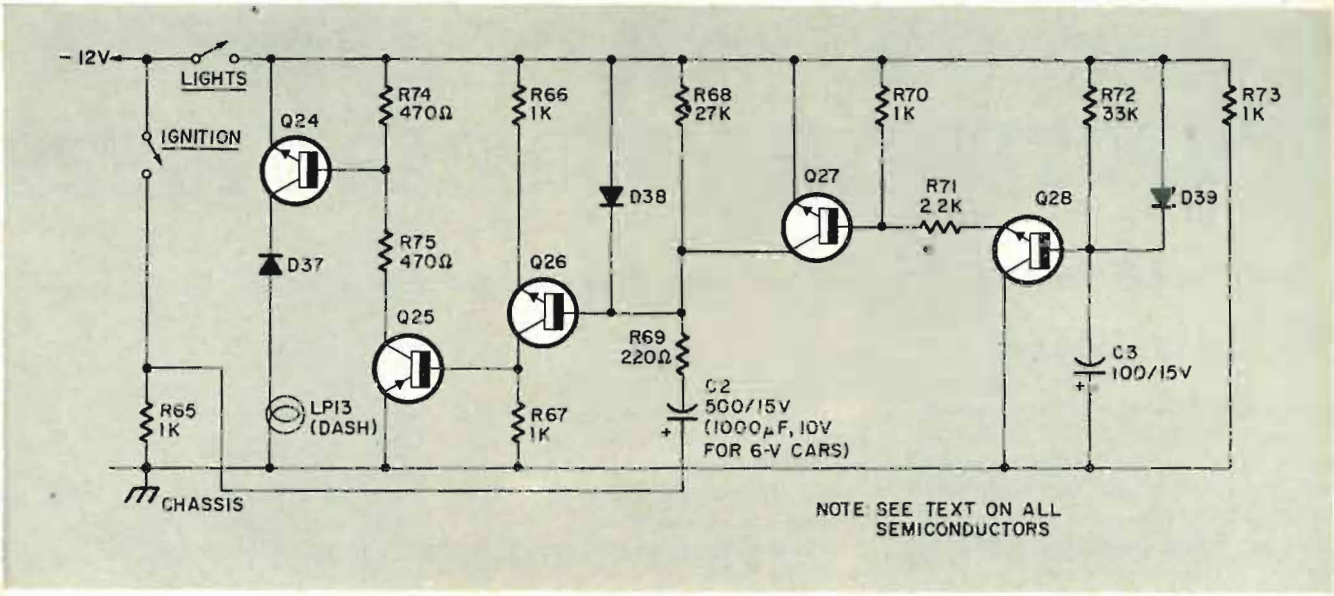


Fig. 7—The "lights-on" reminder provides a 50-second warning when lights are on after the ignition has been turned off.

multivibrator takes the place of LP13 of the earlier circuits.

When operating, the output of the multivibrator taken from Q31's collector alternately switches between near ground potential and near full −12-volt battery potential, and this output is direct-coupled to Q30's base. When the output is at near-ground potential or the multivibrator is inoperative, Q30 is cut off and LP13 is off. When the output is at near full 12-volts potential, Q30 is driven on, and in turn drives Q29 to saturation and thus switches LP13 full on.

Thus, LP13 switches on only when the multivibrator is operating, and switches on and off at a repetition frequency of about 1 Hz.

In the multivibrator D40 and D41 are fitted as "sure start" diodes, and D42 and D43 are used to prevent base–emitter breakdown of the transistors under operating conditions. Use of these diodes insures that the circuit will operate correctly, irrespective of the transistor characteristics. That is, it will work equally well with germanium or silicon af or rf transistors with high or low current gains.

Most component values are shown in Fig. 8, and these apply equally to cars with 12-volt and 6-volt systems. The following notes apply to components not listed in Fig. 8:

Q29: Any germanium npn transistor with a current gain greater than 20 (greater than 40 in a 6-volt system) and an $I_c(_{max})$ of 500 mA or more.

Q30: any silicon pnp transistor with a current gain greater than 20.

Q31, Q32: Any germanium or silicon pnp transistor with a current gain greater than 20.

D40-D43: Any general-purpose germanium diode.

LP13: 12 volts, 1.2 watts. (100 mA in 12-volt systems, or 6V, 1.8 watts (300 mA) or less in 6-volt systems.

In cars with a negative-ground system, all pnp transistors should be changed for npn types, and vice versa, and the polarity of all diodes and capacitors should be reversed.

This flashing warning indicator can be fitted in place of LP13 in any of the earlier circuits without need for component modifications. Voltage supply point A connects to the anodes of D25–D28 (Fig. 3), the anode of D36 (Fig. 4) and/or D37 in Fig. 7. These earlier circuits have, however, each been designed to give maximum output drive currents to LP13 of up to 300 mA. When the flashing indicator is used, on the other hand, the maximum output requirements of these circuits are reduced to a mere 15 mA maximum on a 12-volt system, or 7 mA maximum on a 6-volt system, permitting the component values of these circuits to be changed.

For example, in the lamp-failure detector system of Fig. 3, Q13–Q16 no longer need an $I_c(_{max})$ rating of 500 mA, and can be replaced by virtually any npn transistors with a current gain greater than 20. Similarly, any general-purpose germanium diodes can be used in place of D25–D28. Again, because of the resulting low base-drive requirements of Q13–Q16, the collector loads of Q1–Q12 can be increased considerably (to 2200 ohms), reducing the necessary power ratings (and thus size) of these load resistors, and permitting Q1–Q12 to work correctly even with current gains as low as 4 or 5.

Similar component changes can be made in the remaining circuits, enabling "bargain-pack" semiconductors to be used in many cases, and so considerably reducing cost of the complete system.

A complete list of component values and specifications that can be used in conjunction with the flashing warning indicator is included. These values apply equally to 6-volt and 12-volt lighting systems.

Construction tips

The circuits of Figs. 3, 4 and 5 can be used either on their own or in conjunction with one another. They can be used to drive either a simple LP13 indicator or the flashing indicator of Fig. 8.

These circuits are meant for the fairly experienced constructor only. That's one reason no building instructions are given. Another is that no single construction plan can possibly satisfy all readers. Too many variables are involved.

If you figure that you have enough knowledge to wire up the units from the schematics, and know how to carry out simple functional tests on semiconductors and maybe do a little bit of troubleshooting, construction should present no problems. If you don't have this knowledge, get the help of someone who has, or forget the whole thing.

If you decide to go ahead with construction, take note of the following rules:

(1) Test all transistors for low collector leakage and minimum gain before use. Check all diodes for low reverse leakage before using them. You can carry out these simple tests with an ordinary multimeter.

(2) Read the explanations of circuit operation and make sure you understand them before starting con-

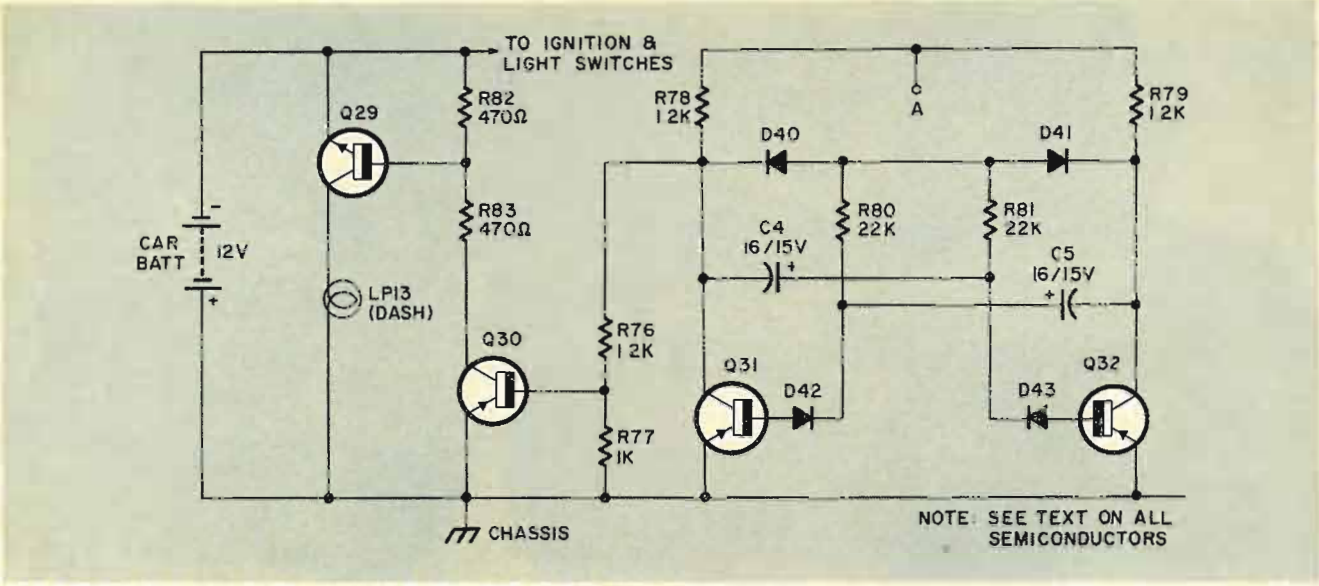


Fig. 8—A flashing light catches driver's eye faster than a steady glow. This flasher circuit is highly recommended.

struction of any given unit.

(3) Where possible, build the units one transistor stage at a time, and carry out a functional test before proceeding with the next. When you've built one complete section, such as the lamp-failure detector, give it a full functional check before continuing.

(4) If you have to do any troubleshooting, remember that most of the circuits used are of the digital type. Their transistors are either switched hard on or are off. Where in doubt, read the explanation of circuit operation, and try to follow the operation through the schematic. If you test all semiconductors before using them, the circuit should work the first time.

(5) Remember that, in a car, the supply battery has a low internal impedance, and thus gives a fairly constant output voltage under different loading conditions. That's the conditions these units are designed to work under, so when you're testing them in the workshop, use a similar low-impedance supply—either a car battery or a stabilized supply unit. Do not carry out tests substituting dry cells.

Finally, we come to the question of building costs. An outstanding feature of all these units is that they have been designed to work with virtually any semiconductors. In most cases, it doesn't matter if transistors are germanium or silicon types, if they have high or low gains, or if you have a 6-volt or 12-volt supply system.

Consequently, you can use semiconductors of the type you get in "bargain packs" from mail-order firms —as long as you test them before use. The full system, including flashing indicator, uses a total of 75 semiconductors; you can get the whole lot, tested, for under $9 from advertisers in this magazine. Untested, you can get them for a lot less than that.

The unit uses 83 resistors. If you shop around and buy in bulk, you can get the lot for under $2. You can build the complete system for under $20. I built mine for about $10, using untested components.

These articles have shown how to build a low-cost computerized system that will detect virtually any lighting fault in your car. Automobile manufacturers are developing similar systems in their labs, but it looks as if it will be several years before they get their systems on the market. Thus you can build an advanced unit that will provide convenience and practical safety features.

You may decide to add a few extras to the basic circuits shown, since there's plenty of room for experiment. You can, for example, feed the output of each unit to an individual lamp rather than LP13, so that each lamp indicates a different fault. Or you can replace these lamps with a prerecorded tape-loop selector, so that a voice tells you the fault when it occurs. **R-E**

MASTER PARTS LIST

(Note: Values for resistors R1-R65 and specifications for transistors Q1-Q23 are for use with the flashing lamp fault indicator in Fig. 8 and may differ slightly from those in the parts lists in Parts 1 and 2 of this article.)

C1—1000-μF, 15-volt electrolytic capacitor
C2—1000-μF, 10-volt electrolytic capacitor (for 6-volt systems) or 500 μF, 15 volts for 12-volt systems
C3—100-μF, 15-volt electrolytic capacitor
C4, C5—16-μF, 15-volt electrolytic capacitor
R1–R12—270-ohm resistors if Q1-Q12 are germanium, 470 ohms if Q1-Q12 are silicon transistors
R13–R24—220-ohm resistor
R25–R36—2200-ohm resistor
R37–R40, R58, R74—470-ohm resistor if Q13-Q16, Q21 and Q24 are germanium, 1000 ohms if Q13–Q16, Q21 and Q24 are silicon transistors
R41–R44, R50, R59, R82—470-ohm resistor
R45—100,000-ohm miniature potentiometer
R46-R47—5600-ohm resistor
R48—12,000-ohm resistor
R49—10,000-ohm resistor
R51, R57, R62, R71, R75—2200-ohm resistor
R52, R54, R61, R63, R67, R70, R77—1000-ohm resistor
R53, R56, R83—470-ohm, ½-watt resistor
R55, R64—4700-ohm resistor
R60—1800-ohm resistor
R65, R66, R73—1000-ohm, ¼-watt resistor
R68—27,000-ohm resistor
R69—220-ohm, ½-watt resistor
R72—33,000-ohm resistor
R76—1200-ohm resistor
R78, R79—1200-ohm, ¼-watt resistor
R80, R81—22,000-ohm resistor
All resistors 1/10-watt, 10% unless otherwise noted
D1–D12—Silicon rectifiers to pass currents of automotive lamps LP1–LP12
D13–D24 and D29–D35—general-purpose silicon diodes
D25–D38 and D36–D43—General-purpose germanium diode
Q1–Q12, Q20—Any npn transistor, h_{FE} greater than 5
Q13–16—Any npn transistor, h_{FE} greater than 20
Q17, Q18—Any pnp transistor, h_{FE} greater than 20
Q19, Q21, Q24—Any npn transistor, h_{FE} greater than 20
Q22, 23—Any pnp transistor, h_{FE} greater than 10
Q25—Any pnp silicon transistor, h_{FE} greater than 20
Q26–Q28—Any npn silicon transistor, h_{FE} greater than 20
Q-29—Any npn germanium transistor with $I_{c\ max}$ 500 mA or greater and h_{FE} greater than 20 (h_{FE} greater than 40 for 6-volt systems)
Q30—Any pnp silicon transistor, h_{FE} greater than 20
Q31, Q32—Any pnp transistor, h_{FE} greater than 20
LDR1—Any cadmium sulphide photocell with face diameter greater than ¼"
LP13—12-volt, 1.2-watt (100-mA) or smaller lamp for 12-volt system or 6-volt, 1.8-watt (300-mA) or smaller lamp for 6-volt system.

Cartridges vs. cassettes: 4 two-hour, 4-track cassettes fit into an 8-track cartridge box

CASSETTES—New Shape of Tape?

By WALTER G. SALM

TAPE RECORDERS ARE MORE THAN 20 years old. The open-reel format is still the most popular, but is waging a serious battle with several young upstarts. The main contenders for first place are two sworn enemies: continuous-loop cartridges and the cassette.

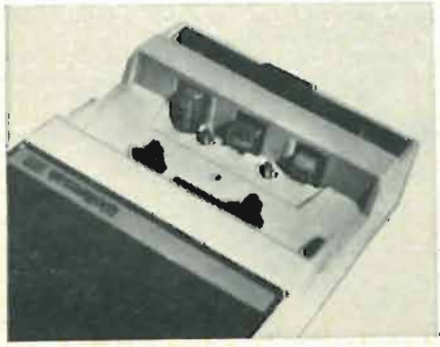
It all started when somebody at RCA decided that there must be an easier way to load tape recorders—a way as easy as putting a disc on a phonograph. The basic idea was fine: put the tapes into an enclosed cartridge to make them more appealing to the mass market. So RCA introduced its tape cartridge, complete with a family of tape recorders designed specifically for the all-thumbs set. The idea caught on—among other manufacturers—who started to produce cartridge machines under license, but somehow the frantic public rush never materialized.

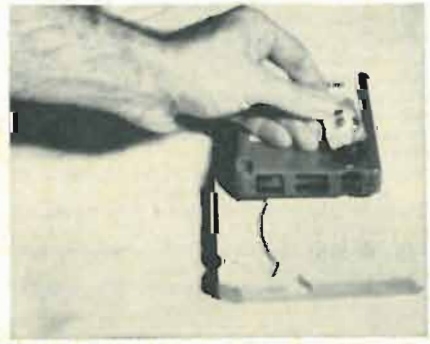
Recently, Philips (N.V. Philips Gloeilampenfabrieken — variously called "Norelco" or "Amperex" in the U.S.) introduced its compact cassette format complete with a dandy battery portable machine that was light enough for the wispiest of 97-pound blondes to carry to the beach. Like the RCA cartridge, the Philips cassette is basically a reel-to-reel tape container. Inherent compactness is partially attributed to its reel arrangement. It doesn't use two full reels. Instead, the tape winds onto a flangeless takeup hub, occupying the space just vacated by tape on the feed hub.

Head assembly of cassette (left) has thin capstan and external rubber pinch roller. In PLAY/RECORD *position, heads and roller make contact with the tape. Automatic Radio's Gidget (center) lets you play 4-track cartridges on 8-track machines. Snap out cassette tab (right) and tape can't be erased. There's one tab for each direction of tape travel. If tab hole is taped over, tape can be reused.*

About the same time that the Philips cassette format burst on the tape recording world, Mad Man (Earl) Muntz was fighting tooth and nail to prove that his 4-track tape cartridges were vastly superior (and if not superior, at least a lot cheaper) when compared with the upstart 8-track systems just beginning to make their appearance. Both systems actually had (and still have) the same basic disadvantages—high friction component in the tape drive, excessive wow, high background noise, lack of such niceties as fast forward (really fast, that is), rewind and automatic shutoff.

The 8-track (originally called the "Lear-Jet" pack) format has had a meteoric rise in popularity, mainly because of its acceptance and installa-





tion as original equipment by several automobile manufacturers. By the time this was happening, Mad Man Muntz was pushing hard with his $39.95 4-track players for under-dash mounting. Here, price was definitely a selling point.

Vive la difference

Both 4- and 8-track cartridges are continuous-loop systems—the tape will play and play and play if you don't shut it off. The single hub of tape unwinds from the inside; the tape passes through a guide, goes between the playback head and the pressure pad (felt or sponge rubber built into the cartridge), is yanked hard by the capstan and pinch roller, and back into the yawning maw of the cartridge to wind onto the outside of the tape roll. As the hub rotates, each layer of tape slides between its neighbors, and its own effective diameter decreases as it moves toward the center of the hub. That the tape endures these incredible mechanical tortures without stretching is a wonder. It must be extremely well lubricated to do this sliding act, but even so, lubricants can rub off with use, and wow creeps into these cartridges—even new ones—with annoying predictability.

The 8-track cartridge has its own rubber pinch roller built in. The 4-track cartridge has a nice big round hole in its underside to admit the tape machine's rubber pinch roller. This roller is usually lying on its side just below the cartridge carrier plate and is locked into position by a manual "play" lever on the front panel. Four-track cartridges carry two stereo programs (comparable to the two sides of an LP record). At the end of the first program, you generally have to punch a button or move a lever to move the head assembly into position for the "B" sequence. Some machines do this automatically.

Most 8-track machines change tracks automatically. The end of the sequence is marked by a strip of metal sensing tape which triggers a solenoid. The solenoid can operate a ratchet or other similar device which moves a cam which moves the head assembly into the next position. It starts with program 1 at the top, then down to 2, 3 and 4, then back up to 1 to start all over again. The system will play the same tape over and over again until you remove the cartridge to shut it off.

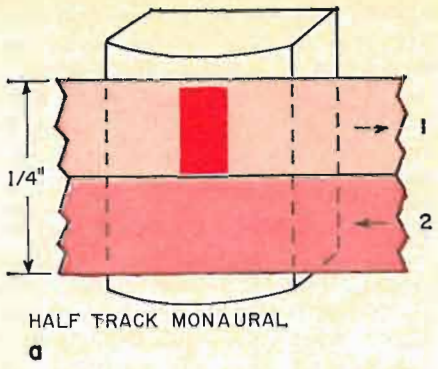
An 8-track cartridge requires very little tape. A length of only 150′ will play for about 8 minutes at the cartridge's 3¾-ips speed. Multiply this by the tape's four programs, and the result is 32 minutes—the average length for most LP records and most tape cartridges.

Both continuous-loop cartridge formats use ¼″ wide tape. But the 8-track format has very narrow tracks, and is often blamed for the tape's relatively poor frequency response and high background-noise level. Fortunately, both of these misuses become unimportant when the tape is played on the highway—ordinary road noise masks the tape hiss and blurs the upper frequency response.

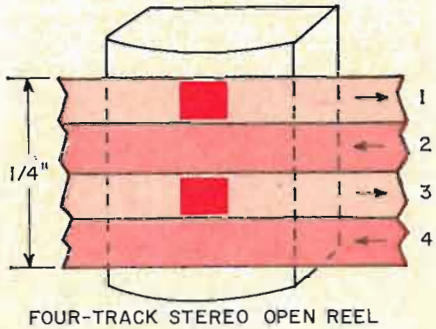
Enter the cassette

When the compact cassette concept was introduced about 5 years ago, it immediately caught on. Philips, in a brilliant *tour de force*, offered licensing arrangements for its cassette concept on such liberal terms that it had 39 companies (German, American and Japanese) signed up in 2 months' time, and today the total is something over 50 licensees.

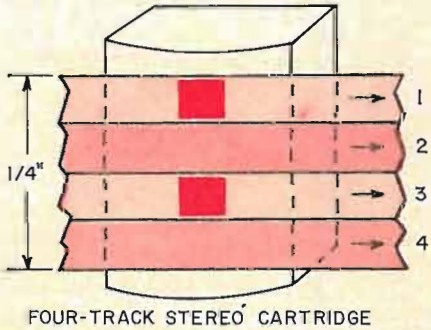
Result: The Philips cassette is



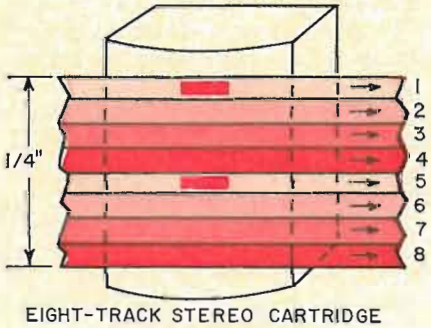
HALF TRACK MONAURAL
a



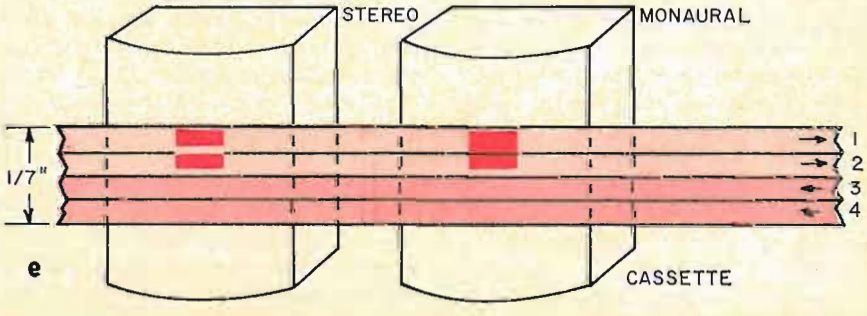
FOUR-TRACK STEREO OPEN REEL
b



FOUR-TRACK STEREO CARTRIDGE
c



EIGHT-TRACK STEREO CARTRIDGE
d



e

TODAY'S FIVE TAPE FORMATS

Modern audio recording uses one of these five major schemes for putting sound on tape. Two-track monaural (a) *is still used in many low-price recorders. Four-track stereo* (b) *first sweeps across the tape in one direction using tracks 1 and 3. Then the tape is turned over and it runs in the other direction using tracks 2 and 4. The 4-track stereo cartridge* (c) *is different in that the tape is in a continuous loop and always travels in the same direction. To switch tracks the head is moved mechanically. Eight-track stereo cartridges* (d) *are quite similar to the 4-track arrangement. The only difference is that tracks are narrower so more of them can fit on the tape. Again, the head moves to switch tracks. The cassette* (e) *uses a different setup. The two stereo tracks in use are located side by side. This enables playing stereo tapes on monaural machines.*

now an industry standard; battery portables and home stereo versions have blossomed forth in a vast profusion of manufacturers' labels, with more companies getting into the act every day: Ampex, Wollensak, Aiwa, Sony, Concord, Philco/Ford, RCA, GE Automatic Radio, Lafayette, Allied, Mercury—these are just a few of the many names deeply committed to the cassette format.

A seemingly logical outgrowth of this controversy is still another cartridge tape system, called Playtape. This is a continuous-loop cartridge about the thickness of a cassette and about ⅔ its size. Playtape cartridges carry two mono tracks, and like their 4- and 8-track cousins, play continuously until stopped by removing the cartridge from the playback machine.

These mini-cartridges hold four or more popular tunes, usually performed by rock groups. The basic playback unit sells for $19.95 and up, and tracks are changed manually with a control switch. The head doesn't move. Instead, Playtape uses a stereo head wired as two individual mono heads. These battery-powered players are strictly for the go-go beach set, although much more sophisticated versions have appeared in an effort to capture a more mature market. This format has a definite place, which it found for itself very early in life.

Why the cassette?

Just what's so special about the cassette? Size, for one thing. An empty plastic or cardboard container for an 8-track cartridge will hold *four* cassettes! A little arithmetic reveals that the cartridge with its 80 minutes' maximum playing time fares poorly against the cassette's 120-minute maximum (multiplied by four for actual size comparison). The result: the cassette has a maximum information packing density at least *six times* as great as the 8-track cartridge.

One of the newest features of the cassette is its use as a *stereo* medium. The original mono cassette portables record half-track mono. That's fine as far as it goes, but the engineers decided that tape properties were advanced enough for 4-track stereo on the cassette's ⅛" wide tape. The result is a track width about the same as for 8-track cartridges, but because the cassette runs only at 1⅞ ips, frequency response is still limited to about 10,000 Hz. New tape formulations and improved heads should push this limit up.

Oh, by the way, the cassette has a built-in safety interlock mechanically linked to the "record" button. If you want to preserve a particular tape, pry out the plastic tab at the back of the cassette. *With the tab removed, you can't erase the cassette.* There are two tabs—one for each direction of tape travel. All prerecorded cassettes already have the tabs removed (naturally). If ever you want to reuse the tape, cover the hole with a piece of adhesive tape and you're in business.

In the cassette the left and right tracks for the same direction are adjacent. No every-other track setup here. The result is that any 4-track stereo cassette can be played on a 2-track mono machine with full program playback compatibility.

The tape in the cassette is mounted captive-fashion—permanently attached to the hub at each end. On some of the lower-cost cassettes it's not fixed as permanently as we'd like. Fortunately, whenever the tape has pulled loose, it's been in a cassette that could be disassembled. Some cassettes don't offer this option. The captive end is a piece of clear or colored mylar leader tape which generally can stand the strain of a sudden stop at the end of a fast rewind.

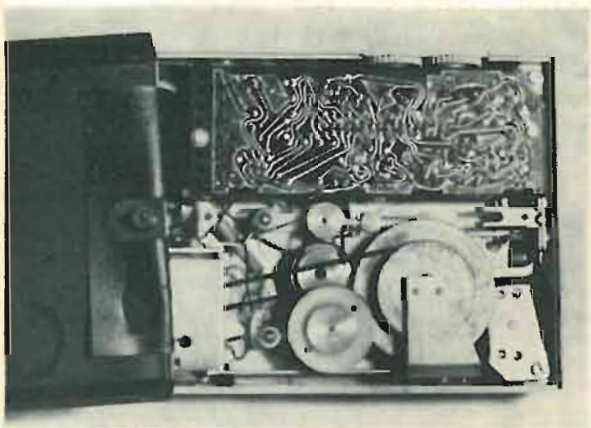
At the end of the tape, the captive leader (or trailer in this case) stops the machine dead. A built-in slip clutch lets the motor continue to run without pulling excessively on the tape. Virtually all cassette machines have this slip-clutch feature.

Cassettes for cars?

The cassette's ascendency as an automobile instrument is just around the corner. One manufacturer, Mercury, is marketing an under-dash stereo machine, and Automatic Radio—an old hand in automobile music equipment—is bringing out its own dash-mounting unit soon. The ideal system will be a family of three machines—two stereo units (one in the car and one at home), and a mono battery portable for swinging beach parties, chasing the kids around for on-the-spot "pop" sounds, and instant sound tracks for those home movies. Several other automobile units are also ready to appear and are likely to become available before the end of the year.

In the meantime, a rapidly growing inventory of prerecorded cassettes threatens momentarily to overtake the already voluminous catalog of 4- and 8-track cartridges. To date, only Ampex and Dubbings are prerecording the mini wonders in the U.S. Both companies are multi-label operations, Dubbings with about a half-dozen labels and Ampex with more than fifty. The recording giants who do their own tapes—RCA, Columbia and Capitol/Angel—haven't yet released any cassette tapes, although RCA is marketing a mono cassette recorder, while the other two are certain to follow suit soon.

And what of the future? Right now, the smart money is on cartridges *and* cassettes simultaneously. Ampex works on a round-the-clock basis to meet the enormous demand for prerecorded tapes in open reel, 4- and 8-track cartridges and cassettes. But they're also the same ones who are predicting the demise of the continuous-loop cartridge and the meteoric ascendency of the compact cassette—and not too long from now either. **R-E**



Inner workings of Philips' Carry Corder (left) shows simple mechanical drive linkage. No parts move more than fraction of inch.

Smaller than a cassette, Playtape's continuous-loop cartridge has two-track mono format. Selector switch changes tracks.

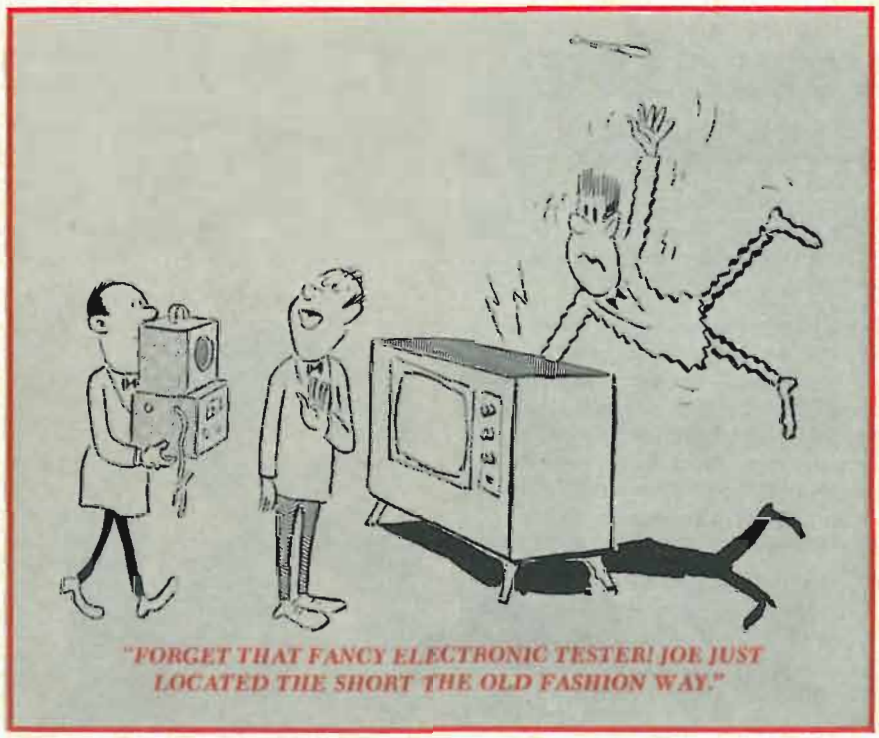
Color TV Troubleshooting—It's A Cinch

Combine basic color circuit theory with test point knowhow to simplify color-circuit service

By MATTHEW MANDL
CONTRIBUTING EDITOR

TROUBLESHOOTING COLOR TV CIRCUITS is faster when you are familiar with circuit operation, test points and the proper use of the right test instruments.

It isn't necessary to know every detail of circuit theory, but it is helpful to know the circuit's function and have a clear picture of its general operation. This knowledge helps when using test points to localize faults by analysis of voltages and waveforms. It also enables locating test points when none are provided by the manufacturer. Similarly, circuit knowledge aids in the selection of the proper test equipment to cut servicing time.



Using test points

Many receivers have terminal-type test points on the chassis for quick-check purposes. These are not all inclusive, but only represent points

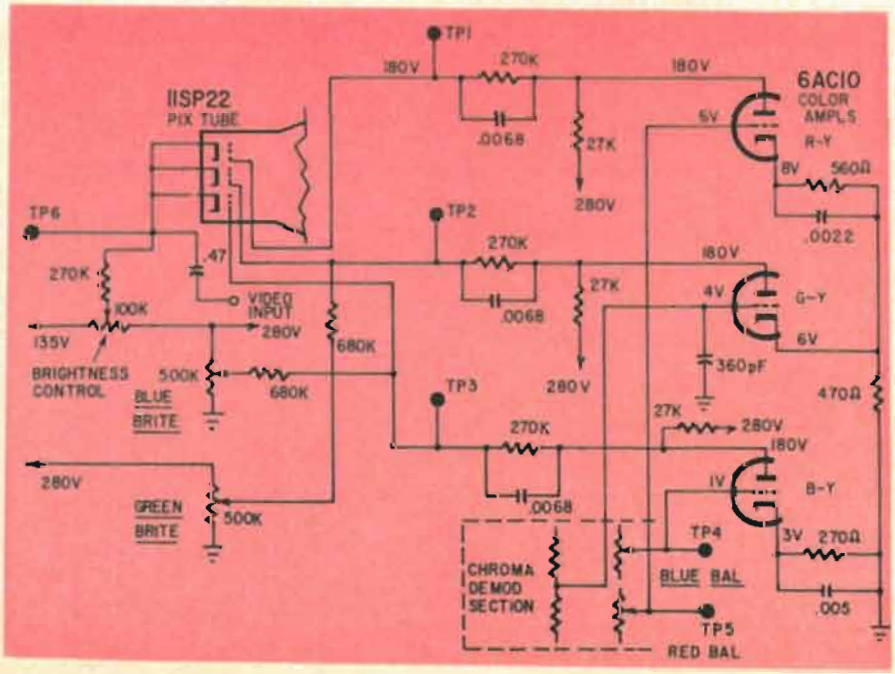
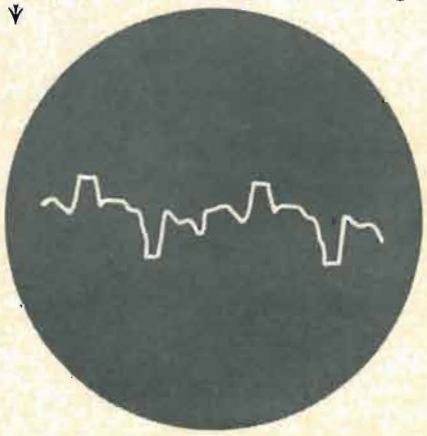


Fig. 1—Typical color-circuit test points are shown on this G-E HB chassis. The 6AC10 contains 3 color amplifiers.

Fig. 2—Waveform at plate of R—Y color amplifier in Fig. 1. Peak-to-peak voltage may vary up to 180, and the pattern will shift as TV picture scenes change.



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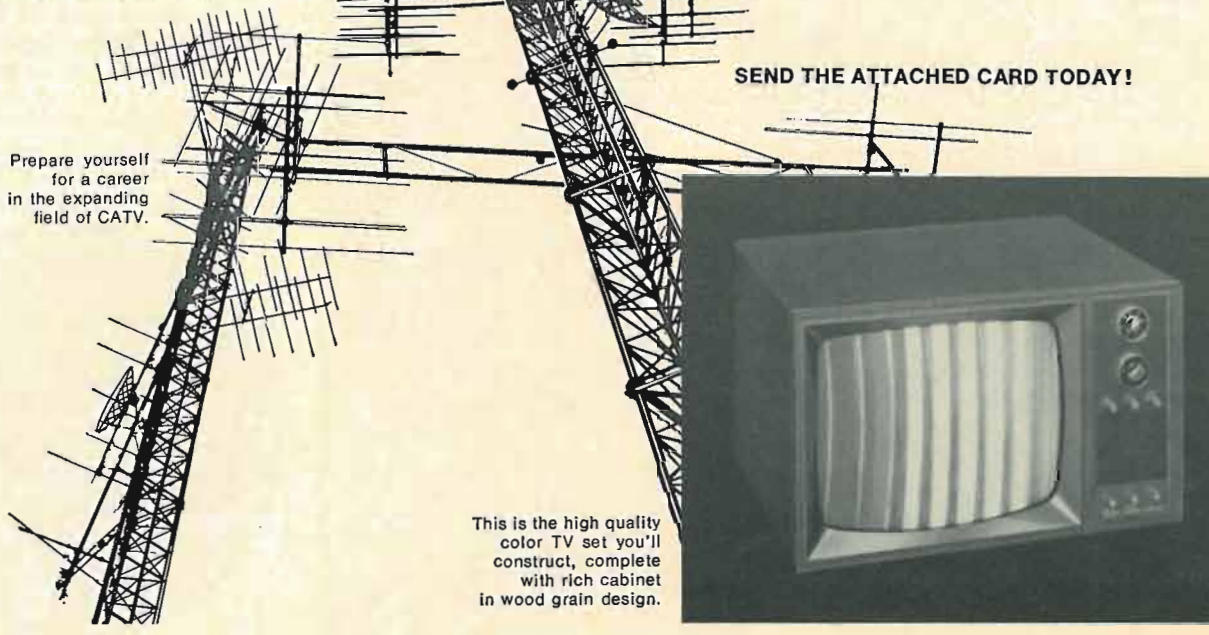

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where common trouble symptoms can be tested. If the test points furnished don't provide sufficient data you'll have to find your own.

Typical test points for G-E HB color amplifier circuits are shown in Fig. 1. Here amplified color signals R — Y, G — Y, and B — Y are fed to the red, green and blue grids of the 11SP22 color picture tube. The b-w signal is fed to the picture-tube cathode from the last video amplifier.

Check CRT grids

Test point 1 (TP1) permits a quick voltage check of the R — Y output to the red grid. This voltage should be approximately that shown on the schematic. If it's off by more than 10%, check the voltage applied to the bottom of the 27,000-ohm resistor. If this voltage is all right, the associated resistors are the likely causes of the trouble.

Incorrect voltages may, of course, also be caused by a gassy or shorted amplifier tube, or defective cathode resistors which alter bias. (The 6AC10 is a Compactron with three triodes in one envelope.)

Test points TP2 and TP3 permit voltage readings for the green and blue CRT grids. Each of these is connected to an individual brightness control, and the test-point voltage depends on the potentiometer setting, since it acts as a bleeder for the voltage. Hence, the voltage may range from 120 to 200. The function of each control can be checked by noting the voltage change at the test point while the control is adjusted. There should be a gradual voltage change. Similarly, the common brightness control can be checked at TP6. The composite video signal can also be observed here with a scope.

There is no red brightness control. The blue and green brightness controls are set higher or lower until their relative brightness equals the red. Additional balance is handled by the blue and red balance controls, which set the grid input signals. Test points TP4 and TP5 permit voltage readings for the grids of the R — Y and B — Y tubes. For voltage readings of the G — Y grid and the amplifier tube cathodes, the circuit leads will have to be located on the chassis and a needlepoint test probe used.

Color amplifier faults

Lack of white areas in scenes, continual absence of a primary color, and general color deterioration are symptoms of a defect in one or more of the color amplifier circuits. If, for instance, the color signal applied to lower than the blue and green signals), the red screen is missing (or much it will affect red areas in scenes.

However, since white areas depend on a combination of red, blue, and green—primary color signals —the white areas become lightly tinted pastel shades. At the same time, other colors will be untrue because it takes certain definite proportions of the primary colors to produce pinks, oranges, purples, cyans, etc.

Voltages may be correct, but the fault may be lack of signal input from the chroma demodulator. This can be checked by observing scope patterns at the grids and plates of the color-amplifier tubes. A typical waveform found at the plate of the R — Y tube is shown in Fig. 2. The pattern will shift with changes in the scenes. For a stationary pattern, use a color-bar generator.

If a stationary sine-wave is observed, it indicates hum or oscillations. Lack of signal requires tracing through the subcarrier amplifier and chroma-demodulator circuits. For the signal shown in Fig. 2, the voltage may range up to 190 volts peak-to-peak. Amplitudes at the anodes of the G — Y and B — Y tubes will be somewhat lower.

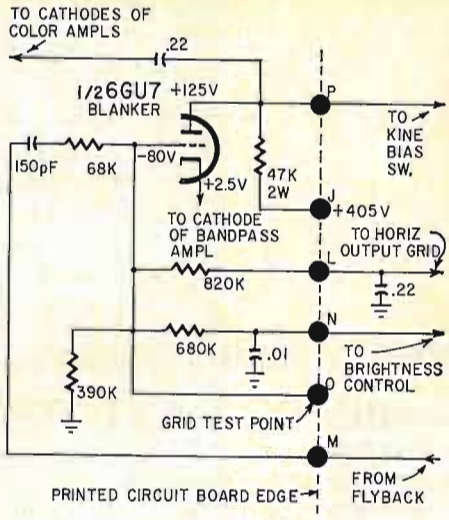


Fig. 3—Test points in this Sylvania DO1 color set are located on edge of printed circuit board, permitting complete check of the blanker circuit. The blanking amplifier cuts off the bandpass and color amplifiers during horizontal retrace.

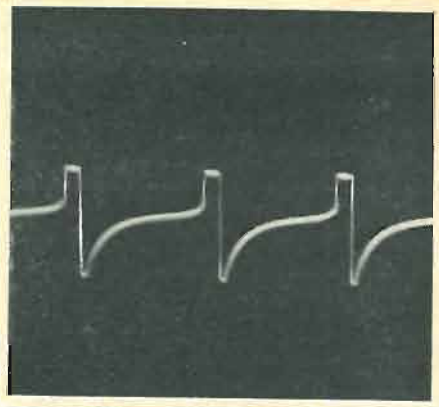


Fig. 4—Normal scope pattern at grid test point O on Sylvania set (left). Check blanker circuit if distortion is present.

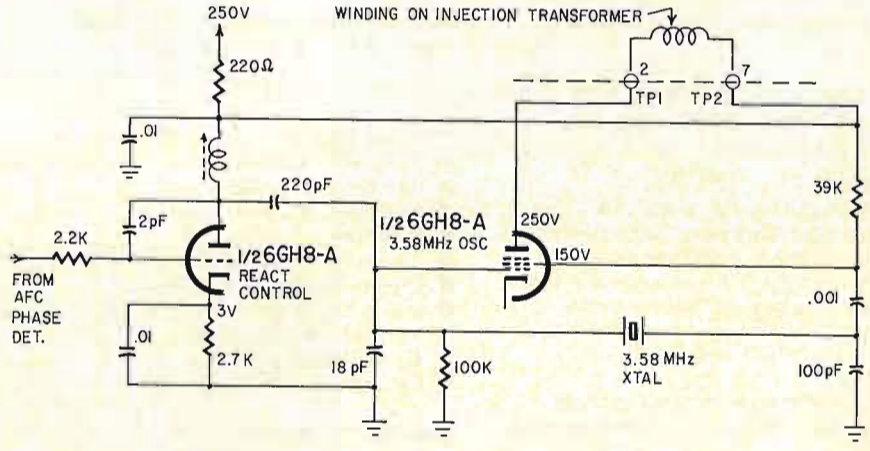


Fig. 5—Color shifts may be traced to the 3.58-MHz oscillator circuit. Test points on this Zenith 23XC36 chassis are for checking the 6GH8-A, used both as an oscillator and reactance-control stage.

Printed-circuit test points

On printed-circuit boards the input and output leads are attached to terminals at the edges of the board and hence serve as test points. Often a manufacturer will bring out extra leads to these terminals for specific check points. This technique is used in the blanker, or blanking-amplifier circuit of the Sylvania DO1 color set shown in Fig. 3.

The blanker, as the name implies, blanks out the 3.58-MHz subcarrier signal. This is the signal which synchronizes the 3.58-MHz oscillator, but

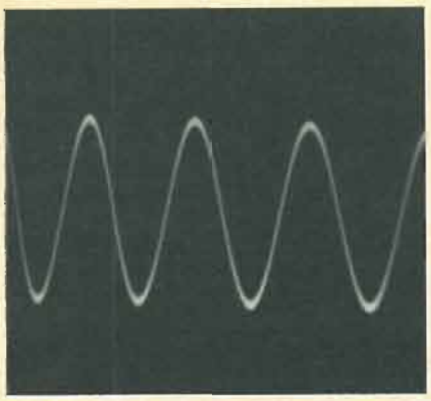


Fig. 6—Correct waveform for TP1 in Fig. 5. Scope should show a 14-volt p-p sine wave, indicating the oscillator is working.

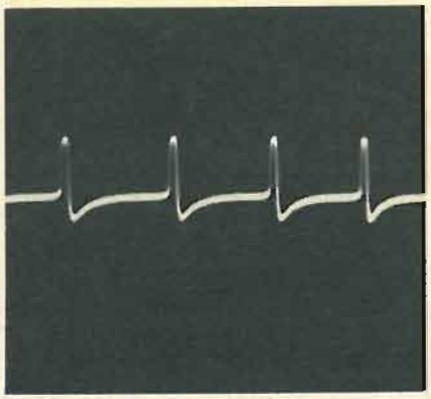
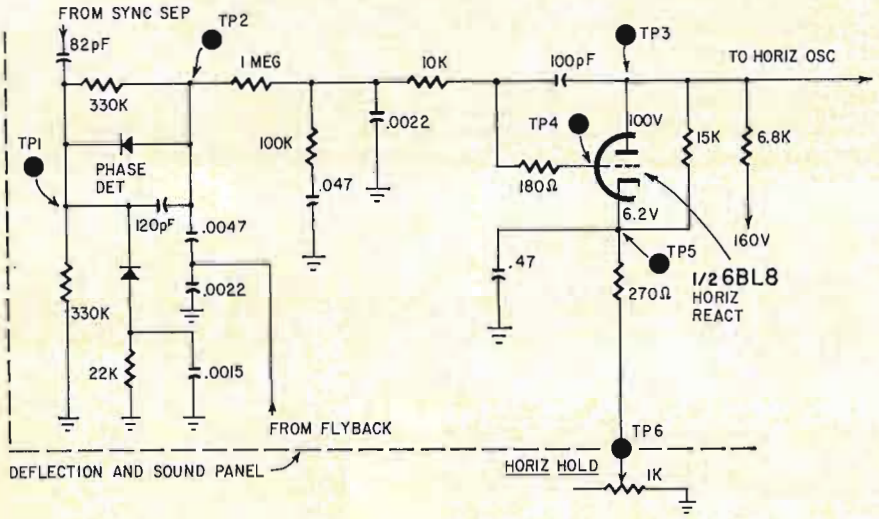


Fig. 8—Waveform at TP1 of Fig. 7 is the input to the phase detector. Signal is about 6 volts peak-to-peak, 15,750 Hz.

Fig. 7—To speed servicing, you can establish your own test points on the circuit board and mark them with labels or pen. Input to the horizontal circuits on this Philco 17KT50 chassis can be quickly checked at the test points shown here.



can cause interference if it reaches the color amplifier tubes. The blanker, synchronized by the horizontal sweep system, applies cutoff bias to the bandpass and color amplifiers during retrace.

The grid test point (Fig. 3) not only permits a voltage check of the negative bias, but also provides a handy terminal for scope checking. The normal pattern is shown in Fig. 4, and any distortion calls for a voltage and component check of the entire blanker circuit. Distortion shows up as an altered pattern and not as a change of height or width as affected by scope control settings.

One terminal provides a direct reading of the plate voltage (125 volts) and the next terminal can be used to check the applied voltage (405 volts). If the plate voltage is much lower than 125 volts, the 47,000-ohm resistor may have increased in value.

3.58-MHz oscillator

A slight shift from true colors (caused by poor color sync) can be caused by troubles in the 3.58-MHz oscillator or the reactance-control stage. A typical circuit is shown in Fig. 5 (Zenith 23XC36 receiver). Two test points are provided. At TP1 you can measure plate voltage or, with a scope, determine if the oscillator is working. A 140-volt peak-to-peak sine wave should be present here, as shown in Fig. 6.

Since oscillator troubles could be caused by the reactance-control circuit, the latter should also be checked. With normal dc voltages but poor operation, try a new tube. (In Fig. 5, the dual-purpose 6GH8-A serves both the reactance and the oscillator circuits.) If tube and voltages are OK, try readjusting the reactance-tube plate coil slightly. Rotate the slug a bit clockwise and counterclockwise, while watching results on the screen when a color broadcast is being received.

Other check points

Many receivers do not have terminal lugs specifically designated for test purposes. In these, study the schematic and compare it with component layout in the receiver to locate desirable test points.

In some printed-circuit boards, components are identified by printed numbers, letters or symbols corresponding to the manufacturer's schematic. Printed-circuit wiring is difficult to trace and not always readily accessible. Locate a specific tube, transistor or transformer, and follow the connecting components as they lead away from the identified part to other sections. If parts replacement is necessary, have all leads and terminals well tinned and solder quickly to avoid damaging the printed-circuit board.

You can establish your own test points in any given circuit and tag them with a stick-on label or marking pen. Representative test points established for the input circuits to the horizontal system of Philco's 17KT50 receiver are shown in Fig. 7. Test point TP1 is useful for checking signal presence. It is isolated from high-voltage dc by series capacitors. The waveform is a 15,750-Hz signal of approximately 8 volts peak-to-peak (Fig. 8).

Test point TP2 is an additional check for input signal. Open series resistors and shorted shunt capacitors show up here. Test point TP3 is used to check for proper plate voltage (100 volts in this case). Test point TP4 is for measuring grid signal, while TP5 can be used to check for the dc voltage drop across the cathode resistor. An open cathode resistor will make the stage inoperative. Because of the linking resistor between cathode and anode, however, a vtvm voltage reading will still appear at the cathode.

A shorted cathode–resistor bypass capacitor will remove bias and cause excessive current flow through the tube. With a shorted bypass capacitor, there will be no voltage at TP5.

Test point TP6 is a terminal at the edge of the circuit panel that can be used to check the horizontal-hold control. There should be a gradual variation of voltage as the control is rotated through its entire range.

Other test points can, of course, be established as needed and marked for identification during service checks at a later date. Thus, once an offending circuit has been corrected, it has been readied to save time if troubles develop in it later. **R-E**

New Life For Stereo Music

Expander-compressor puts those peaks back where they belong and helps make recorded music sound like it did in the concert hall

by W. E. McCORMICK

IF YOU PREFER THE FULL, DYNAMIC music range of original performances to the electronically compressed material from tuner, tape or disc, the stereo volume expander-compressor described here will enable your hi-fi system to deliver it.

Or, if you want a limited, preset level of music or TV audio, the unit will provide that too. In addition, the volume expander-compressor will act as a limiter with other reproducing equipment.

It operates with any hi-fi system, and can be driven by almost any signal source, including carbon microphones. It has two operating modes: expansion and compression. Specifications meet those of commercial units (see chart), and the compressor-expander can be constructed for about $20.00.

Amplitude swings produced during live musical sessions are often too great to be broadcast or recorded, and must be reduced in level for the media used to convey them. When these dynamics are linearly restored, realism is greatly enhanced.

Various devices for replacing this dynamic dimension have been marketed.

After deciding to add this feature to my hi-fi system, I considered several methods. Some were merely gimmicks: resistors, varistors, even incandescent lamps were placed across the amplifier output, where their loading effect varied inversely, but seldom linearly, with the current through them.

Other units with built-in "take charge" circuits use the variable conduction of back-biased diodes to make the output of a cathode follower increase faster than its input. These operate between fixed points over which there is no convenient control. They also require alterations in criti-

SPECIFICATIONS

Expansion. To 8dB per channel.
Compression. To 20 dB per channel.
Distortion. None
Input Impedance. 1000-100,000 ohms with RCA photo-cell. About 250-100,000 ohms with Clairex photo-cells.
Output impedance. 47,000-470,000 ohms average.
Use with amplifier. 4-8 or 16-ohm output impedance.
Drive voltage required—0.7 volt to initiate dynamic action
Frequency response. ± 1 dB throughout audio range.
Inputs . . . . 2 Stereo version
Outputs . . . 2
Rise time* . . . 10 msec. with RCA cells; 12-15 msec. with Clairex cells.
Insertion loss . . . 2 dB on compression. 6 dB average on expansion.

*Measured from instant of applied illumination until cell current reaches 63% of its total value. This is a function of distance between lamp and cell and illumination intensity. Since the maintaining neon lamp voltage is less than the firing voltage, a sufficiently long decay time is automatically produced. This also tends to produce a light bias on the cells, which keeps them ready for firing.

cal signal circuits, which many audiophiles do not like.

The principle employed in some commercial expanders had an appealing simplicity. Signal-driven, they use neon lamps to activate photoconductive cells and require no other power supply. Their major component, however, had been especially designed for a specific product.

Special components needed

With a circuit configuration in mind, however, what was demanded of the components could be assessed. Some of the qualities needed were out of the ordinary, but hardly unique. Needed were:

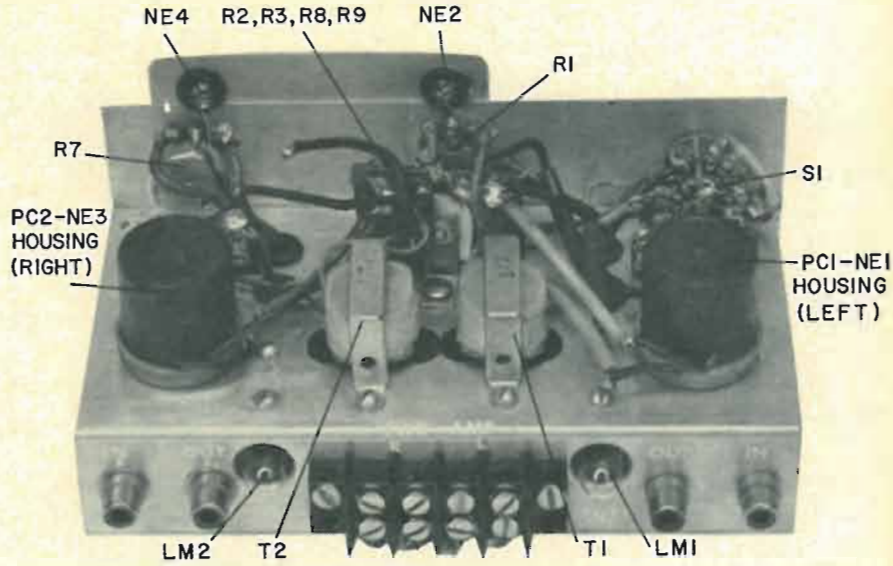
- A transformer with practically flat frequency response over the audio range.
- A high-impedance input winding to permit connecting it across an output transformer's secondary without appreciable loading.
- A turns ratio high enough to drive a neon lamp from an audio signal voltage of 1 volt or so.
- A neon lamp with a firing voltage and ionization time the same in total darkness as in ambient light.
- A light output that would remain proportional to the voltage applied and not behave erratically after a few overloads.
- A photoconductive cell with proper spectral response. Great sensitivity. Fast rise time. Proper light-to-dark conductance ratio. Appropriate resistance extremes and extreme linearity at very low light levels.

Such parts were rounded up, and Fig. 1 shows a stereo version of the expander-compressor. If a monophonic unit is desired, build only one channel.

How it works

Briefly, here's how the expander-compressor works. Since operation of both channels is identical, only one is described.

A small signal voltage across potentiometer R1 from the power amplifier is stepped up by transformer T1, passed through current-limiting resistor R2 and applied to neon lamp NE-1. Lamp LM1 is a fuse to protect the transformer and lamp NE-1. NE-2, located on the front panel, is a remote indicator showing NE-1's response. At some pot setting, NE-1 and NE-2 will begin to flicker. The intensity of NE-1 will be proportional to the voltage across it. This light, falling on photoconductive cadmium selenide (or cadmium sulphide) cell PC-1, causes its conductance (resistance) to vary with the illumination applied. Resistance



Compandor parts arrangement. Note left-right symmetry. Identical parts arrangement was used for each stereo channel. It makes assembly considerably easier and neater.

Parts List

C1, C2, C3, C4—0.47 μF, 200V
R1, R7—500-ohm, 5-watt, wire-wound potentiometer (Mallory VW500 or equal)
R2, R3, R8, R9—330,000-ohm, 1-watt, 10% resistor
R4, R5, R10, R11—47,000-ohm, ½-watt, 10%
R6, R12—100,000 ohm, ½-watt, 10% resistor
NE1, NE2, NE3, NE4—Neon lamp, Signalite NE2V or ASA No. A2B. Allied Radio part #K002 122.
PC1, PC2—Photo cells, Clairex CL504L or RCA 4425
T1, T2—Transformer, primary impedance 500,000 ohms, secondary impedance 50 ohms (Argonne AR-142, Lafayette Radio see text)
LM1, LM2—fuse, No. 44 lamps, 6.8V, 0.25 amp
S1—4 pole, 3-position switch (or Lafayette part No. 99H6170, 9-pole, 3-position)
Misc—Terminal strip (Jones 4-screw, barrier type or equal), resistor board (for 4, 1-watt resistors), solder lug terminal strips (two with 2 insulated and 1 gnd. lug, one with 4 insulated and 1 gnd. lug), phono jacks (4 RCA audio type and plugs as needed), chasis (Bud CB-1628, 1¼" h x 6⅛" w x 3" d), cabinet (Spectrum Products, No. 488, Bud SC-2130 or CU-465), metal panel (approx. 3" x 6"), plastic or metal light housings, panel jewels and threaded bushing set, lamp-cell housings, knobs, grommets, wire, etc.

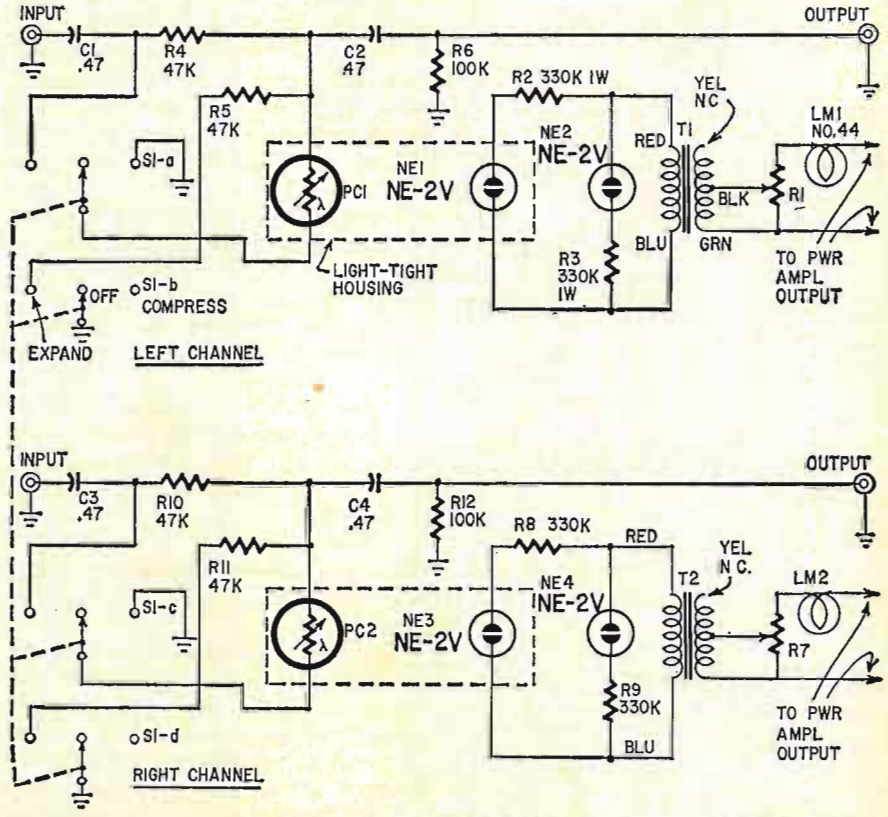
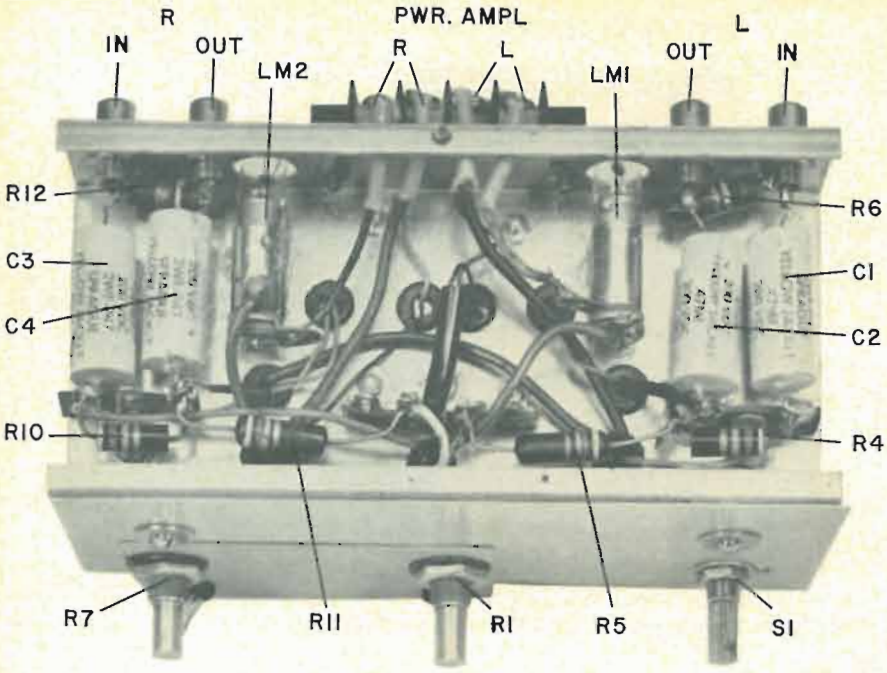


Fig. 1—Stereo version of the compandor. Resistance of photoconductive cells is varied by stepped up signal from amplifier that fires neon lamps. Cell resistance is used in voltage dividing network to produce desired effect. R1 and R7 are 500 ohms, 5 watts.



Underchassis closeup shows where the rest of the compandor components are located. The circuit is completely passive and, therefore, has no power supply of any sort.

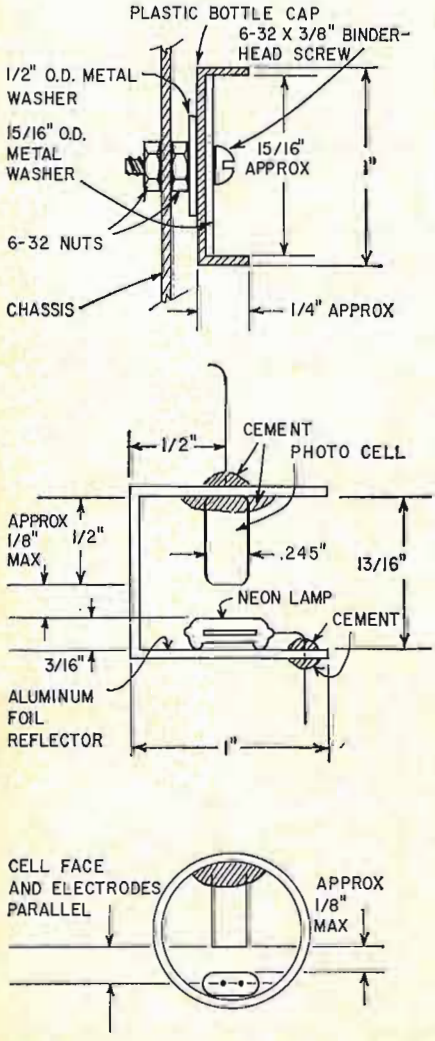


Fig. 2—Lamp-cell housings are plastic. Secure lamps and cells with clear cement.

decreases as light intensity increases.

Cell PC-1 now acts as a resistor that varies linearly with amplitude variations of the power amplifier.

Using the changing cell resistance in the signal-voltage dividing network consisting of R4, R5, R6 and blocking capacitors C1 and C2, the switching arrangement behaves as follows:

Position 1 (EXP) places the light-variable section of the dividing network in series with the signal. On louder passages the signal has less resistance to overcome and expansion occurs.

Position 2, the off position, allows the signal, minus the insertion loss of the expander-compressor, to pass straight through. By selecting your listening level with the expander-compressor in its off position, compensation is automatic.

Position 3, COMP places the dividing network across the input signal. On louder passages more drop takes place across series resistor R4 and compression occurs.

Parts placement is not critical. There is no interference between channels with the compact arrangement shown.

The function selector switch, the two operating-level pots and the two remote-indicator neon lamps are mounted on the front panel. The lamps are held in grommets and jeweled bushings are used for dressup.

On the back of the chassis are four phono jacks (an input and output pair for each channel) and a terminal strip with four screw terminals (two for each drive-signal circuit). Other parts are located as shown in the photographs. Grommets are used to protect leads passing through the chassis.

Resistors and capacitors are mounted on solder-lug terminal strips or supported by their leads. Current-limiting resistors R2, R3 and R8, R9 are mounted on a resistor board on top of the chassis near the lamp housings.

Build the lamp-cell combinations

Each lamp-cell combination should be in a light-tight housing. The housing shown in Fig. 2 was made from a 1 5/16" ID plastic bottle. Metal 35mm film cans are also suitable. Saw about 1 1/8" off the bottom of each bottle, and paint the inside black. Cement the cells and neon lamps in place. Give the outside of the module a one-turn-plus wrap of black construction paper. Slit the ends of the paper for the neon lamp leads, and slit the center for those of the cell. Next, apply cement to the wrap, which is pressed over the cell and lamp leads. Then plug the assembly into its cap, which contains a metal stiffening washer, and bolt the assembly upside down on the chassis.

Pieces of aluminum foil about 7/16" long x 5/16" wide, cemented *bright side in* beneath the neon drive lamps, will increase the unit's dynamic range, sometimes considerably. Cement all components with a clear-drying adhesive such as Elmer's Glue or White Glue.

The neon lamp should be not more than 1/8" from, and perpendicular to, the face of the cell being driven. Lamp anodes should be parallel to the face of the cell.

Alternate lamp-cell housings can be devised, but must be lightproof. The flash of a room lamp or the flicker of fluorescents will affect the sensitive cells. Light from one channel striking the cell of the other will disrupt the entire system.

How to use it

When used with an integrated system (preamp and power amplifier on one chassis), the expander-compressor is inserted between the program source and the preamp, as shown in Fig. 3-a. Be sure to use the right preamp input, since compensation for a record player, for instance, is different from that for tape. If the unit is unstable with an integrated system, shield the top of the chassis with perforated metal and add a metal bottom plate.

With component systems, place the expander-compressor between the preamp output and the power amplifier input (Fig. 3-b).

In this location, the unit will act

on program material from the preamp, allowing you to switch from one program source to another without changing cables.

Signal voltage to drive the unit is obtained from the output of the power amplifier, preferably from a 16-ohm tap. If this impedance is not available, use the 8- or 4-ohm tap. Never connect the unit across a 70.7-volt or other constant-voltage line. A small signal swing drives it through its entire dynamic range.

Regardless of which terminals the drive circuit is connected to, the speaker system always sees its matching impedance.

The volume level at which the unit will go into action depends largely on speaker sensitivity. If this is more sound than you customarily use when loud passages are played, the circuit shown in Fig. 4 will compensate for above-average transducer efficiency, usually permitting *full* expansion and compression at normal listening levels.

To connect the unit to high output impedance amplifiers of any kind, place a resistor in series with one side of the line to the drive circuit. Use a value about 50 times that of the output impedance.

Input and output cables for use with integrated systems can be standard shielded audio cable. A length of 3′ is recommended although longer ones can be used if a capacitance of about 100pf is maintained.

With component systems, your existing audio cables may be used. Cathode follower preamps usually permit the use of much longer cables. Lamp cord of any reasonable length can be used between the power amplifier output and the drive terminals.

The expander-compressor can perform several limiting jobs. It can be used when making tape recordings to prevent overload distortion right in the concert hall, if you wish.

You can hear soft passages of program material played in high-ambient noise locations. By compressing the loud passages and raising the volume level of all the material to where the loud passages were, the soft passages will come through as only the loud ones previously did.

Even works with TV

Used with a TV receiver, it keeps those "important messages from the sponsor" at a level commensurate with their importance. Connect from the high side of the de-emphasis capacitor to ground, and across the volume control. Remove the low side of the de-emphasis capacitor from ground; a 3′ cable will substitute its capacitance closely enough.)

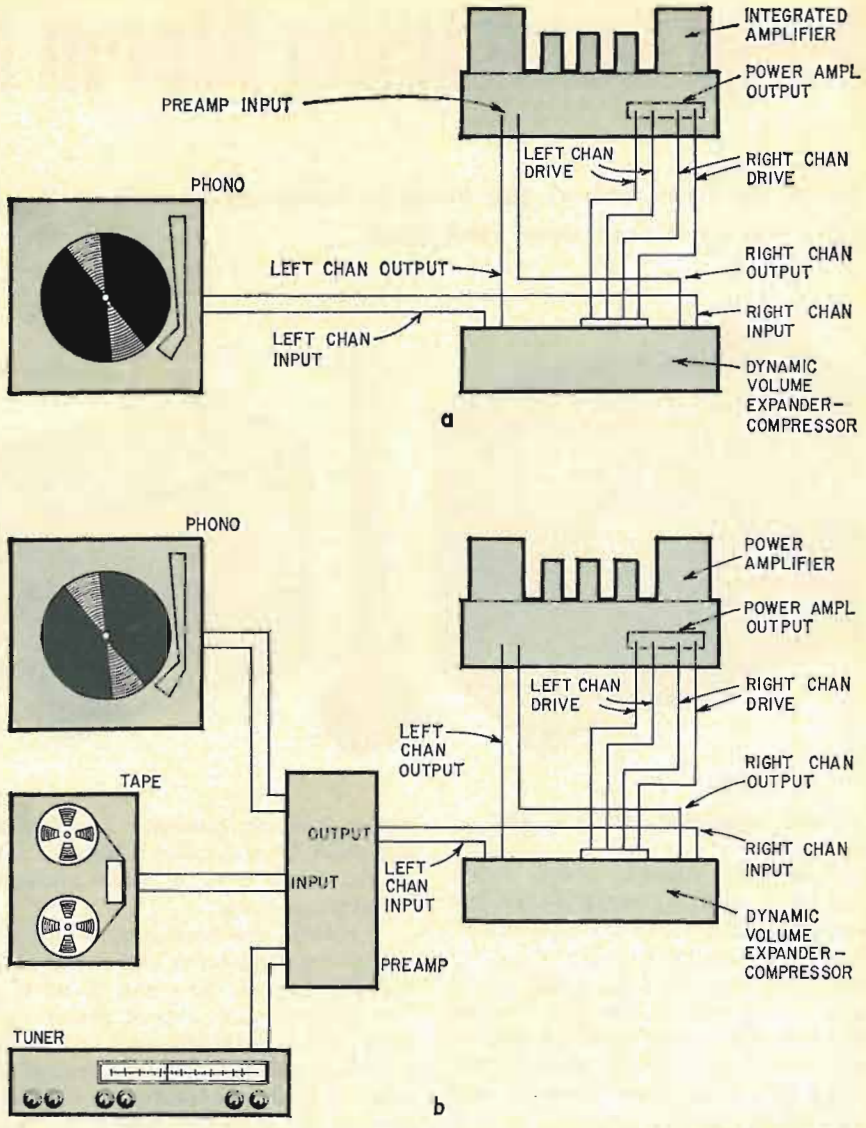
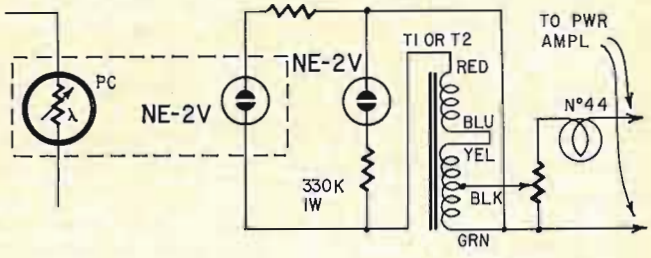


Fig. 3—Hookup for integrated system (a), *program material is fed directly to inputs. Drive signals come from speaker terminals and compandor output is fed to preamp. Component system* (b) *compandor is inserted between preamp and power amplifier.*

Fig. 4—Transducer too efficient? This circuit takes care of that problem should it arise in your unit.



Here's another bonus. In the compression mode, try playing those noisy records you were about to throw away. Start with the operating level controls fully clockwise.

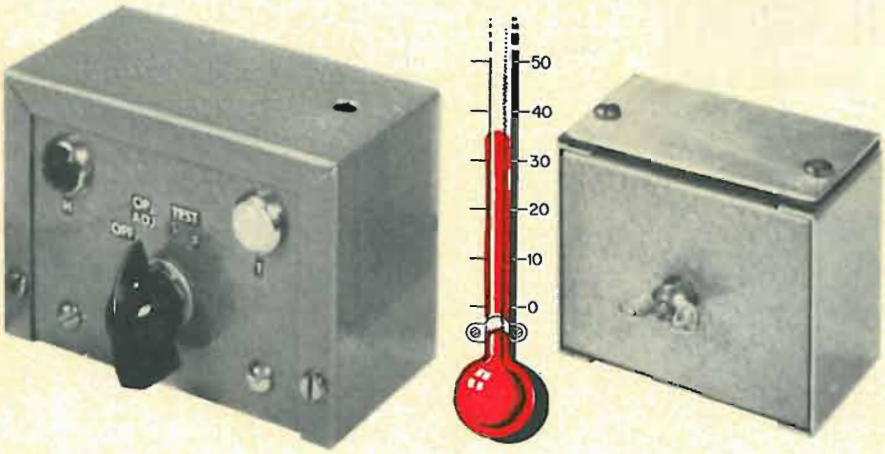
What happened to those clicks and crackles? Being spike pulses, they were cut off. The level controls can now be adjusted to the point where only loud clicks are cut off. Too much compression will make even a splendid performance sound singsong.

Now get out your finest tapes or records and play them with dynamic expansion. Set the amount of expansion desired for the *loudest parts* of the material. As the operating level controls are advanced, the remote indicator lamps will begin to flicker, indicating when the compandor takes hold.

The great dimensional changes you now hear left the recording studio as tiny pips on the signal, some of them barely got out at all. But now, even at low listening levels, the full dynamics of music are present. **R-E**

Build Road Icing Alarm For Your Car

Want to know when the road is icing up before it does? This handy alarm does just that.



By JAMES E. PUGH, JR.

Relative humidity near 100% combined with a temperature near freezing or below can make driving or flying very dangerous, since these are the conditions that can cause unexpected formation of ice. Anyone can see ice forming on his windshield when conditions are *beyond* the critical range, but when both humidity and temperature are *near* the critical point, one may not realize that ice is forming just a short distance beyond.

The icing-condition indicator (ICI) described here is intended to keep the driver alerted to critical moisture and temperature conditions, individually and in combination. Construction is simple and easy, the cost is reasonable, and once installed and adjusted, it is stable over a wide temperature range and should require no further attention.

How it works

Humidity sensing element R3 (see schematic) is a sensitive resistive element (humistor) that increases in resistance as the ambient moisture increases. It controls the collector current in common-emitter dc amplifier Q1 by controlling the base-to-emitter resistance. As the humidity increases, R3's resistance increases, Q1 base-to-emitter voltage increases, Q1 collector current increases, and indicator lamp LM1 lights.

Potentiometer R2 (LEVEL H) sets the lamp brightness to a suitable level during critical humidity conditions, and diode D1 maintains a constant Q1 amplification over a wide ambient temperature range.

Inverse feedback is provided by connecting the positive end of the base bias network to the collector of Q1. This improves the overall circuit stability and, combined with a silicon transistor, decreases the transistor warmup time to a negligible interval. Resistor R4 is used for testing the humidity portion of the indicator.

The temperature sensing portion of the circuit is the same as the humidity section, except that thermistor R9 senses temperature. Since the thermistor resistance increases as the temperature drops, LM2 lights when the temperature drops to the critical range. Thus, LM1 lights steadily when the humidity nears 100%, and LM2 lights steadily when the temperature nears freezing.

In addition, to provide a distinctive indication when *both* conditions are nearing the critical point, capacitors C2 and C4 were added to form an astable multivibrator circuit. The GAIN control, R6, sets the multivibrator operating point to cause alternate flashings of LM1 and LM2 when the humidity reaches approximately 95% any time that the temperature is about 35° or below. Resistor R12 is made approximately equal to R6 at the starting point of the multivibrator. This gives approximately equal lamp intensity when they are flashing.

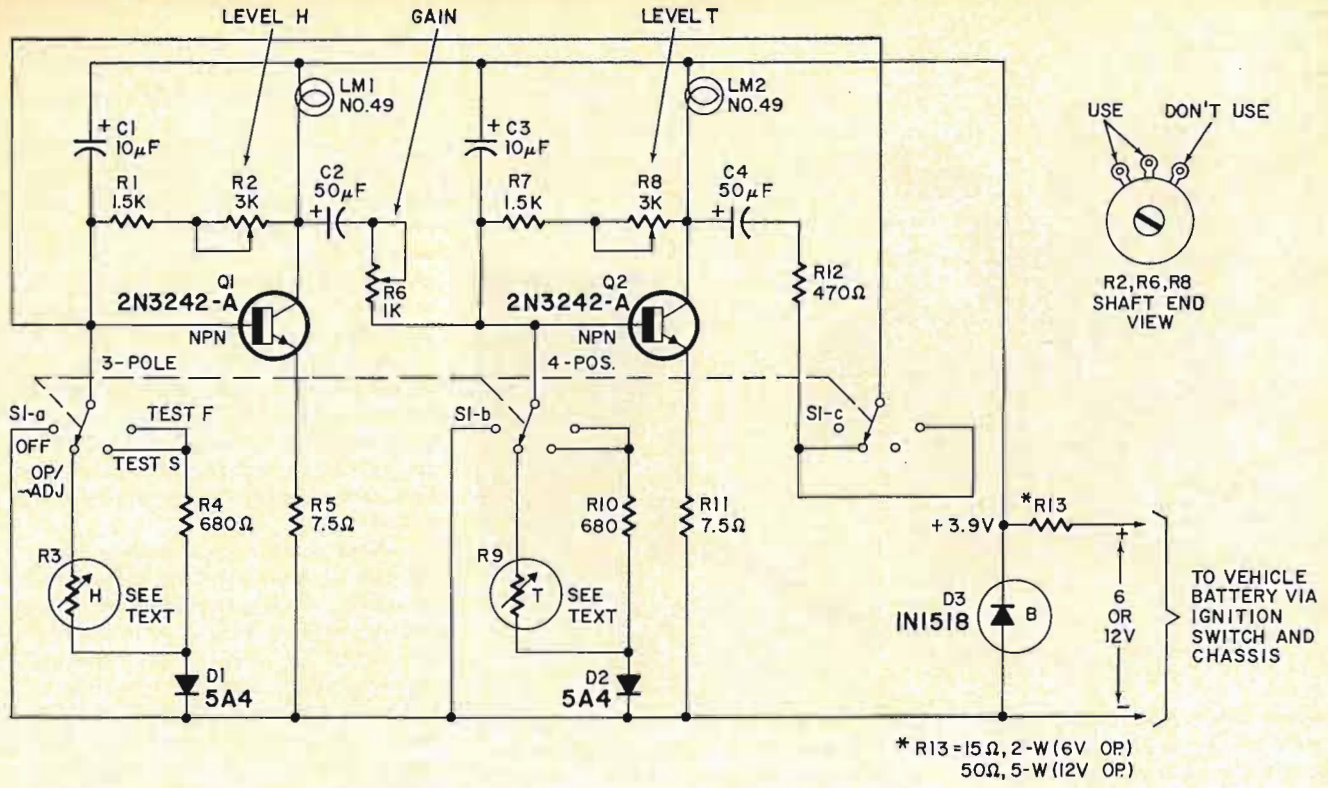
A Zener diode, D3, is used to maintain the operating potential approximately constant at 3.9 volts with normal variations in battery voltage. The input voltage can be any dc supply desired, provided that a suitable dropping resistor (R13) is used. The 15 ohm value of R13 given is for a 6-volt supply voltage. If a 12-volt battery is used, increase R13 to 50 ohms (5 watts) and mount it outside the case.

As shown in the photos, bolt the humistor inside the top section of the box with an intervening block of foam rubber. Make the top clamp for a section of thin plastic, in which a ⅝" × ¾" window is cut to permit unrestricted air flow to the humistor. Fasten clips removed from a 7- or 9-pin miniature tube socket to the plastic to connect to the humistor pins. Solder 2-inch flexible leads to each clip before mounting to prevent melting the plastic clamp. Use a 4-terminal tie point to mount the thermistor and to make cable connections to the control unit. Solder the thermistor to the tie point last to minimize the chance of heat damage.

Drill about 20 small holes (about 1/16" diameter) in both sides of the bottom section of the box to permit a free flow of air to the sensing elements. If the box is to be mounted where rain will strike it, make a small metal plate to mount above the vents on the top side. This will allow air to flow in the bottom vent and out the rear slot formed by the box top and the plate.

A machine screw can be mounted in the back of the box, or in any other suitable location, for mounting the sensing unit to the vehicle. After construction is completed, cover all openings with plastic tape. A rubber gasket can be used between the top plate and the outer edge of the box. Mount the unit where air can flow over it freely, but preferably where water cannot strike it directly. Also, if dusty roads are encountered frequently, mount the unit in a sheltered place to minimize contamination of the humistor.

Make the 4-wire cable connecting the sensing unit to the control unit long enough to reach the control unit mounting position easily. Allow plenty of extra length for routing around obstacles in the engine compartment. Make sure that the cable is located where it won't interfere with any maintenance or repair work on the engine. Wrap the cable with thin cord just inside the sensing unit box to prevent



Two transistors, a humistor and a thermistor form the core of the icing alarm circuit. The circuit is relatively simple and could keep you out of trouble this winter. So if you drive in the cold weather ahead, and who doesn't, think twice about this circuit.

strain on the tie point.

All parts except the sensing elements are mounted in the control box which will normally be located inside the vehicle. The metal box listed is suitable where mounting space is limited, but if you have plenty of space, a larger box can be used to make wiring easier. After drilling all holes and mounting the switch, lamp holders, and potentiometers, make two subassemblies on 6-terminal tie points, using the parts shown. Q1, Q2, C4, R5, and R11 can be soldered to unused switch contacts. Point-to-point wire all other parts, and install the subassemblies. Be sure to insulate all bare leads.

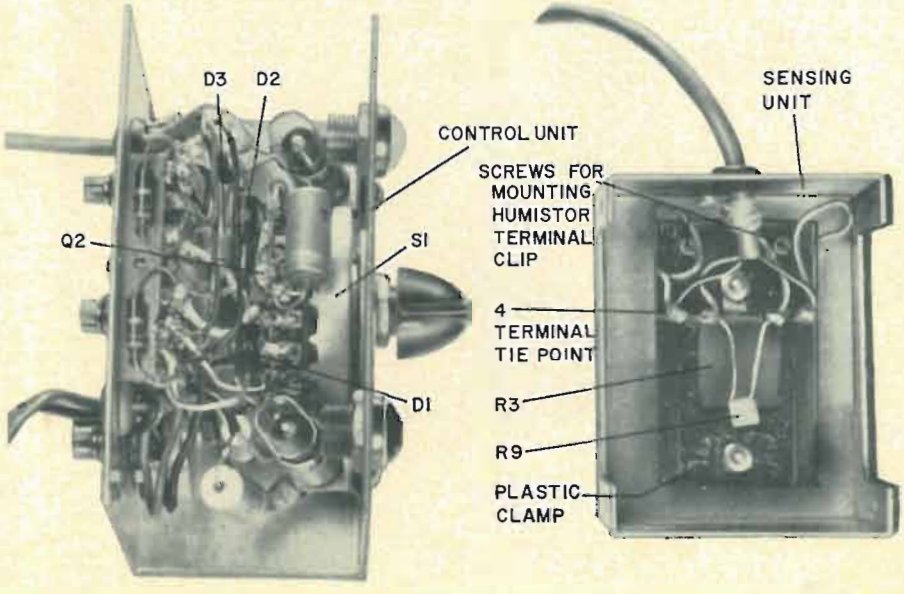
After mounting the control unit in the vehicle, connect the 4-wire cable from the sensing unit to the terminals provided on the top tie point. Then connect the positive and negative leads to the vehicle battery via the chassis and the ignition switch. Make sure that the "hot" lead from the control unit is connected to the coil side of the ignition switch as shown.

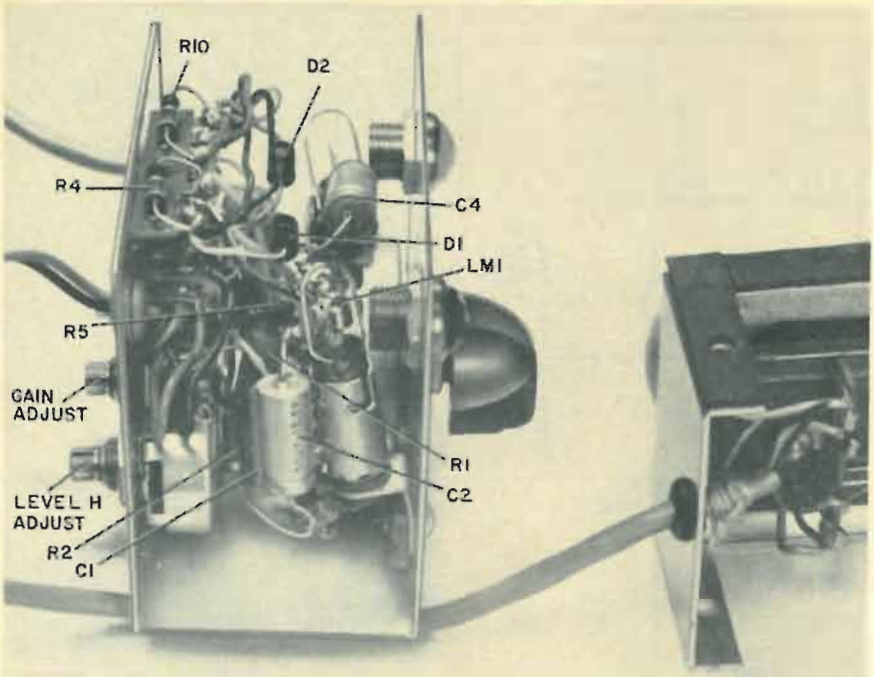
An "OFF" position is provided on the control unit switch, but it does not disconnect the supply voltage. It simply provides an idle position by grounding the bases of both transistors to reduce the collector current to the minimum. Wire potentiometers (R2, R6, and R8), so resistance decrease when the shaft of these controls is ro-

PARTS LIST

C1, C3—10μF, 6-volt electrolytic capacitor
C2, C4—50μF, 6-volt electrolytic capacitor
D1, D2—5A4 silicon diode, International Rectifier Corp
D3—1N1518 Zener diode, 3.9-volt, 1-watt, IRC
LM1, LM2—Type 49 lamp
Q1, Q2—2N3242-A silicon transistor, NPN
R1, R7—1.5k ohm, ½-watt resistor
R2, R8—3.0k ohm potentiometer, linear taper
R3—Humistor, DeVry Hygropak HA-26
R4, R10—680 ohm, ½-watt resistor
R5, R11—7.5 ohm, wire wound resistor, IRC type BWH
R6—1.0k ohm potentiometer, linear taper
R9—Thermistor, 200 ohm @ 25° C, Fenwal KB 22J1
R12—470 ohm, ½-watt resistor
R13—15 ohm, 2-watt wire wound resistor (6-volt operation)
50 ohm, 5-watt wire wound resistor (12-volt operation)
S1—3-pole, 6-position rotary switch, shorting, Mallory 3136J
2—miniature lampholders, Leecraft 7-20
2—lens, 11/32" diameter, Dialco 514
1—knob, ¼" shaft
1—4 x 2 x 2¾ aluminum box, PMC 1015
1—2¾ x 2⅛ x 1⅝ aluminum box, PMC 1000
1—4-wire cable, 22 AWG stranded, 7 x 30, Belden 8444
2—6-terminal miniature tie points
wire, grommets, solder, plastic strip, tube socket, decals, etc.

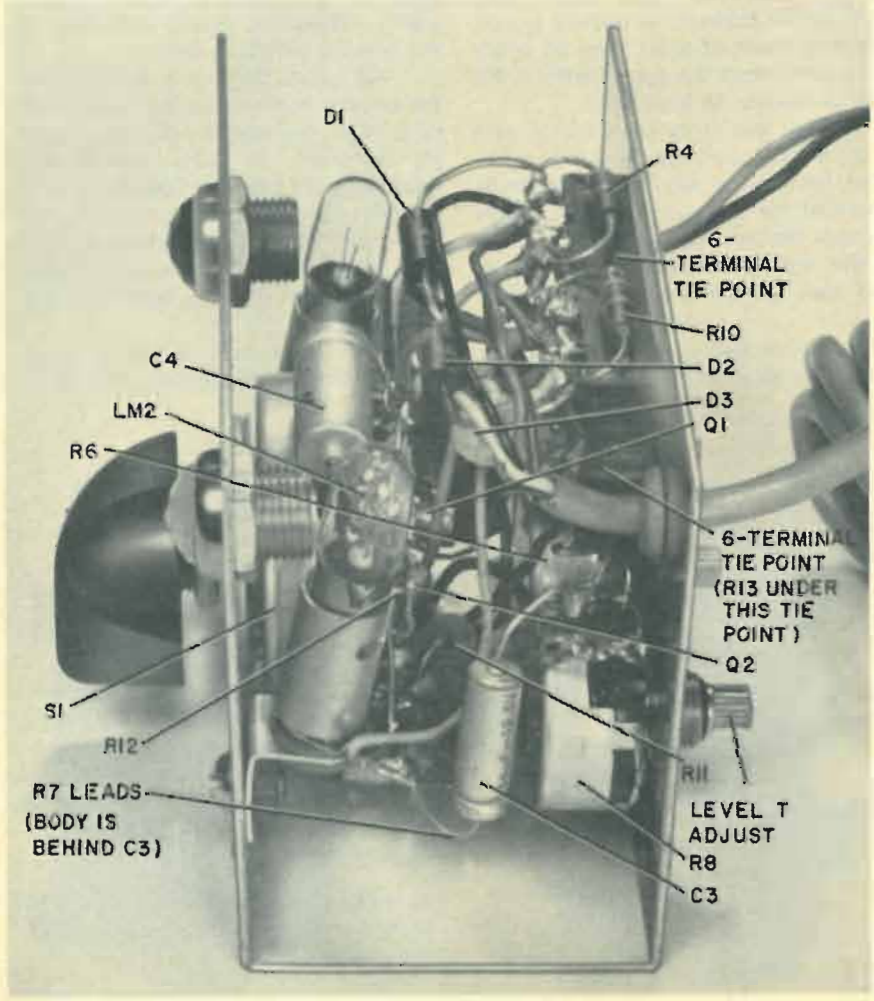
Take a close look at the inside of the sensing and control units. Match this parts placement as closely as possible and you will have little trouble building the alarm.





Another view of the control unit. This time we're looking at it from the humidity circuit end. Obviously, if you fit a larger case in your car, it will make the construction job considerably easier as it will leave more room for parts and avoid squeezing.

Here's that control unit again. This time from the opposite end where the temperature circuit is located. Parts placement is not critical, but if you follow the arrangement here, your assembly problems will be eased and you can reduce assembly time.



tated clockwise. This causes lamp brightness to increase and flashing to start with clockwise rotation, making adjustments easier.

First make a coarse adjustment as follows: Set the three potentiometers to their maximum resistance position (fully counterclockwise). Set control switch S1 to TEST S (steady) and then rotate the LEVEL H and LEVEL T controls clockwise until the lamps are visible in a slightly darkened area. (A vtvm or a 20,000 ohms/volt vom connected across LM1 or LM2 should indicate about 0.85 volt at a suitable lamp intensity.) Now set the switch to TEST F (flash) and carefully rotate the GAIN control until the lamps just start to flash.

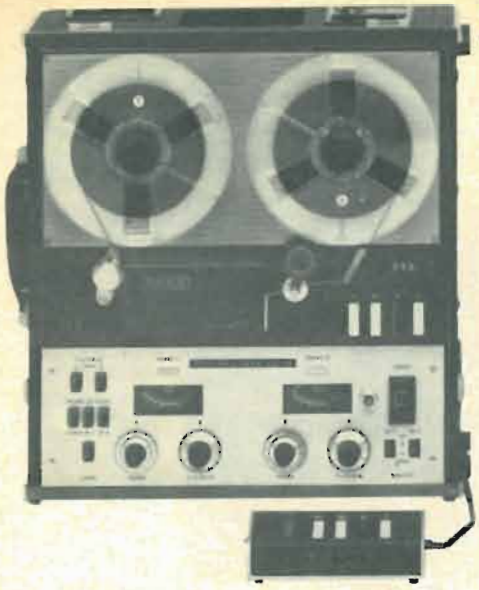
Next make a fine adjustment during critical humidity and temperature conditions. This is best done by actual measurement of these conditions. With the switch at the OP'ADJ position, make the adjustment for even lamp intensity and then for flashing at a humidity of about 95% and a temperature of about 35° F. Any hygrometer and thermometer of moderate accuracy will be suitable for making the measurements, since the lamp indication of humidity and temperature is not a precise indication. It is intended only to indicate the *range* where dangerous conditions may exist. I used an inexpensive slide hygrometer that is available at Lafayette Radio Electronics (Stock No. 99C9006) for $2.69.

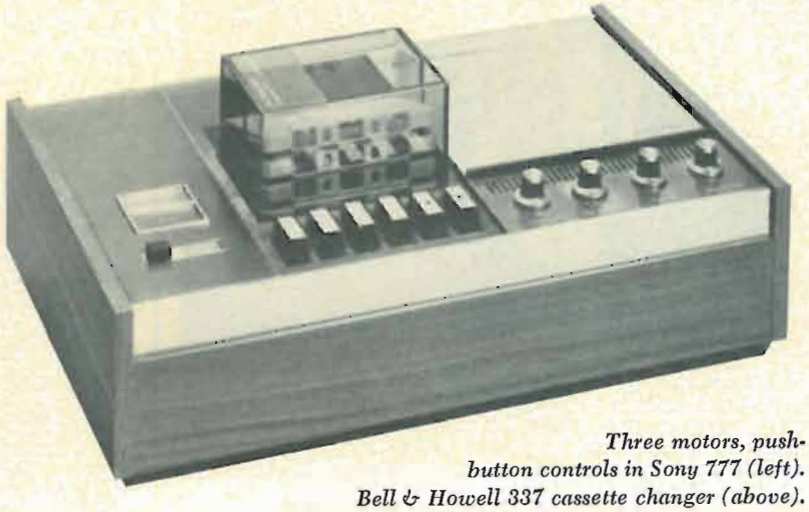
After making the fine adjustment, check that the lamp intensity is approximately the same at the TEST F and OP/ADJ positions during critical temperature and humidity conditions. If there is more than a moderate difference, change the value of R4 and/or R10 as required to make lamp intensity equal at both switch positions.

In use, as either the critical humidity or temperature range is neared, the corresponding lamp will become brighter. When both conditions reach the critical point simultaneously, the lamps will start flashing at a greater intensity and will continue to do so until either or both conditions drop below the critcal range.

Note: Since it is not always possible to simultaneously obtain humidity in the range of 95 to 100% and temperature in the range of 32° to 35°, set the two LEVEL controls separately. Then when the weather is suitable, the GAIN control can be set for flashing. If a suitable hygrometer is not available, a satisfactory adjustment of the humidity indicator can be made when driving through a light fog. Do not try this during rain or snow, however, because the humidity is often considerably less than 100% at such times. **R-E**

Features once found only on expensible machines are being offered on more and more moderate-cost recorders





Three motors, push-button controls in Sony 777 (left). Bell & Howell 337 cassette changer (above).

RECORDERS: What's Happening

By FRED PETRAS

DOLLAR FOR DOLLAR, TODAY'S TAPE RECORDER PURCHASER IS getting the best buys ever. Ease of use, compactness, good looks and an abundance of features—these are what he is getting for his money.

A study of today's recorder's shows that more and more manufacturers are offering features such as automatic level control, voice activation, automatic reversing, easy threading, plus a variety of remote control devices. There is also a trickle of multiple-play machines in reel and cassete form to make the tape recorder an even more appealing instrument than it already is.

Today, recorder manufacturers must make three kinds of recorders—reel-to-reel, cassette machines, and three kinds of continuous-loop cartridge instruments. Why all three? Because each type is selling well and, as long as there is a demand, the manufacturer must make such a machine.

For the moment, reel machines are "king" because they offer the greatest versatility and capabilities in recording and reproducing sounds on tape. But cassette recorders and playback-only cassette units are coming up fast. They are convenient and easy to use and, despite their compactness, they deliver surprisingly good sound. Also making their presence felt are loop cartridge machines. These are mostly confined to auto use as playback-only devices, but are also coming on strong as home playback machines. A handful of machines in this category offers recording capability, albeit not with the greatest of ease.

New "king" in the making?

Astute crystal-ballers predict that all three basic systems will live side by side for a long time to come, each fulfilling a different set of needs. Reel-to-reel units are expected to continue as the top-quality sound medium with the greatest flexibility in editing. Cassettes will move forward as the handiest recording-playback system. Loop concepts will move on the basis of convenient playback.

The recent National Electronic Week (NEW) show and the Consumer Electronics Show (CES) were by and large "cassette shows" in that they featured an inordinate number of cassette products. These events are noted showcases for the industry, and are considered harbingers of the future. On the other hand, last autumn's hi-fi shows in New York and Los Angeles were "reel shows."

"Human engineering" was manifest in virtually all the new offerings at the four shows. The term covers a multitude of items concerned with making a product easier to use through a logical placement of controls, functioning elements, the relationship of mechanical to electronic elements, etc. Automatic level control, voice activation and the other features mentioned earlier are all, in effect, end products of human engineering.

Solid-state devices have helped producers come up with some new design concepts, primarily portable recorder/radio combinations, but also tabletop receiver/recorder combos. Coming into broader use are recorders with high power outputs that enable them to be used as the core of a music system incorporating a record player and/or radio tuner.

Basic compactness of cassette recorder/playback equipment also lends itself well to combinations. There are a number of cassette/recorder combos, including modular audio component systems such as Harman-Kardon's popular Model SC3520 and a unit from Benjamin with a detachable cassette tape deck.

A number of trends have been shaping up for the industry overall. The tendency is away from cheap machines, with the low-priced rim-drive units so popular a few years ago virtually absent from the shelves of self-respecting dealers. Where dealers do carry such units they play them down by pointing out their limited use and value.

The trend is toward better and higher-priced machines, within each of the many categories—the three basic concepts, plus the "breakdowns" within each of the concepts, i.e., decks, battery-operated portable, ac-operated portables, decks, professional type instruments, etc.

Manufacturers are trying to please everyone, it seems. One example of this is in the way they develop product "clusters," a basic recorder offered in three or more forms. For example, a new recorder (Model 10000) from Martel Electronics under the Uher brand name is being offered as a full stereo portable complete with built-in speaker systems, as a record/playback deck less power amplifiers for about $100 less, and also as a stripped-down deck substantially less than the full deck. If a person likes the basic deck mechanism but already has an amplifier and speaker systems, plus auxiliary equipment, he can have this particular mechanism without paying for built-in electronics he has

no need for. By the same token a newcomer to the field of high-quality sound might find the most elaborate version ideal as the beginning of a full hi-fi system since it incorporates a 20-watt amplifier (enough to drive good-size speaker systems), and can accommodate a tuner, phonograph or what have you.

The KX-899 is a 4- and 8-track cartridge recorder made by Kinematix, Inc. Unit has automatic stop. $170. There are 3 heads in the Harman-Kardon TD-3 recorder.

Another trend is the gradual entry of virtually "anybody who is anybody" into the tape recorder business. G-E, RCA, Philco and a few others have been in recorders for some time, but now other big-name producers such as Sylvania are in it, and more are planning product entries. This gives people who have been dealing with the big brand names a chance to buy tape recorder products under those names. However, some big-name, full-line manufacturers do not make the tape recorders they sell. For example, one large manufacturer obtains its machines from at least three different sources.

Some big-name audio component manufacturers are also getting more and more involved with tape recorders. Harman-Kardon is setting the pace by recently adding individual reel recorders to its cassette entry, plus combining a reel machine with a modular-type stereo receiver. The spectacular demand for the cassette recorder is making all kinds of manufacturers perk up their design departments to accommodate cassette mechanisms in their products, both in components and in consoles.

Big boom in cassettes

The reasons for the big interest in the cassette on the part of the big-name producers is that they can hop aboard the tape recorder bandwagon in an easy way because of the cassette's no-nonsense ease of handling, and because the mechanism itself is small enough and inexpensive enough to be logistically and economically feasible. A number of console stereo phonograph makers have tried the tape recorder route but found they didn't do so well. The sets ended up much larger than straight phono-radios, and in a price bracket that caused many prospects to take the individual audio components route instead. Now console makers can add a tape recorder in cassette form without making the cabinet much larger—if at all, since the cassette mechanism are quite small. Sets using a cassette mechanism might be priced about $60 more than a straight combo, versus $200 for a console incorporating a reel-to-reel deck.

Cassettes for the young adult

Big-name producers in both full-line home entertainment products as well as audio components are also eyeing the cassette as a way of reaching people in the under-25 age bracket, particularly the teenager. Several companies are wooing teenagers with cassette players-only under $30.

The under-$30 playback units are also stimulating interest in short-play tapes priced under $2. Some industry observers liken the $30 players and their short-play tapes to the 45-rpm record player and records. They expect a his-

torical parallel; as youngsters with 45's moved to LP, so, too, will teeners who bought $30 playback cassette units move to reel form, toward machines that offer automatic reversing, easy tape threading and some of the other automation of today's technology.

Another 4- and 8-track cartridge player, the KX-900, by Kinematix (above). Cassette tape player by Masterworks is at right.

Cartridge tapes gain

What about continuous-loop cartridge tapes and tape equipment? Much is happening. Basically the trend is toward eight-track equipment and tapes despite the protestations of a certain group within the industry that still claim four-track will win out because it is cheaper and "better". Theoretically four-track loop tapes *should be better,* but this difference is virtually indistinguishable because of the environment in which most cartridge tapes are played—in the automobile. Perhaps a four-track cartridge can be produced with a better signal-to-noise ratio, but who can tell the difference in a fast-moving car with all the ambient noise of such an environment?

Far-seeing persons would be wise to select the eight-track concept as this is where most manufacturer emphasis is being put. Four-track will continue strong in certain parts of the country, but, say the experts, there is already evidence of a tapering off in sales and interest, with eight-track getting a correspondingly greater share of attention.

For those who started out with four-track cartridge players but wish to enjoy the eight-track concept because of its particular group of artists, a number of companies have provided "compatible" players that play both four-track and eight-track loop tapes on eight-track machines. A person trading off his old car with a four-track—or for that matter eight-track—player in it might well consider a compatible machine for his new auto.

Coming from PlayTape is a new concept—a machine that will use the two-track PlayTape concept, as well as the four- and eight-track loop concepts. The company is also producing a gadget that permits playing PlayTape cartridges in an eight-track or compatible player, thus effecting "total" capability with the right machines.

What about PlayTape itself? This concept, using short-play cartridges with four selections for its popular music category, has been regarded as a teenager item. But the manufacturer is taking it several steps beyond, with a new batch of tapes that cover a lot of ground. Now there are language tapes in the PlayTape format, along with "talking books" and other literary selections. Upcoming are operas and longer-play classical type tapes.

Up to this point the PlayTape approach has not been compatible with the other two concepts which use the 3¾-ips speed as a common denominator. But with PlayTape's new compatible machine in the offing, all this will change. Further, PlayTape will not be the only company making such a set. Just as there are many models and brands of players offering PlayTape playback capability, so, too, will there be a variety of compatible machines using the "all-cartridge" system developed by PlayTape. **R-E**

EQUIPMENT REPORT

B&K Model 970 Radio Analyst

For manufacturer's literature, circle No. 30 on Reader Service Card.

TAKEN SEPARATELY, THE INSTRUments which make up the B&K 970 Radio Analyst aren't unusual. Put them all together in one case and they are very handy! It includes all

the test equipment needed for a radio test setup, for transistor portables, auto radios and audio amplifiers.

A 10-position switch tapping a filtered dc supply selects any voltage from 1.5 to 15. An auxiliary dc supply provides a second voltage when required.

Two AUTO positions, 6 and 12 V, provide slightly more current than the normal 6–12-V taps. The 15-V tap can simulate engine-running auto radio conditions.

A 5500-ohms-per-volt vom on the panel has dc voltage scales of 0–2, 0–20, 0–200 and 0–500 V and current scales of 0–20 mA, 0–200 mA, 0–2 amps and 0–5 amps. The ohmmeter section has ×1, ×10 and ×100 scales. The basic scale is calibrated from 0 to 1 megohm. The meter is also used on transistor tests, and is calibrated GOOD–?–BAD and directly in beta.

An all-transistor 4-band rf signal generator provides alignment signals for AM and FM radios. It covers 250–750 kHz, 750–2000 kHz, and 10.0-11.4 MHz AM, plus 10.0–11.4 MHz and 88–108 MHz FM. A dual knob is used for fine-tuning, and the calibration is very accurate. The audio signal is brought out to a separate jack; its level can be controlled by a potentiometer with switch.

A built-in transistor tester checks for beta and leakage. Both out-of-circuit and in-circuit tests can be

(continued on page 68)

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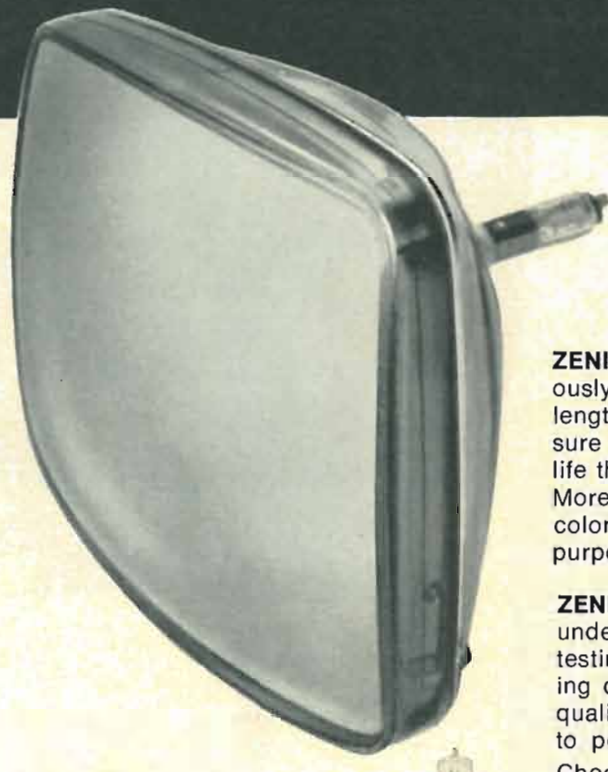

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EQUIPMENT REPORT

(continued from page 62)

made very easily indeed.

Current tests are useful in all transistor servicing, but they're not easy. They can be made very quickly with the 970, by plugging a 6" patch cord between the power-supply and meter jacks. Current reading on portables can be used as an alignment indicator. The more current drawn, the better the alignment.

This will also help in bias setting after power-transistor replacement in auto radios and small audio amplifiers, or for checking motor-speed control circuits in auto tape players.

Safety features

When using this instrument, get used to turning the power switch off when changing connections, etc. If the power leads short, pop goes the fuse thoughtfully placed in both primary and secondary circuits.

Even if the fuse is blown by a short with the current meter still in-circuit, it will be safe. The meter is protected by a diode shunt used for just this emergency.

Now, here's a final bouquet, and a couple of small comments. The bouquet is a favorable reaction to the handiness of the instrument. Controls are well placed, calibration is accurate, and the 970 is easy to use. It can speed transistor radio servicing.

The ohmmeter's lowest range is crowded at the low-resistance end. The first calibration mark is 100 ohms, and there are only four scale divisions between this and the end.

The instruction book says, in the section for transistor testing out-of-circuit, "If you read *no* leakage and no beta, reverse the npn/pnp switch." In our tests, we found that reverse polarity on a transistor showed a full-scale+ reading, on good transistors. I interpreted this to mean that the collector was forward-biased and conducting heavily. With the switch set properly, all test transistors checked correctly, including the carefully preserved units with a definitely known amount of excess leakage. (Before someone asks, the reversal *does not damage transistors.*)

Beta and leakage readings on the 970 agreed with our test transistors and other transistor testers, some much more elaborate. The 970 caught transistors with too much leakage.

This is a useful instrument to have around, and could be used all by itself to set up a radio department in your shop.— *Jack Darr* **R-E**

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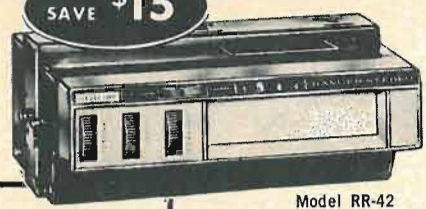

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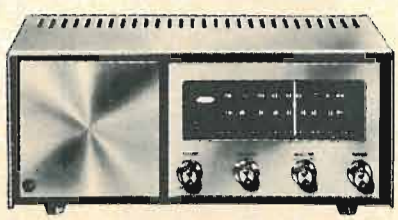
Save $12.77

BONUS! ALL THESE ITEMS FOR ONLY $1 MORE:

Fully assembled shortwave antenna | "ABCs of Shortwave Listening"—96pp book | 8 extra "C" batteries for months of listening | Big 30x40" world map to locate SW stations!

A national magazine called it "one of the best buys around... such wide-range coverage, there isn't anything going on you can't intercept." Only 10½" wide, yet it brings you sharp, clear reception and big tone. Plays on 4 "C" batteries (incl.) or AC. 15 transistors, 6 diodes; telescoping FM-VHF antenna; slide-rule dial; dial light; tone control; fine tuning; AFC; 3 x 6" speaker plus earphone. Size: 7⅜ x 10½ x 3". From Japan. Shpg. wt. 15 lbs.

10 PE 0039 L3U Radio with Bonus Pkg.....**60.50**
10 PE 4362 RX Radio Alone. Shpg. wt. 9 lbs....**59.50**



Allied A2589 Dual-Band FM Monitor Tunes 30-50 mHz and 152-174 MHz

79.95

$5 monthly

Our First FM monitor to tune **both** VHF Police and Public Service bands. Solid-state circuit with 20 transistors, 10 diodes, 2 thermistors. Has four IF stages, AVC, squelch circuit. Jack for extra speaker or headphones. 5-7/16x11-7/8x 3/4". 117V, 50-60 Hz AC. From Japan.

17 PE 6980U Wt. 11 lbs. $5 Monthly.....**79.95**
17 PE 6226 Dual Headset. Wt. 1 lb.....**5.95**
17 PE 6714X Ground Plane Antenna. 6 lbs. **9.95**
17 PE 6883 50' Foam Coax Cable. 2 lbs.. **5.50**

SAVE $30.80

Allied TD-1030 Stereo Tape Deck

$139.95

Separately, $170.75

Feature-filled stereo tape deck in walnut case, at low, low price! Records/plays stereo or mono thru stereo system or console. 23 lbs.

15 PE 0082 L2U
$7 Monthly ...**139.95**

BONUS! Two Allied Dynamic Mikes with Fitted Carrying Case

ONLY ALLIED GIVES YOU ALL THIS:

The world's largest selection of electronic components

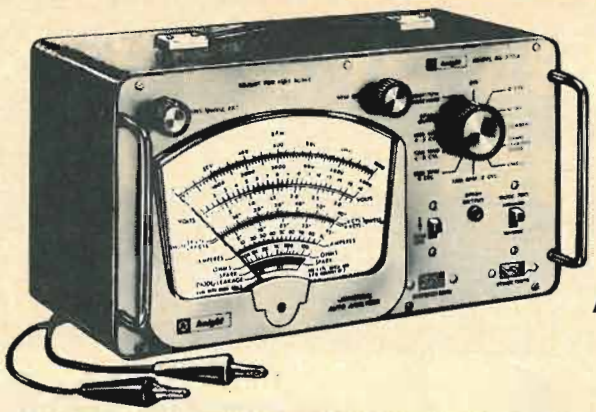
Nowhere else on the face of the earth can you find so many famous brands—and so many different models of each brand. Whatever you need—Allied is more likely to have it than anybody!

Money-saving low prices, always

Allied buys big: passes the savings on to you! And Allied's own brands offer you spectacular values in fine merchandise!

No money down—up to two years to pay

If you want it now, have it now—with an Allied Credit Fund Account. Make add-on purchases, too!



Save Hundreds of Dollars—Tune up and Troubleshoot Any Car With *knight-kit* Solid-State Auto Analyzer Kit!

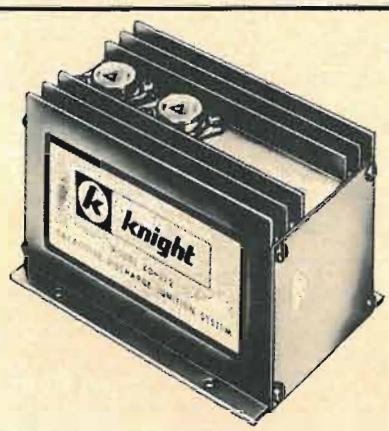
$49.95
$5 monthly

Checks voltage and current regulators, generators and alternators, diodes. Detects distributor wear, variation in dwell angle and condition of points; locates poor or open electrical ground circuits. Portable. Easy to build; use on any 6 or 12V system, positive or negative ground. With tune-up chart, tune-up and trouble-shooting manual, solder, test leads, 4 "C" batteries, step-by-step instructions. Size: 6½ x 12½ x 5½". From Japan.
22 PE 3323X Shpg. wt. 11 lbs. $5 monthly.....49.95

knight-kit Capacitive-Discharge Ignition System Kit Saves Gas, Boosts Plug Life!

$28.95
$5 monthly

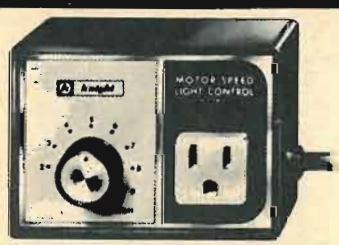
Build it yourself to save money—then install it in 10 minutes in your car or boat to save more money! Increases gas mileage up to 20%; boosts spark plug life 3 to 10 times! Improves starting; provides more complete combustion. For any 12V system. Wt. 2½ lbs.
22 PE 9575X $5 monthly 28.95



$19.95
$5 monthly
Compares to assembled timing lights costing much more!

knight-kit Timing Light Kit Checks Timing, Spark Advance, Distributor Cam Wear—For Better Mileage, More Power

Built-in solid-state power supply—delivers up to 1250 flashes per minute—brighter flash than units operated from ignition coil. Easy-to-assemble kit with all accessories. For 6- or 12V systems. From Japan.
22 PE 3312X Shpg. wt. 2 lbs. $5 Monthly...19.95



knight-kit® **$9.95**

Motor Speed & Light Control Kit

Makes your power tool a variable-speed tool; controls brightness of incandescent lamps. Solid state. Circuit breaker. (Not for AC—only motors).
22 PE 3335X Shpg. wt. 2 lbs.....9.95


Better Work with Sander, Buffer!

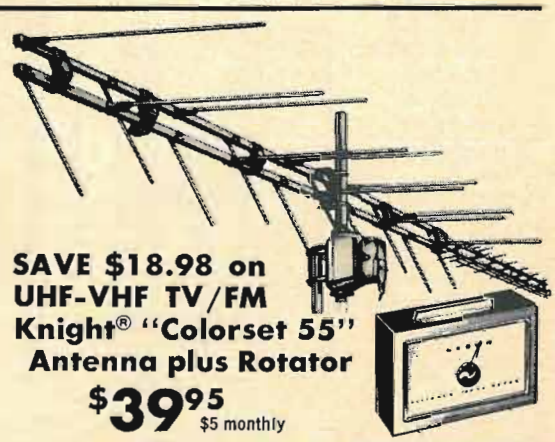

Drill Plastic Without Gumming!


Limits Soldering Iron Heat!


Compact, with Easy Single Control!

knight-kit® **VOM Kit**
20,000 Ohms-per-Volt DC
$11.95

Outstanding value! Ideal for radio-TV servicemen, hobbyists. Pocket size (5 x 3½ x 1¾"); easy to assemble. With all parts, leads, battery, instructions. From Japan.
22 PE 3907X Wt. 1 lb.....11.95



SAVE $18.98 on UHF-VHF TV/FM Knight® "Colorset 55" Antenna plus Rotator

$39.95 $5 monthly

The greatest antenna value we've ever offered! Knight "Colorset 55" 55-element antenna brings in color and black and white 82-channel TV (UHF and VHF) plus FM—Alliance T-45 rotator aims antenna for sharpest reception. Pre-assembled boom with VHF-UHF signal splitter. UL Listed. 120 VAC on rotator. Shipped truck or express. Shpg. wt. 26 lbs.
11 PE 0062 L2ZW $5 Monthly 39.95

Shown in Wood Case

Allied® "365" 65-Watt Stereo FM-AM Receiver

$199.95 $10 monthly

Powerful 65-watt solid-state stereo FM-AM receiver now at huge savings! 130-watt peak; stereo switching. With metal case. 5 x 16 x 12". Japan.
14 PE 5072 RU Wt. 28 lbs. . . **199.95**
14 PE 5003X Walnut Wood Case 6 lbs. **19.95**

Shown in Wood Case

Scott 299T 65-Watt Stereo Amplifier

$149.95 $8 monthly

One of Scott's finest, at Allied's amazing low price! All silicon transistors. 5¼ x 15½ x 12". Shpg. wt. 12 lbs.
13 PE 2730 U $8 Monthly . . **149.95**
13 PE 2040 X Walnut Wood Case 6 lbs. **20.82**

Imagine! Full-Response Stereo Headphone Kit, Only $6.95

Response: 20-20,000 Hz! Large earcushions seal out room noise. Adjustable headband. Lightweight. In kit form, easy to assemble. From Japan.
22 PE 9550R Shpg. wt. 2 lbs. **6.95**

You get ALL this:

Turntable

Walnut Base

Dust Cover

Choice of Stereo Cartridge

Allied® "919" 4-speed Automatic Turntable with all accessories

$54.95 $5 monthly

Check the features: cuing and pause control with 1-groove accuracy; low-mass pickup arm; anti-skate control. Plays records in stacks or singly. Your choice of Empire 888E, Pickering V15/ATE-3 or Shure M93E stereo elliptical cartridge. 13⅛ x 11¼". Shpg. wt. 18 lbs. England.
14 PE 0131 CD3U Specify cartridge **54.95**

Here's your ALLIED Order Blank

TO BUY ON CREDIT, WITH NO MONEY DOWN, COMPLETE APPLICATION ON OTHER SIDE

IMPORTANT SHIPPING INFORMATION

Please Take a Minute to Read This Helpful Information Allied will ship your order the best and lowest cost way from its Chicago warehouse. Allied is noted for speedy and safe shipment.

On CREDIT FUND orders you never have to figure shipping charges — Allied prepays the charges and includes them in your Credit Fund statement.

On CASH orders send enough money to cover shipping charges — any excess will be refunded at once. Items on these four pages with suffix "U" in Allied's stock no. are usually sent by REA Express. Items with suffix "W" or "Z" are usually sent by truck. For rates, call your REA Express or truck agent. Other items on these four pages are mailed Parcel Post. NOTE: On Parcel Post shipments, please also include insurance fees to cover orders of the following values:

$2 to $15. . . . . 20¢ $15.01 to $50. . . . . 30¢
$50.01 to $100. . . . 40¢ $100.00 to $150. . . . 50¢
$150.01 and Up . . . . . 60¢

PARCEL POST RATES (DISTANCE FROM CHICAGO)

WEIGHT	Up to 150 mi.	150-300 mi.	300-600 mi.	600-1000 mi.	1000-1400 mi.	1400-1800 mi.	Over 1800 mi.
2	$0.60	$0.60	$0.65	$0.70	$0.80	$0.85	$0.90
3	.65	.70	.75	.85	.95	1.05	1.15
4	.70	.75	.85	.95	1.10	1.20	1.35
5	.75	.80	.90	1.05	1.25	1.40	1.60
6	.80	.90	1.00	1.15	1.40	1.55	1.75
7	.90	.95	1.10	1.30	1.50	1.75	1.95
8	.95	1.00	1.15	1.40	1.65	1.90	2.15
9	1.00	1.05	1.25	1.50	1.80	2.05	2.35
10	1.05	1.15	1.35	1.65	1.90	2.25	2.55
11	1.10	1.20	1.40	1.75	2.00	2.40	2.75
12	1.15	1.25	1.50	1.85	2.15	2.55	2.90
13	1.20	1.35	1.55	1.95	2.25	2.70	3.10
14	1.25	1.40	1.65	2.05	2.40	2.85	3.25
15	1.30	1.45	1.75	2.15	2.50	3.00	3.45
16	1.35	1.55	1.80	2.25	2.60	3.15	3.60
17	1.40	1.60	1.90	2.35	2.75	3.30	3.80
18	1.45	1.65	1.95	2.45	2.85	3.45	4.00
19	1.50	1.75	2.05	2.55	2.95	3.60	4.15
20	1.55	1.80	2.10	2.65	3.10	3.75	4.35
21	1.60	1.85	2.15	2.75	3.20	3.90	4.50
22	1.65	1.90	2.25	2.80	3.30	4.05	4.70
23	1.70	1.95	2.30	2.90	3.40	4.20	4.85
24	1.75	2.00	2.35	3.00	3.55	4.35	5.00
25	1.75	2.05	2.45	3.05	3.65	4.50	5.20
26	1.80	2.05	2.50	3.15	3.75	4.65	5.35
27	1.85	2.10	2.55	3.25	3.90	4.80	5.55
28	1.90	2.15	2.60	3.35	4.00	4.90	5.70
29	1.90	2.20	2.70	3.40	4.10	5.05	5.90
30	1.95	2.25	2.75	3.50	4.20	5.20	6.05

ALLIED RADIO CORP.
100 N. Western Ave.
Chicago, Ill. 60680
Dept. No. 045

Date_____

Acct. No._____ (if credit order)

Name_____ Phone Number_____
First Middle Initial Last Area Code Number

Street Address_____

City_____ State_____ Zip Code_____

Quantity	Stock Number	Description	Price Each	Total Price	Weight Lbs	Weight Oz

IF THS IS AN ADD-ON ORDER:
(Minimum add-on order, $10)

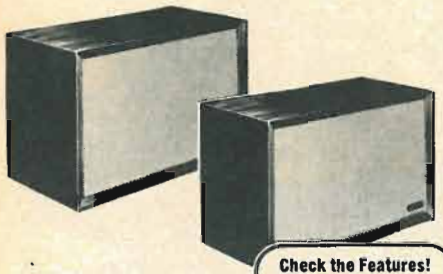
ALLIED RADIO CORPORATION, Chicago, Illinois 60680: Please add the merchandise listed above as a purchase under my present Allied Credit Fund Account. This purchase will be combined with my present account, and I will pay on the one combined account according to the contract terms set forth in your current catalog and upon the conditions stated in my original contract.

PLEASE SIGN HERE_____

If your account was paid up 12 months ago or more, please fill in the information requested on the other side.

TOTAL FOR GOODS		
Illinois residents add 5% tax		↑ TOTAL WT.
Handling charge—strike out if order is $5 or more	.50	
SHIPPING CHARGES		
INSURANCE		
TOTAL AMOUNT		

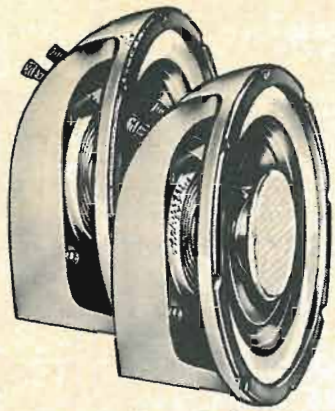
☐ Check here if order is C.O.D. (Minimum $10; 20% deposit required)



Allied Exclusive! This Pair of UTAH AS-2 8-inch Speaker Systems

One System	Two Systems
$49.95	$50.95
$5 monthly	$5 monthly

What a buy! Handsome, compact systems have 40–18,000 Hz response; 2-way design with 4500 Hz crossover. Exceptionally clean sound: interior design damps out standing waves and other spurious vibrations. Power capacity, 15 watts. Impedance, 8 ohms. Each system 11x8x9". Shpg. wt. 22 lbs. each.
20 PE 7073 RU One System. $5 monthly...**49.95**
Two Systems. $5 monthly...**50.95**

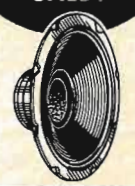


Utah "Celesta" 3-Way 12-inch Speakers

One Speaker	Two Speakers
$34.95	$35.95
$5 monthly	$5 monthly

Amazing response: 25 Hz to beyond audibility. 12" woofer with cloth-roll suspension; die-cast frame with shallow design. Capacity: 25 watts. Impedance: 8 ohms. 5-11/16" deep. Wt. 11-3/4 lbs. each.
20 PE 8229 RX One Speaker **34.95**
Two Speakers **35.95**

CLOSEOUT SALE!



Utah 15-in. Musical Instrument Speaker

$15.00

Our Lowest Price Ever!

Ideal for electric organ and bass guitar. Steel chassis, massive 6¾-lb. magnet structure, oversize voice coil. 75 watts peak. 8 ohms. Mounting depth 6½". Limited quantity.
16 PE 3183X 12¼ lbs...**15.00**

Buy Mikes and Get Headphones For Only $5 More!

SAVE $6.95 — **$38.75** — $5 monthly

Two Allied 4525 Mikes plus Allied H-878 Stereo Headphones.
12 PE 0030 L2 5 lbs....**38.75**

Set of 3 Stereo Demo Records

$3.29

Test balance, performance of your system. 12" 33⅓ rpm.
24 PE 9010 R 2 lbs. 3 for **3.29**

Application for ALLIED CREDIT FUND ACCOUNT

RETAIL CHARGE AGREEMENT

ALLIED RADIO CORPORATION, Chicago, Illinois 60680. Please open a Credit Account for me. I agree that each purchase made under this contract will be subject to the following terms: Until the merchandise is fully paid for, title to and right to possession of the merchandise shall remain in you; Upon default in payment of any installment of the purchase price, you may without notice declare the entire balance immediately due and payable, and pursue all remedies available to you by law. I shall pay an installment each month as billed by you, which will include a service charge in accordance with the terms stated in your current catalog; and if I elect to pay the full account within 30 days after the first billing date, there will be no service charge. This agreement shall be governed by and construed in accordance with the laws of the State of Illinois. For the purpose of obtaining credit, I make the following representations listed below.

NOTICE TO BUYER:

Do not sign this contract before you read it or if it contains any blank space. You are entitled to an exact copy of the agreement you sign. Under the law, you have the right among others, to pay off in advance the full amount due.

SORRY—NO APPLICATIONS ACCEPTED FROM PERSONS UNDER 21

CREDIT FUND PAYMENT TABLE

Monthly Payment Only	Unpaid Balance Buys Up To
$5	$100
$6	$120
$7	$140
$8	$160
$9	$180
$10	$200
$11	$220
$12	$240
$13	$260
$14	$280
$15	$310
$16	$340
$17	$370
$18	$400
$19	$440
$20	$480
$21	$500
$22	$525
$23	$550
$24	$575
$25	$600
$26	$625

Over $625—Monthly payments will be in proportion to amounts on chart.

Small Service Charge. Only a small service charge of 1½% of the previous month's balance, minimum 70¢, is added to your previous month's balance. There are no other charges. Your monthly statement shows exactly what you pay, what you owe and how much unused credit you have.

DATE_____

(SIGN FULL NAME X)_____ SOCIAL SECURITY NUMBER_____ YOUR AGE_____

HOME ADDRESS_____ CITY_____ STATE_____ ZIP CODE_____

HOME PHONE_____ HOW LONG AT PRESENT ADDRESS?_____ ☐ OWN HOME ☐ RENT ☐ OTHER_____ RENT OR MORTGAGE PAYMENTS $_____ PER MO.

WIFE'S NAME_____ MARITAL STATUS ☐ MARRIED ☐ SINGLE ☐ DIVORCED ☐ SEPARATED ☐ WIDOW(ER) NUMBER OF DEPENDENT CHILDREN_____

PREVIOUS ADDRESS_____ CITY & STATE_____ HOW LONG AT THIS ADDRESS?_____

(IF SELF-EMPLOYED—PLEASE STATE NAME AND ADDRESS OF BUSINESS)

HUSBAND'S EMPLOYER_____ PHONE_____ POSITION_____ MONTHLY INCOME $_____

EMPLOYER'S ADDRESS_____ Street City State HOW MANY YEARS ON PRESENT JOB?_____

PREVIOUS EMPLOYER_____ Name Mailing Address HOW LONG?_____

WIFE'S EMPLOYER OR ADDITIONAL INCOME_____ Name Mailing Address MONTHLY INCOME $_____

BANK ACCOUNT WITH (Name)_____ Mailing Address ☐ CHECKING ☐ SAVINGS ☐ LOAN

CREDIT ACCOUNT WITH (Name)_____ Mailing Address

CREDIT ACCOUNT WITH (Name)_____ Mailing Address TOTAL MONTHLY PAYMENTS EXCLUDING RENT OR MORTGAGE $_____

NAME OF RELATIVE NOT LIVING WITH YOU_____ Mailing Address RELATIONSHIP_____

(IF YOU ARE IN MILITARY SERVICE, FILL IN BLANKS BELOW)

MILITARY ADDRESS_____ RANK_____ PAY GRADE_____

SERIAL NO._____ COMMANDING OFFICER_____ YOUR TIME IN SERVICE_____ YRS._____ MOS.

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#290. **Antenna Engineering Handbook** by Henry Jasik. Provides a vast storehouse of data on antenna design for commercial and military applications.
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#850. **Mathematics for Electronics with Applications** by H. M. Nodelman. Offers the working engineer practical, time-saving mathematical techniques.
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Pub. Price, $15.00 **Club Price, $12.75**

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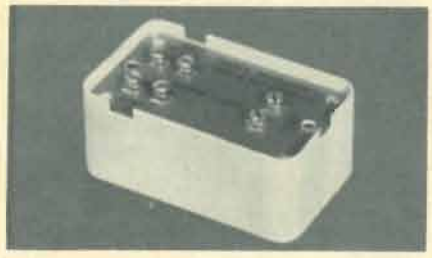
DYNA-FLEX 3-POINT PROBE, *Model FP-3* is used with in-circuit transistor testers, vtvm's, vom's and tvom's to check transistors, diodes and most other components. In addition, unit makes temporary component substitutions on

printed wiring boards. Adjusts automatically to any spacing from 1/32" to 3/8". Eliminates troublesome unsoldering and provides simultaneous connection to 3 printed-board terminations. Contact resistance is less than 0.05 ohm. $9.95.—B&K Division of Dynascan Corp.

Circle 46 on reader's service card

UHF 2-SET COUPLER *Model C-200* is designed for use with uhf antennas without having interference between receivers causing color smears. The splitting loss is less than 4.5 dB and vswr is better



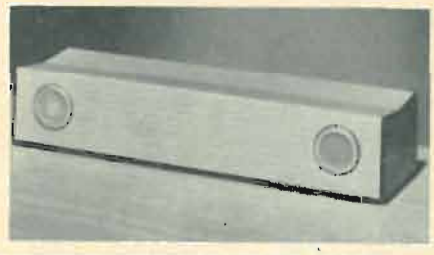
than 1.5 to 1, assuring a minimum of line reflections. Isolation between sets is at least 25 dB. Uses matched ferrites to provide low loss, high isolation and match over the entire uhf spectrum. $3.75 with mounting screws.—Gavin Instruments Inc.

Circle 47 on reader's service card

HEATHKIT AR-15 STEREO RECEIVER now comes as two coomponents: *AJ-15* FM stereo tuner with solid-state circuitry has a sensitivity of 1.8 μV; two crystal filters in the i.f. strip for a perfect response curve. Two tuning meters; one for FM station tuning and one for received signal strength. Two output phone jacks; one pair variable outputs plus two fixed outputs for amplifiers, tape recorders, etc. *AA-15* (shown) stereo amplifier, 150 watts; harmonic and IM distortion 0.5%; frequency response from 8 Hz to 40 kHz at 1 watt. Power supply is electronically filtered. *AJ-15*, $189.95; *AA-15*, $169.95. Both prices less optional walnut cabinet *Model AE-18*.—Heath Co.

Circle 48 on reader's service card

BURGLAR ALARM, *Model A-1*. Intrusion alarm will protect an entire room or the equivalent open space, indoors or outdoors. Alarm responds to any moving ob-



ject within 20'–30' range. Relies on Doppler effect and ultrasonics. Two sockets are provided for connection of external lamps and bells. Installation is simple . . . just plug into an ac receptacle and adjust position and range. Two or more units may be used to protect larger areas.—**Euphonics Marketing**

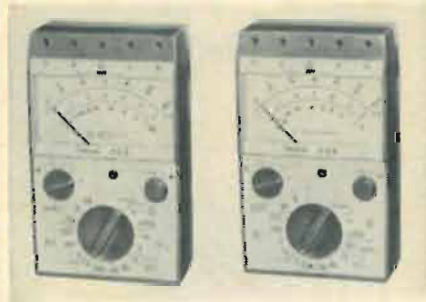
Circle 49 on reader's service card

MUSICVISION SYSTEM produces a profusion of colored light beams which splay out across screens or walls in pulsating patterns in perfect time with music. Light from a suitable source (a 35-mm slide projector with an aperture

added) passes through a revolving color wheel onto the face of a speaker. Drawn across the face of the speaker is an airtight elastic material on which are mounted several small front-surface mirrors. Sound-induced movement by the speaker cone pushes air against the elastic material, thus causing the mirrors to vibrate and giving orbiting patterns of light. Fully assembled unit/do-it-yourself kit under $100.—**Edmund Scientific Co.**

Circle 50 on reader's service card

HAND-SIZE VOM'S. Two models, both measuring 6" x 3⅝" x 1 11/16" ond weighing 18 oz, feature built-in alternating-current ranges and have separate inputs for voltage and current, simplifying volt-amp measurements. A continuity indicator gives quick "yes" or "no" answers. Illuminated scale permits readings in poorly

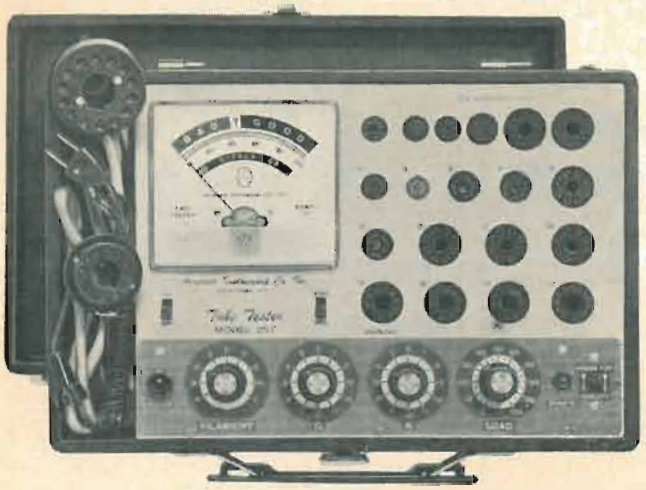


lighted locations. *Model 208* measures current in 6 ranges from 0.06 mA to 3 amperes. Sensitivity 10,000 ohms per volt for ac and dc. $72.50. *Model 209* measures current from 0–120 mA to 12 amps for dc and from 0–6 mA to 12 amps for ac. Sensitivity is 1,666 ohms per volt. $68.00. Shoulder-strap carrying case and extra pair of leads are available.—**Simpson Electric Co.**

Circle 51 on reader's service card

The New 1969 Improved Model 257 **A REVOLUTIONARY NEW**

TUBE TESTING OUTFIT



- **Tests all modern tubes including Novars, Nuvistors, Compactrons and Decals.**
- **All Picture Tubes, Black and White and Color**

ANNOUNCING... for the first time

A complete TV Tube Testing Outfit designed specifically to test **all** TV tubes, color as well as standard. Don't confuse the Model 257 picture tube accessory components with mass produced "picture tube adapters" designed to work in conjunction with all competitive tube testers. The basic Model 257 circuit was modified to work **compatibly** with our picture tube accessories and those components are not sold by us to be used with other competitive tube testers or even tube testers previously produced by us. They were custom designed and produced to work specifically in conjunction with the Model 257.

COMPLETE WITH ALL ADAPTERS AND ACCESSORIES, NO "EXTRAS"

STANDARD TUBES:

- ✔ Tests the new Novars, Nuvistors, 10 Pins, Magnovals, Compactrons and Decals.
- ✔ More than 2,500 tube listings.
- ✔ Tests each section of multi-section tubes individually for shorts, leakage and Cathode emission.
- ✔ Ultra sensitive circuit will indicate leakage up to 5 Megohms.
- ✔ Employs new improved 4½" dual scale meter with a unique sealed damping chamber to assure accurate, vibration-less readings.
- ✔ Complete set of tube straighteners mounted on front panel.

BLACK AND WHITE PICTURE TUBES:

- ✔ Single cable used for testing all Black and White Picture Tubes with deflection angles 50 to 114 degrees.
- ✔ The Model 257 tests all Black and White Picture Tubes for emission, inter-element shorts and leakage.

COLOR PICTURE TUBES:

- ✔ The Red, Green and Blue Color guns are tested individually for cathode emission quality, and each gun is tested separately for shorts or leakage between control grid, cathode and heater. Employment of a newly perfected dual socket cable enables accomplishments of all tests in the shortest possible time.

The Model 257 is housed in a handsome, sturdy, portable case. Comes complete with all adapters and accessories, ready to plug in and use. No "extras" to buy. Only **$47.50**

NOTICE

Accurate has been producing radio, TV and electronic test equipment since 1935, which means they were making Tube Testers at a time when there were relatively few tubes on the market, 'way before the advent of TV. The model 257 employs every design improvement and every technique learned over an uninterrupted production period of 32 years.

Maxon Electronics, Inc.

SEND NO MONEY WITH ORDER
PAY POSTMAN NOTHING ON DELIVERY

Try it for 10 days before you buy. If completely satisfied then send $10.00 and pay the balance at the rate of $10.00 per month until the total price of $47.50 (plus P.P., handling and budget charge) is paid. If not completely satisfied, return to us, no explanation necessary.

MAXON ELECTRONICS, INC.
Dept. D-103 2435 White Plains Road, Bronx, N. Y. 10467

Please rush me one Model 257. If satisfactory I agree to pay $10.00 within 10 days and balance at rate of $10.00 per month until total price of $47.50 (plus P.P., handling and budget charge) is paid. If not satisfactory, I may return for cancellation of account.

Name_____

Address_____

City_____ Zone_____ State_____

☐ Save Money! Check here and enclose $47.50 with this coupon and we will pay all shipping charges. You still retain the privilege of returning after 10 day trial for full refund.

Circle 110 on reader's service card

OSCILLOSCOPE, *Model 1450,* designed for use in radio and TV repair shops, schools, laboratories and industrial plants, indicates where the intermittent

trouble in a TV set occurs. Its features include an intermittent-analyzer circuit, automatic synchronization, and a direct-reading, calibrated screen that reads peak-to-peak voltages and built-in vectorscope.—**B&K Test Equipment Div., Dynascan Corp.**

Circle 52 on reader's service card

FM STEREO RECEIVER, *Model 341.* Scott's silver-plated FET front-end circuitry eliminates all cross-modulation and drift, and provides greater sensitivity. The FET tuner section achieves 2.5-μV

sensitivity with 80 dB cross-modulation rejection. Separation is 30 dB, and capture ratio is 2.5 dB. Using silicon transistors, the 50W amplifier output is direct-coupled. $259.95—**H.H. Scott, Inc.**

Circle 53 on reader's service card

DYNA-ROTOR combines an all-solid-state control unit with a TV antenna rotor. Mast-mounted unit is permanently synchronized with the control unit at the TV set and locks into any selected position without regard to wind loading. Housed in a cast aluminum case, rotor assembly weighs 5 lb. It rotates 360° in less than 40 seconds. Pilot light inside the unit indicates when the antenna is in motion, goes out when the antenna reaches its aimed position. $54.95. — **Jerrold Electronics Corp.**

Circle 54 on reader's service card

FLAMELESS HEAT GUN produces safe heat from 100° to 1000°F and is available in portable or bench-mounted 115V or 230V models. Can be used to soften, mold, weld and cure plastics, dry

paint finishes, dry wet surfaces, desolder (melt solder and blow it away), thaw frozen pipes, soften floor tile and putty, make hot plastic patches and bond vinyl film.—**Master Appliance Corp.**

Circle 55 on reader's service card

EYEGLASS AM RADIO, *Model A-1002,* about 2¾" long and weighing over 1 oz can pick up any station in a listener's area, throughout the entire broadcast band. Complete with a miniaturized

magnetic earplug for private listening. Ferrite antenna swivels for instant fine tuning and adjustment. Powered by two Saxton B-102 batteries (or equivalent). Case is polystyrene. Sensitive solid-state unit clips instantly to any eyeglass frame. $16.95 less batteries.—**Saxton Products Inc.**

Circle 56 on reader's service card

FM-AM STEREO RECEIVER, *Model 395,* 150 watts, has frequency response: ±3dB, 30–50,000 Hz; harmonic distortion: 1%; hum and noise: magnetic

phono, −60dB, on amplifier circuit, and on tuner circuit, FM section, IHF sensitivity: 1.8mV; harmonic distortion:0.7%; separation: over 28 dB; signal-to-noise ratio: 56 dB; capture ratio: 1.5 dB. For AM section, sensitivity is 1.5 mV. In addition to two ac outlets, there are inputs for every program source—magnetic or ceramic phono, tape deck, tape transport with equalization for 7½ and 3¾ ips and TV. $299.95 with metal cabinet.—**Allied Radio Corp.**

Circle 57 on reader's service card

NEW LITERATURE

All booklets, catalogs, charts, data sheets and other literature listed here with a Reader's Service number are free for the asking. Turn to the Reader's Service Card facing page 74 and circle the numbers of the items you want. Then detach and mail the card. No postage required!

ELECTRONIC INSTRUMENTS of the "fourth generation" such as counter/timers, frequency counters, pulse generators, frequency synthesizers and digital clocks are described in 16-page *Catalog No. 4200.*—**Mosanto Electronics Technical Center.**

Circle 58 on reader's service card

AUDIO MIXER *Report 307TR* provides most answers asked by average hi-fi enthusiasts and many other questions on mixer features and applications. Four pages, it includes buyer's guide intended to give the prospective purchaser a convenient means of comparing mixers currently on the market. Also listed are important mixer features with fill-in spaces to allow the user to compare different mixers feature by feature.—**Switchcraft, Inc.**

Circle 59 on reader's service card

ACOUSTA-VOICING method and its principle are detailed in a 12-page brochure. Also describes how it improves the performance of sound-reinforcement systems where feedback, reverberation coloration and other problems hamper good music and voice distribution to all areas of an audience.—**Altec Lansing,** Div. of **LTV Ling Altec Inc.**

Circle 60 on reader's service card

ELECTRONIC PRODUCTS. More than 30 units are described in 12-page *Catalog AS-68.* Products listed include: *MST, E,* Mustang and Specialty toggle switches; rotary and pushbutton switches, pilot lights, readout indicators, ceramic terminal strips and aluminum instrument knobs. Detailed specs and price lists are provided.—**Alco Electronic Products Inc.**

Circle 61 on reader's service card

AUDIOTAPE CATALOG, 24 pages, entitled *How to Select a Recording Tape* describes the performance characteristics of the 5 Audiotape formulations and how each performs to meet specific needs in recording and playback. Included also are: a chart which illustrates the variety of types, lengths and reel sizes applied to each formulation; a table of recording time for various tape lengths and speeds; a chart matching types of tape with their uses. A glossary of tape recording terms supplements the explanation.—**Audio Devices Inc.**

Circle 62 on reader's service card

ELECTRICAL WIRE. Chart provides basic wire and cable spec data in a simple-to-use format with diigrams and illustrations. Included is a guide to military specifications for hookup wire requirements for Mil-W-76-B and Mil-W-16878D; a *Wire Sizes and Resistance Chart;* and a *Wire Stranding Chart.* Also shown is an estimator for cut wire and tubing pieces.—**Alpha Wire Mfg.**

Circle 63 on reader's service card

BOGEN STEREO RECEIVERS *Models RX200, RX150, TR100X, TA150* and *RP150BM* are described in *Catalog No. 548.* All receivers feature separate bass, treble and loudness contour controls and offer automatic stereo switching. Bogen-Lenco turntables with variable speed are explained. Easy-to-read charts provide specs on amplifier section and tuner sections of receivers, circuit type and turntables. Prices are listed for each model.—**Bogen Communications Div. R-E**

Circle 64 on reader's service card

Service Clinic

By JACK DARR
SERVICE EDITOR

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

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 200 Park Ave. South, New York 10003.

Streaks and Flashes in Picture

The mysterious symptom seen in the photo has puzzled lots of technicians. The cause is arcing in the high-voltage rectifier circuits. Common causes are breakdown of insulation in the high-voltage rectifier socket, or pulse damage to a rectifier in series with the high-voltage lead from rectifier socket to picture tube. In very rare cases, it may be due to gas in the rectifier itself.

This is often seen in color sets. It's especially apt to happen if the filter resistor is used in the high-voltage lead. (The value is 1500 ohms or so.) The resistor breaks down internally from the terrific pulse voltages, and makes very tiny arcs across the carbon element. In one case, the resistor was completely open, but the high-voltage was going through anyhow! It was "flowing" across two socket terminals—rather, the places where the two socket terminals *had been!*

If the trouble is just starting you

may see very small horizontal pips on the sides of vertical lines in the picture. If this is heavy enough, it could be confused with network or station video-tape trouble. However, high-voltage pips are almost always very sharp; video-tape trouble causes vertical lines to "sawtooth", or make horizontal bands about 16 lines wide across the picture, very evenly spaced from top to bottom.

If the resisotor is burned out, replace it with a heavier one, say about 2 watts. In many sets, it can be left out without trouble.

Shielded tv lead-in?

Can I run a lead-in from a chimney antenna, down alongside the chimney, through a tight-fitting waterproofed hole in the roof and then on down through the ceiling to the TV set? It would have to run across and along some cast-iron soil pipes and electrical wiring in the attic. —A. V., Philadelphia, Pa.

Ordinary 300-ohm lead-in, no; I would not recommend it. Putting this too near big metal objects costs you a lot of signal strength, and you're apt to pick up some dandy interference from those ac lines. However, if you use the right material, you can.

Shielded 300-ohm lead-in is available (Belden 8290, for one). This can be run through roofs and alongside metal objects without bothering anything.

Incidentally, a Mosley Roof-Thru, a special fitting made just for this purpose, will give you a low-loss and leakproof passage through any roof with the lead-in. Then, you may be able to route the line up and away from the metal pipe and ac wires. Use whichever works the best.

Scope transformer

I need a power transformer for my Jackson CRO-3 scope. Can you tell me where I can get it in Canada?—Z.P., London, Ont.

Write the Canadian agents for Jackson: William Cohen Corp., 8900 Park Ave., Montreal 11, Quebec. Order by the regular Jackson part number; in this case, "14-59." **R-E**

IN NOVEMBER . . . .

TV expert Matt Mandl puts shorted rectifiers on the run. He turns to the underlying causes and asks—what makes them blow?

See These G/L-TAB Books at Your Parts Jobber!

THREE GREAT NEW, EASY-TO-BUILD PROJECTS BOOKS!

ELECTRONIC HOBBYIST'S IC PROJECT HANDBOOK: Bob Brown and Tom Kneitel. 50 projects you can build from inexpensive integrated circuit components. Some, like the voice-controlled switch, are simple. More sophisticated devices include an electronic organ, Hawaiian guitar device, auto tachometer, and a metal detector/finder. Hams will like the 11 to 6 meter receiver, 20-meter DX preamp, electronic keyer, and others. Audiophiles will appreciate the RIAA equalization preamp, 50-watt amplifier, tape recorder booster, and many others. Also included are projects of interest to CB'ers, experimenters, and technicians, plus a section of schematics for 32 of the most popular ICs. 160 pps. **Order No. 464** ..... **only $3.95**

104 TRANSISTOR PROJECTS YOU CAN BUILD: Bob Brown. Here are over 100 easy-to-build projects for everyone from hobbyist-experimenter to experienced hams and audiophiles. Devices range from those everyone can use around the home (even one to "bug" the kid's room) to more specialized hi-fi and ham radio equipment. Other projects are simply for fun and games, or for use on your car. Every circuit is safe, even for beginners, since no high voltages are required. All parts are readily available, inexpensive, catalog items; in many cases, values are not critical, which means you can use "junk box" parts to build a number of projects. 224 pps. **Order No. 462** .... **only $4.95**

104 HAM RADIO PROJECTS FOR NOVICE & TECHNICIAN: A well-rounded assortment of devices, many you'll want to build and use in your own shack. Emphasis is on transmitting and receiving gear, including modulators, monitors, filters, B F Os, and converters. In addition, there are projects for the 80, 40, and 15 meter Novice; 6, 2, 1½, ¾ meter, and 1296 MHZ for Technician classes. In all, the 10 categories include antenna devices, audio equipment, CW aids, interference suppressors and eliminators, power supplies, preamps and preselectors, receivers and converters, transmitters, and transmitter-receiver accessories. 192 pps. **Order No. 468** ..... **only $4.95**

99 WAYS TO USE YOUR OSCILLOSCOPE: Al Saunders. A pictured-text guide to the use of a scope in analyzing electronic circuit behavior. Full-page pictorial diagrams show settings of all controls and equipment connections. Numerous waveform photos show ideal results, plus displays indicating circuit troubles and improper equipment set up. 224 pps. **Order No. 483** **only $4.95**

HAM RADIO INCENTIVE LICENSING GUIDE: Bert Simon, W2UUN. Contains the info needed to pass all the ham license exams—Novice, Technician, Conditional, Advanced, and Extra Class. Included are study sections for each class, from learning the code to equipment and operating rule requirements. Q & A sections, cover about every question on FCC exams for any class. 160 pps. **Order No. 469** **only $3.95**

MANAGING TODAY'S RADIO STATION: All about all phases of the business of radio—from audience surveys, to programming, promotion and sales. Here are the facts on station operation, including the financial side! A really up-to-date guidebook for all those in, or interested in, radio broadcasting. Every conceivable facet of the subject is covered. 288 pps. Hardbound. **Order No. 461** **only $12.95**

VHF HAM RADIO HANDBOOK by Ed MacKinnon. Tells you how to get on the air quickly and inexpensively to join the growing ranks of VHF'ers everywhere. Describes easy-to-build transmitting gear, antenna systems, and other necessary equipment. Explains how to modify existing gear for 6 and 2 meters, on up to 1300 MHz! Deals with every facet of operation on VHF bands. 176 pps. Paper. **Order No. 460** ..... **only $3.95**

PROCEEDINGS OF 1968 NAB ENGR. CONFERENCE: Vital source of ideas to help radio and TV broadcasters keep pace with tomorrow. Covers eqpt., measurements, color TV, maintenances. 256 pps; 8½" x 11". **No. T-148** **only $10.00**

ELECTRONIC ENGINEERING NOMOGRAMS—Contains over 100 nomograms based on frequently used equations. Large-size charts assure dependable results. Saves time by eliminating math computations. 176 pps. **No. 254** **only $9.95**

WORKING WITH THE OSCILLOSCOPE: Al Saunders. This unique, pictured-text-handbook is of greater value than any other book on the subject! Clear, large-size drawings simplify understanding the function of the instrument. Many "work-shop test projects" show you, step-by-step, how to set up the scope for making all types of tests and measurements, and how to analyze waveforms. 104 pps. BIG 8½ x 11" size. Over 100 illus. **Order No. 472** **only $4.95**

MODERN ELECTRONIC TROUBLE-SHOOTING: A down-to-earth handbook that deals with today's servicing problems on a practical level, to cope with the special problems created by printed boards and solid-state circuitry. Covers monochrome and color TV, multiband radio receivers, hi-fi equipment, tape recorders, two-way communications, equipment, and appropriate test instruments. 256 pps., over 100 illus. **Order No. 474** **only $4.95**

MODERN TV CIRCUIT & WAVEFORM ANALYSIS: Stan Prentiss. Tells how to use a triggered-sweep scope to diagnose TV troubles. Explains how individual circuits work and shows you over 100 waveforms that should appear at strategic points, so you can quickly locate a circuit malfunction, and put your finger on the defective component in short order. Includes 15 solid-state troubleshooting charts. 256 pps., 175 illus. **Order No. 476** **only $4.95**

TRANSISTOR CIRCUIT GUIDE-BOOK: Byron C. Wels. A guide to the operation and application of over 100 transistor circuits, many for complete units such as amplifiers, transmitters, receivers, signal generators, etc. Written for the technician needing information on transistor circuit operation, and for the hobbyist, experimenter, circuit designer seeking guidelines to the construction of useful devices. 224 pps. **Order No. 470** **only $4.95**

TV SERVICING GUIDEBOOK — PROBLEMS & SOLUTIONS: Art Margolis. A brand-new, practical guide to TV receiver troubles, their causes and cures. Describes all the typical circuits you'll encounter in TV sets, with meaningful descriptions of their operation. Explains the effects of various circuit defects on voltages and signals. Gives step-by-step procedures, 192 pps. **Order No. 484** **only $4.95.**

MODERN RADIO BROADCASTING: Complete guide to successful practices of radio stations in small-to-medium-sized markets. Written for announcers, program directors, managers, etc. and anyone interested in getting into broadcasting as a career. Encompasses market studies, program formats, sales, promotion, scheduling, equipment, studio, transmitter, etc. 288 pps. Hard. **Order No. 482** **only $12.95**

FET APPLICATIONS HANDBOOK: Chock-full of current, practical FET circuit design data! Includes latest info on FET types, parameters, and characteristics, and operational modes. Covers linear applications, chopper and switching circuits, integrated circuits, and photo-FETS. Includes many basic circuit descriptions. 23 Chapters; 288 pages; 225 illus. Hardbound. **Order No. 240** **only $12.95**

PRACTICAL COLOR TV SERVICING TECHNIQUES: Loaded with easy methods and dozens of case histories on locating and repairing problems in both old and new color sets. Discusses new portables and solid-state receivers only recently introduced! Learn new techniques for isolating troubles. 304 pps; 230 illus; 8-p. schematic foldout; Dozens of full-color photos. **Order No. 436** **only $4.95**

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NOW—Color-Coded Schematics for 1500 TV Sets . . . at an Unbelievable 1.3¢ Per Set!

Yes, now you can speed-repair 1500 popular TV receivers for just about 1¢ each. . . . with the serviceman-proved COLOR-CODED TV COLORGRAMS . . . which were a real bargain at their original total price of $102.50. Now, offered at only $19.95!

Colorgrams are amazing new color-coded charts that help you isolate TV receiver difficulties with less effort than you ever dreamed possible. Each COLORGRAM chart is clearly color-coded to show signal-flow, continuity, test points, and voltages.

Each COLORGRAMS Service-Pak contains everything you need to service a whole series of TV sets—including charts for IF, Video, Audio, Vertical and Horizontal (showing sync and sweep circuits), B+ distribution and AGC circuits. The Pak also includes a complete color-keyed master schematic providing an overall view of the receiver circuit. It also shows test points, waveforms, voltage, resistance, capacitance, practical alignment data. Third, the Pak includes a Rapid Repair Manual, containing service notes, circuit modifications, parts list, Pictorial Tube and Component Location Chart, and a Tube Failure Guide. What do you get for your money? 50 complete Service-Paks (each Pak originally selling for $1.95) containing data on approximately 30 TV sets. PLUS a 148-page MASTER-INDEX and Cross Reference Replacement Parts Guide which lists all 1500 TV sets you can quickly repair with TV COLORGRAMS. It describes the black-and-white receivers of Admiral, Emerson, General Electric, Magnavox, Motorola, Philco, RCA, and Westinghouse. **Order No. T-444** **only $19.95**

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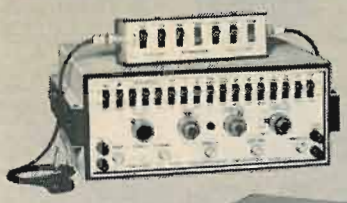

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The new IG-57 plus a 'scope is all you need . . . no external sweep generator required. Switch selection of any of 15 crystal-controlled marker frequencies (you can view up to six different frequencies on one 'scope trace). Select the sweep range and you are ready to instantly see the results of any changes you make. Four markers for setting color bandpass, one for TV sound, eight at IF frequencies between 39.75 & 47.25 MHz plus picture and sound carrier markers for channels 4 & 10. Three sweep oscillators produce the 5 most-used ranges . . . color bandpass, FM IF, color & B&W IF and VHF channels 4 & 10. Save hundreds of dollars and put full alignment facilities in your shop too — order your IG-57 now. 14 lbs. Kit IG-14, same as IG-57 w/o the sweep, 11 lbs., $99.95.

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The IG-37 fills every need for alignment & trouble shooting of multiplex adapters, FM tuners & receivers. Generates mono or composite stereo FM signals. Crystal-controlled 19 kHz pilot signal, adjustable in level. Switch select 400 Hz, 1 kHz, 5 kHz, 19 kHz, 38 kHz & 65 kHz or 67 kHz SCA signals for total alignment capability. 100 MHz sweep signal (adjustable ±2 MHz). Crystal-controlled marker oscillator for IF & dial tracking. Phase test for adjusting subcarrier transformers. 12 lbs.

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In-Circuit transistor testers don't have to be expensive, and the IT-18 is proof of that . . . tests DC Beta 2-1000, in or out-of-circuit . . . leakage Icbo and Iceo current 0-5000 uA out-of-circuit . . . identifies NPN or PNP devices . . . tests diodes in or out-of-circuit for opens & shorts . . . identifies unknown diode leads . . . matches PNP & NPN transistors. The IT-18 is completely portable — runs on just one "D" cell. Easy to use too . . . rugged polypropylene case, attached 3′ test leads, big 4½″ 200 uA meter, all front panel controls, 10-turn calibrate control. 4 lbs.

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An essential instrument for solid-state circuitry design applications, the IM-37 allows you to read the results of varying parameters. Measures DC Beta to 400 on calibrated scales. Variable bias permits collector currents up to 15 amps . . . internal power to 9 volts in 1.5 v. steps . . . separate voltage & current range switches for both Gain & Leakage settings. External power supply connections for Gain, Leak & Bias supplies too. Four lever switches for fast test selection. 9 lbs.

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If you work with transistors, this is the power supply for you. All solid-state circuitry provides 1-15 VDC at up to 500 mA continuous. Features adjustable current limiting, voltage regulation, floating output for either + or — ground, AC or DC programming, circuit board construction, and small, compact size. Operates on either 110 or 220 VAC. A remarkable value at a remarkable price. 5 lbs.

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A good-looking, compact & versatile instrument for any workshop or lab. Supplies B+ from 0-400 VDC at 0-100 mA continuous with less than 1% variation, bias voltage 0 to —100 VDC at 1 mA and 6.3 & 12.6 AC filament voltages. Separate meters for B+ output voltages and current; voltmeter switched to read C-volts. Repeated tube warmup is eliminated by the use of separate filament & HV tranformers and a "DC ON/Standby" switch. For a value-packed HV supply, order the IP-17. 21 lbs.

HEATHKIT IP-27 Regulated Low Voltage Power Supply

Here's a low voltage supply that has all the features of more expensive units and Heathkit styling too . . . Zener reference-voltage power supply, "outside" mounted calibration controls, solid-state circuitry that's virtually immune to overload from transients, and relay protection against shorts & overloads. Supplies 0.5-50 VDC with better than ±15 mV regulation at 50 mA, 150 mA, 500 mA & 1.5 A. Adjustable current limiting, a panel meter that reads output voltage or current & a "DC ON/Standby" switch that eliminates warmup delays. 16 lbs.

HEATHKIT IO-18 Wide-Band 5″ 'Scope

The New Heathkit IO-18 is destined to be the world's most popular 'scope, just as its predecessor, the IO-12 was. Features 5 MHz bandwidth, the famous Heath patented sweep circuit — 10 Hz to 500 kHz in 5 ranges, two extra sweep positions which can be preset to often-used rates, frequency compensated vertical attenuation, built-in P-P calibration reference, Z-axis input, retrace blanking, wiring options for 120 or 240 VAC operation and new Heathkit instrumentation styling in beige and brown. Circuit board-wiring harness assembly speeds construction. 24 lbs.

HEATHKIT IO-17 3″ General Purpose 'Scope

The "just right" 'scope for thousands of applications . . . schools, hobbyists, shops, labs & servicemen all appreciate features like these: 5 MHz bandwidth . . . 30 mV P-P sensitivity . . . recurrent sweep generator, 20 Hz to 200 kHz in 4 ranges . . . x50 pullout frequency compensated vertical attenuator . . . front panel 1 v. P-P reference voltage . . . horizontal sweep from internal generator, 60 Hz line or external source . . . wide range automatic sync . . . shielded CRT . . . all front-mounted controls (except astigmatism) . . . solid-state high & low voltage power supplies . . . new Heathkit instrumentation styling in beige and brown . . . circuit board construction . . . dual primary power transformer for 120 or 240 VAC operation. 16 lbs.

Heathkit® Test Instruments

HEATHKIT IM-25 High Impedance Volt-Ohm-Milliammeter

Now you can buy the performance & features of a $200 instrument for only $80! Here's what the IM-25 has: 9 DC voltage ranges, 150 mV full scale to 1500 v. full scale . . . 9 AC voltage ranges, 150 mV full scale to 1500 v. full scale . . . 7 resistance ranges, 1 ohm to 1000 megohms . . . 11 current ranges, 15 uA full scale to 1.5 A full scale. 11 megohm input impedance on DC, 10 megohms on AC . . . AC response to 100 kHz . . . 6" 200 uA meter with zero center scale for + and — voltage measurements without switching. 1% precision resistors . . . all solid-state circuitry . . . precision ten-turn thumbwheel zero adjust . . . portable or line operation. 10 lbs.

kit IM-25 **$80.00**

wired IMW-25 **$115.00**

HEATHKIT IM-16 Solid-State VOM

The value leader in its class, and no wonder . . . 8 DC voltage ranges, 8 AC voltage ranges, 7 ohmmeter ranges . . . 11 megohm input impedance on DC, 1 megohm on AC . . . internal battery or 120/240 50-60 Hz line operation at the flick of a switch with minimal zero adjustment . . . virtually drift-free zero . . . a single probe with fingertip flip switch makes all measurements — permits "hands-free" operation . . . separate switches for individual functions for much less knob twisting . . . wiring harness and circuit board construction . . . new Heathkit styling. 10 lbs.

kit IM-16 **$44.95**

wired IMW-16 **$64.95**

HEATHKIT IM-17 Solid-State VOM

Another very popular VOM from Heathkit engineering and it's easy to see why — all solid-state circuitry . . . high impedance FET input, 11 megohms on DC, 1 megohm on AC . . . 4 AC voltage ranges . . . 4 DC voltage ranges . . . 4 ohm ranges . . . 4½" 200 uA meter . . . 3 built-in test leads . . . DC polarity reversing switch . . . zero-adjust & ohms-adjust controls . . . continuous 12-position function switch. And that's not all — the IM-17 is battery powered for complete portability and comes in a rugged polypropylene case with built-in handle. Simple circuit board assembly, rugged reliability and famous Heath engineering make the IM-17 the best value going. 4 lbs.

kit IM-17 **$21.95**

HEATHKIT IM-38 Laboratory AC VTVM

For general service work, audio design or lab analysis, you can't buy a better value than the IM-38 AC VTVM. Here's why — 10 voltage ranges — from 0.01 to 300 volts RMS full scale . . . extended frequency response, ±1 dB from 10 Hz to 500 kHz . . . 10 megohm input on all ranges for high accuracy, low circuit loading . . . wide dB range from —52 to +58 dB . . . VU-type ballistic meter damping . . . amplifier brown instrument styling . . . 120/240 50-60 Hz AC wiring options. 5 lbs.

kit IM-38 **$39.50**

wired IMW-38 **$54.95**

HEATHKIT IT-28 Capacitor Checker

Provides complete analysis of all capacitor types at low cost. Features direct reading scales to eliminate involved calculations. Measures capacitance from 10 pF to 1000 uF and resistance from 5 ohms to 50 megohms. 16 leakage voltage positions, 3-600 VDC. Comparator circuit measures "L", "C" and "R" with external standard. Calibrated power factor control. Low bridge voltage for safe testing of miniature electrolytics. Determine transformer turns ratios quickly and read directly on the dial. External generator provisions included for measurements at frequencies up to 10 kHz. 120/240 VAC operation. New Heathkit beige and brown styling. 7 lbs.

kit IT-28 **$31.95**

HEATHKIT IM-48 Audio IM Analyzer

Three audio test instruments in one . . . combines the functions of an AC VTVM, Wattmeter and IM Analyzer. Built-in 60 Hz and 6 kHz signal sources for IM tests. Built-in non-inductive load resistors for 4, 8, 16 and 600 ohms. Wide frequency response: AC VTVM 10 Hz to 100 kHz; Wattmeter 10 Hz to 50 kHz. Ten AC voltage ranges .01 to 300 volts RMS. dBm range reads from —65 to +52 dBm. Wattmeter ranges 0.15 mW to 150 W. IM analyzer reads from 1% to 100% full scale. New Heathkit beige and brown instrument styling, 120/240 50-60 Hz wiring options, and a top performing instrument that's actually three in one. 13 lbs.

kit IM-48 **$69.00**

HEATHKIT IM-58 Harmonic Distortion Meter

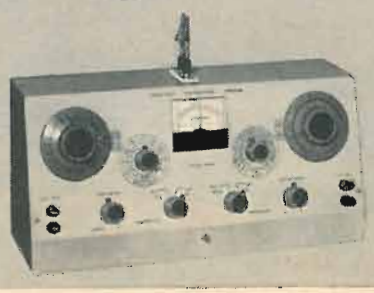
An accurate measurement of harmonic distortion between 20 Hz and 20 kHz. Five distortion ranges — 1, 3, 10, 30 and 100% full scale. Large, easy to read meter calibrated in volts RMS, % distortion and dB. Measures noise levels down to —60 dB, voltage from 1 to 30 in four ranges. The high input impedance and the use of 1% precision resistors in the VTVM voltage divider assure accurate, repeatable results. New Heathkit beige and brown styling; easier to read settings; 120/240 VAC wiring options. Your best buy in a harmonic distortion meter is the Heathkit IM-58. 13 lbs.

kit IM-58 **$65.00**

HEATHKIT IB-28 Impedance Bridge

Laboratory accuracy in a versatile, easy to use instrument. Combines four popular bridge circuits for precision testing of components — a Wheatstone bridge for resistance, Capacitance Comparison for capacitance, Maxwell bridge for low Q inductance and a Hay bridge for high Q inductance. Built-in power supply and external binding posts for DC measurements; built-in 1 kHz generator and terminals for external generator. Internal vacuum tube detector & amplifier and terminals for external detector. Measures resistance 0.1 to 10 megohms, capacitance 100 pF to 100 uF, inductance 0.1 mH to 100 H, dissipation factor 0.002 to 1 and storage factor 0.1 to 1000. New Heathkit beige and brown instrument styling. 11 lbs.

kit IB-28 **$85.00**



More New Heath Products On Next Pages

Look What's New In Your

NEW kit MI-18-1
$29.95
NEW kit MI-18-2
$32.95

Heathkit Solid-State Tachometer

The Professional Tach. That's the new Heathkit MI-18. **In Design:** breaker point, "tach" lead or unique inductive pickup connection; use it with any spark-type engine and any ignition system, 2 cycle 1-6 cyl. engines or 4 cycle, 2-8 cyl. engines . . . all electronics are in the tach itself. **In Performance:** 0-6000 & 0-9000 RPM ranges . . . 250° edge-lighted dial . . . temperature-compensated, ±4% accuracy from 0° —120° . . . adjustable red line pointer . . . 10.5 to 17.5 VDC operation. **In Styling:** stainless steel hardware, splash-proof black & chrome case and scratch-proof glass face for use in rugged conditions. The MI-18-1 mounts in your dash — requires only a 3¼″ hole & 2¼″ depth. The MI-18-2 comes with mounting case & hardware. Put a Professional Tach in your car, boat, dune-buggy, or bike now — the Heathkit MI-18! Shpg. wt. 3 lbs.

NEW kit GR-17
$43.95

Heathkit AM-FM Portable Radio

Here's performance others can't match. The new Heathkit GR-17 portable has 12 transistor, 7 diode circuit with the same front end as Heathkit hi-fi tuners; 3-stage IF; big 4″ x 6″ speaker; tone control; AFC on FM and amplified AGC on AM; built-in AM rod antenna plus telescoping 34″ FM antenna; 350 milliwatt output; and 200-300 hour battery life. Shpg. wt. 5 lbs.

NEW kit AD-27
$169.95

Heathkit FM Stereo COMPONENT-COMPACT

This new Heathkit AD-27 stereo compact has features not found in other units costing twice as much for one very simple reason. It wasn't engineered to meet the usual level of compact performance. Instead, Heath took one of its standard stereo/hi-fi receivers, the AR-14, and re-arranged it physically to fit a compact configuration. The result is performance that is truly high fidelity without compromise. It features 31 transistor, 10 diode circuitry with 15 watts per channel dynamic music power (enough to let you choose most any speaker systems you prefer), full-range tone controls, less than 1% distortion, and 12 to 60,000 Hz response. The pre-assembled FM stereo tuner section with 4-stage IF offers 5 uV sensitivity, excellent selectivity, AFC, and the smoothest inertia tuning. The BSR McDonald "500" turntable offers features usually found only in more expensive units . . . like low mass tubular aluminum tone arm, anti-skate control, cueing and pause control, plus a Shure magnetic cartridge with diamond stylus. It's all housed in a smart oiled walnut cabinet with sliding tambour door that disappears inside the cabinet. For value and performance choose the AD-27, the new leader in stereo compacts. Shpg. wt. 41 lbs.

NOW, THE TUNER AND AMPLIFIER OF THE FAMOUS HEATH AR-15 RECEIVER ARE AVAILABLE AS SEPARATE COMPONENTS

NEW kit AJ-15
$189.95*

HEATHKIT AJ-15 Deluxe Stereo Tuner

For the man who already owns a fine stereo amplifier, and in response to many requests, Heath now offers the superb FM stereo tuner section of the renowned AR-15 receiver as a separate unit. The new AJ-15 FM Stereo Tuner has the exclusive design FET FM tuner for remarkable sensitivity, the exclusive Crystal Filters in the IF strip for perfect response curve and no alignment; Integrated Circuits in the IF for high gain, best limiting; elaborate Noise-Operated Squelch; Stereo-Threshold Switch; Stereo-Only Switch; Adjustable Multiplex Phase, two Tuning Meters; two variable output Stereo Phone jacks; one pair variable outputs plus two fixed outputs for amps., recorders, etc.; front panel mounted controls; "Black Magic" panel lighting; 120/240 VAC operation. 18 lbs. *Walnut cabinet AE-18, $19.95.

NEW kit AA-15
$169.95*

HEATHKIT AA-15 Deluxe Stereo Amplifier

For the man who already owns a fine stereo tuner, Heath now offers the famous amplifier section of the AR-15 receiver as a separate unit. The new AA-15 Stereo Amplifier has the same superb features: 150 watts Music Power; Ultra-Low Harmonic & IM Distortion (less than 0.5% at full output); Ultra-Wide Frequency Response (±1 dB, 8 to 40,000 Hz at 1 watt); Ultra-Wide Dynamic Range Preamp (98 dB); Tone-Flat Switch; Front Panel Input Level Controls; Transformerless Amplifier; Capacitor Coupled Outputs; Massive Power Supply; All-Silicon Transistor Circuit; Positive Circuit Protection; "Black Magic" Panel Lighting; new second system Remote Speaker Switch; 120/240 VAC. 26 lbs. *Walnut cabinet AE-18, $19.95.

Free 1969 Heathkit® Catalog

New Lower Prices On Heathkit Color TV Make Them A Better Buy Than Ever!

Deluxe "295" Color TV...Model GR-295

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New improved phosphors and low voltage supply with boosted B+ for maximum color fidelity and operation • automatic degaussing • exclusive Heath Magna-Shield • ACC and AGC assures color purity, flutter-free pictures under all conditions • preassembled IF with 3 stages instead of the usual 2 • deluxe VHF turret tuner with "memory" fine tuning • choice of installation—wall, custom or optional Heath factory assembled cabinets • Easy to assemble.

Big, Bold, Beautiful . . . With Advanced Features and Exclusive Heathkit Self-Servicing. Top quality, American brand color tube . . . 295 sq. inch viewing area. The built-in dot generator and full color photos and simple instructions let you set-up, converge and maintain the best color pictures at all times. Add to this the detailed trouble-shooting chart in the manual and you put an end to costly TV service calls for periodic picture convergence and minor repairs.

GRA-295-4, Mediterranean cabinet shown **$119.50**
Other cabinets from $62.95

Deluxe "227" Color TV...Model GR-227

now only **$399.95** (less cabinet)

Has same high performance features and built-in servicing facilities as the GR-295, except for 227 sq. inch viewing area. The vertical swing-out chassis makes for fast, easy servicing and installation. The dynamic convergence control board can be placed so that it is easily accessible anytime you wish to "touch-up" the picture.

GRA-227-1, Walnut cabinet shown **$59.95**
Mediterranean style also available at $99.50

Deluxe "180" Color TV...Model GR-180

now only **$349.95** (less cabinet)

Same high performance features and exclusive self-servicing facilities as the GR-295 except for 180 sq. inch viewing area. Feature for feature the Heathkit "180" is your best buy in deluxe color TV viewing . . . tubes alone list for over $245. For extra savings, extra beauty and convenience, add the table model cabinet and mobile cart.

GRA-180-5, table model cabinet and cart **$39.95**
Other cabinets from $24.95

Now, Wireless Remote Control For Heathkit Color TV's

Control your Heathkit Color TV from your easy chair, turn it on and off, change VHF channels, volume, color and tint, all by sonic remote control. No cables cluttering the room . . . the handheld transmitter is all electronic, powered by a small 9 v. battery, housed in a small, smartly styled beige plastic case . . . feather-light and contoured to fit comfortably in your hand for easy pushbutton operation. The receiver contains an integrated circuit (15 resistors, 10 transistors, 1 diode) and a meter for adjustment ease. Circuit board construction and plug-in wire harness make installation of receiver and control motors easy. For greater TV enjoyment, order yours now.

kit GRA-295-6, 9 lbs., for Heathkit GR-295 and GR-25 Color TV's **$69.95**
kit GRA-227-6, 9 lbs., for Heathkit GR-227 and GR-180 Color TV's **$69.95**

3 HEATHKIT® COLOR TV'S NOW! ALL WITH 2-YEAR WARRANTY ON PICTURE TUBE

kit GR-295

kit GR-227

kit GR-180

NEW Wireless TV Remote Control

$69.95

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Circle 121 on reader's service card

How To Buy A Tape Recorder

Make sure you get the recorder you really want **By FRED PETRAS**

BUYING A TAPE RECORDER IS, ON ONE HAND, A SIMPLE matter. On the other, it is quite involved. There are two key questions: How much do you intend to spend (or can afford)? What is the tape recorder to be used for?

The first is easy to answer. How much you spend is related to how the recorder will be used. The more demanding the uses expected of it, the greater the cost. I suggest that you set a *price range,* a flexible limitation that leaves room for trading up to something perhaps a bit better or more feature-full than your original want.

Stereo cassette recorder is combined with AM/FM stereo tuner in Crown model SHC55.

The second question—the use factor—is the involved one. Do you want a simple unit primarily for capturing the voices of your family and close friends, or do you want a unit to record or play back music with high quality reproduction? Do you intend to keep a permanent record of what you put on tape, or will they be merely programs you will erase when you tire of them? If so, a quality machine is not needed. However, if you intend to be serious about what you put on tape, and intend to keep it for a long time, a quality machine is the only answer.

Bone up as much as you can about recorders in general before going out to buy one. The fact that you are reading this magazine, this article on the subject, is a good start. Drop in on local dealers and ask for brochures or other available literature on tape recorders. Study it, compare features of the units, and narrow down the choice to make your final selection easier.

Here are some salient points to consider in evaluating the recorder you will eventually buy:

MOTORS: Four- and six-pole shaded motors are the most widely used in inexpensive tape recorders. Hysteresis–synchronous motors—noted for their ability to withstand fluctuations in house current—are used in more expensive machines and are regarded as the most reliable.

COMING NEXT MONTH

The November issue is crammed full of articles you won't want to miss. Here's a look at some of them.

☆ COLOR TV X-RAY DETECTOR

Circuits, descriptions, details of the X-Ray detector used by the U.S. government to measure radiation from color TV's.

☆ BUILD A 10-WATT SOLID-STATE GUITAR AMPLIFIER

The first in a series of eight build-it articles covering electronic musical instruments. Try the amplifier, then add on extras later.

☆ MAKE AN IC DECIMAL READOUT MODULE FOR $10

If price has kept you from building digital instruments, this article will put you back in the ball game.

☆ SPOT DIODE BLOWOUTS

Modern TVs use solid-state diodes in several circuits. Learn how to spot the troubles a bad diode can cause and to find the diode that went sour.

Most low and medium price recorders use one motor to drive the tape transport. More expensive instruments have two or three motors. But there are some classic exceptions of high-priced machines with only one motor. When two or more motors are used, frequency of breakdowns is lower as the work load is spread about. The more motors, the less linkage between the mechanical elements, the less there is to go out of order. Also, where a machine uses separate motors for fast forward or rewind, this work will be done at a much faster rate, and more smoothly

SPEEDS: The old standard of 7½ ips is expected to be less and less valuable as time goes by. Hardly a decade ago 15 ips was considered the minimum for top sound. Today, when tapes are made with quality equipment and use the proper raw tape, the quality difference between 7½- and 3¾-ips recordings is negligible, even to trained, highly critical ears. More and more companies are using the slower speed for their prerecorded tape products, even for "heavy" classics and opera.

The slower speed also offers great economies in tape cost and storage space. Today, 3¾ ips is strong. Tomorrow it will be stronger. Coming up—primarily as a voice-recording speed—is 1⅞ ips. Many of today's small recorders combine this speed with 3¾ ips. Equivalent machines of a few years back ran at 3¾ and 7½ ips. The 1⅞ speed on *some* machines is also capable of fair quality music recording and reproduction. This is the speed at which today's highly popular cassette recorders operate. On some machines even a 1⅝₁₆-ips speed is available for use where considerable recording time is needed.

It is possible to find tape recorders offering all four of these speeds, permitting great flexibility and economy. The average person, however, generally uses one or two speeds for all-around taping or playback.

HEADS: Today's recorders offer a basic minimum of two heads, or as many as six in automatic reversing type machines. The two-head units generally utilize a combination record–playback head, and one for erasing. Three-head machines additionally offer monitoring capabilities, or special effects such as sound-on-sound or sound-with-sound. Some of today's automatic reversing machines require a double complement of heads, either four or six, to do the job.

AUTOMATIC REVERSE: Auto-reverse—as it is often called—makes using a tape recorder much easier, requiring far less attention. It is a highly desirable feature, but comes at a price—starting at around $250. It cuts tape threading chores in half. When the reel comes to the end of one side, the auto-reverse takes over, sending the tape in the opposite direction to complete the second side. There are several reversing methods, including foil stripping ends of tapes, adding a low- (or high-) frequency sound or providing silent intervals in the tapes.

EASY THREADING: A handful of machines offer virtually automatic threading of tape. For example, drop a length of tape in some Ampex units, and a spoked takeup reel does the rest. Slip off a strip of tape in the new Bell & Howell units and air power takes over. Such machines are great for people who are "all thumbs," and they make recorders more pleasant to use.

AUTOMATIC SHUTOFF: This feature stops the tape reel from spinning when it is finished playing, and prevents tape ends from flapping and getting damaged. It is also useful if a tape breaks in playback, to prevent snarling and other tape-spill hazards. Some shutoffs disconnect the amplifier as well, making such recorders ideal for lulling you to sleep with music.

AUTOMATIC LEVEL CONTROL: More and more recorders are offering this feature that virtually guarantees

a recording will "come out" even though the volume levels of the source vary.

LEVEL INDICATORS: There are three common types—VU meters, neon light or "magic eye" tubes. The most useful is the VU meter, used in machines of all price ranges. Neon lights are used mostly in inexpensive, low-quality sets. The magic eye is generally used in medium- or high-price equipment and is regarded by many as the control with the best ability to prevent overloads and distortion. However, portable machines demand a meter.

PAUSE CONTROLS: If you do much "stop and go" recording—for instance, while taping programs of popular music from a radio or tuner—a pause control is ideal for stopping the recorder to bypass commercials. There are two basic types. A "hold" pause requires the user to keep his finger on the control during the hold period. A lock pause permits keeping the tape at a standstill without holding the control manually.

AMPLIFIER POWER: Coming into popularity as a result of the growth of solid-state devices are recorders with big-output amplifiers, ranging from 5 to 20 watts per channel. These can be ideal space savers in that they eliminate the need for a separate amplifier.

AUTOMATIC VOICE ACTUATION: Many of today's portable recorders include this feature, which is

ideal for conference work or dictation. Talking into the mike triggers the machine into operation, and it stops when you stop talking. This feature is a great tape saver. It also speeds transcribing a tape by eliminating the long pauses common in much dictation work. The main disadvantage is that a word or two may be "clipped" when taping starts.

EASE OF OPERATION: Many of today's recorders stress easy use via a logical layout of the controls or the use of certain types of controls. Some people prefer piano-key controls on their recorders, others like a rotating knob or lever. I suggest that you select a machine that "feels" right to your fingers and does not tax your wits to make it operate correctly. For example, it might be wise to avoid machines which feature a reverse tape load (a tape that requires threading from the "North" side, as opposed to the far more popular "South" side). Some professionals prefer this for editing, but, if you play prerecorded tapes, you must place the program-listing side face down on the first pass of the tape using North-oriented threading layouts.

CLOSEOUTS: The prospective recorder purchaser can find some real buys when a manufacturer closes out some models. However, some of the closeouts may be products from a manufacturer going out of the tape recorder business. **R-E**

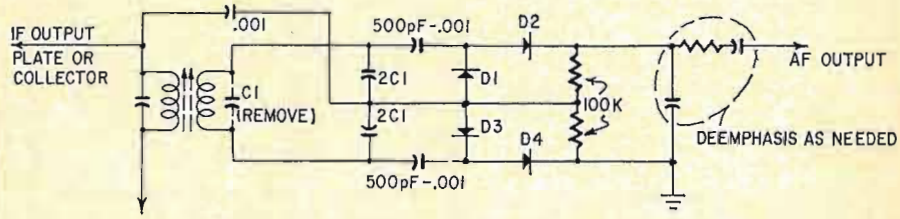
NOTEWORTHY CIRCUIT

NOVEL DISCRIMINATOR FOR NBFM

Quite often ordinary AM receivers are used with short-wave converters to listen to two-way narrow-band FM transmissions. In this case, the receiver must be tuned slightly to one side of the carrier frequency so the signal can be recovered by slope detection. This technique is OK for casual listening but a ratio detector or a discriminator is required for serious monitoring.

When 455-kHz FM detector transformers are not readily available, you can use the scheme used by Sven Weber, G8AAC, and described in *RSGB Bulletin* (London, England). Instead of an i.f. transformer with a center-tapped secondary, he makes a capacitive center tap (see diagram) by replacing the secondary tuning capacitor (C1) with two capacitors of twice the value in series.

The detector is a form of Foster-Seeley discriminator with a pair of diode integrators—roughly, half-wave voltage doublers—replacing each diode. D1, D2, D3 and D4 are four matched small-signal diodes.



This circuit works best when preceded by a limiter. You can install a simple diode-type limiter across the primary of one of the i.f. transformers or provide some degree of limiting (mainly on very strong signals) by removing the avc voltage from one of the i.f. stages. **R-E**

SCHOOL DIRECTORY

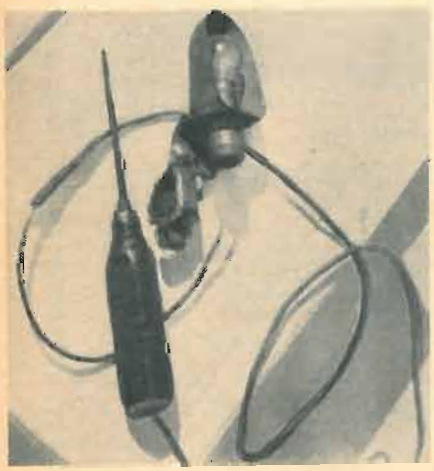
TRY THIS ONE

TWO TEST LAMPS

The top photo shows the handy test lamp we made up out of a 117-volt bulb encased in a plastic pill bottle to

save the lamp from damage in the tool kit or pocket.

The second photo is a test lamp for troubleshooting wire harnesses, especially in appliances. One side of the 117-volt bayonet bulb is grounded to the



shade, to which is soldered an alligator clip that holds the lamp in any convenient position. The other lamp wire terminates in the icepick, which probes through insulation of suspected wiring.

—Harry J. Miller **R-E**

COMING IN NOVEMBER

Get ready to make music. Starting in November, Radio-Electronics presents 8 exclusive solid-state electronic musical "instruments". Start off with a guitar amplifier, then add a vibratto, fuzz box, electronic bongos, 50-watt booster amplifier, reverberation, mixer and a dc-to-ac inverter.

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BRAND NEW 2N307 TRANSISTORS, PNP type, 10 watts Tungsol brand. 29¢ ea., 6 for **$1.60**

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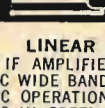

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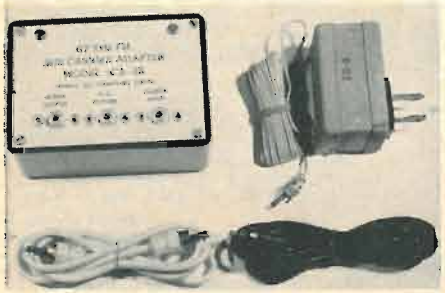

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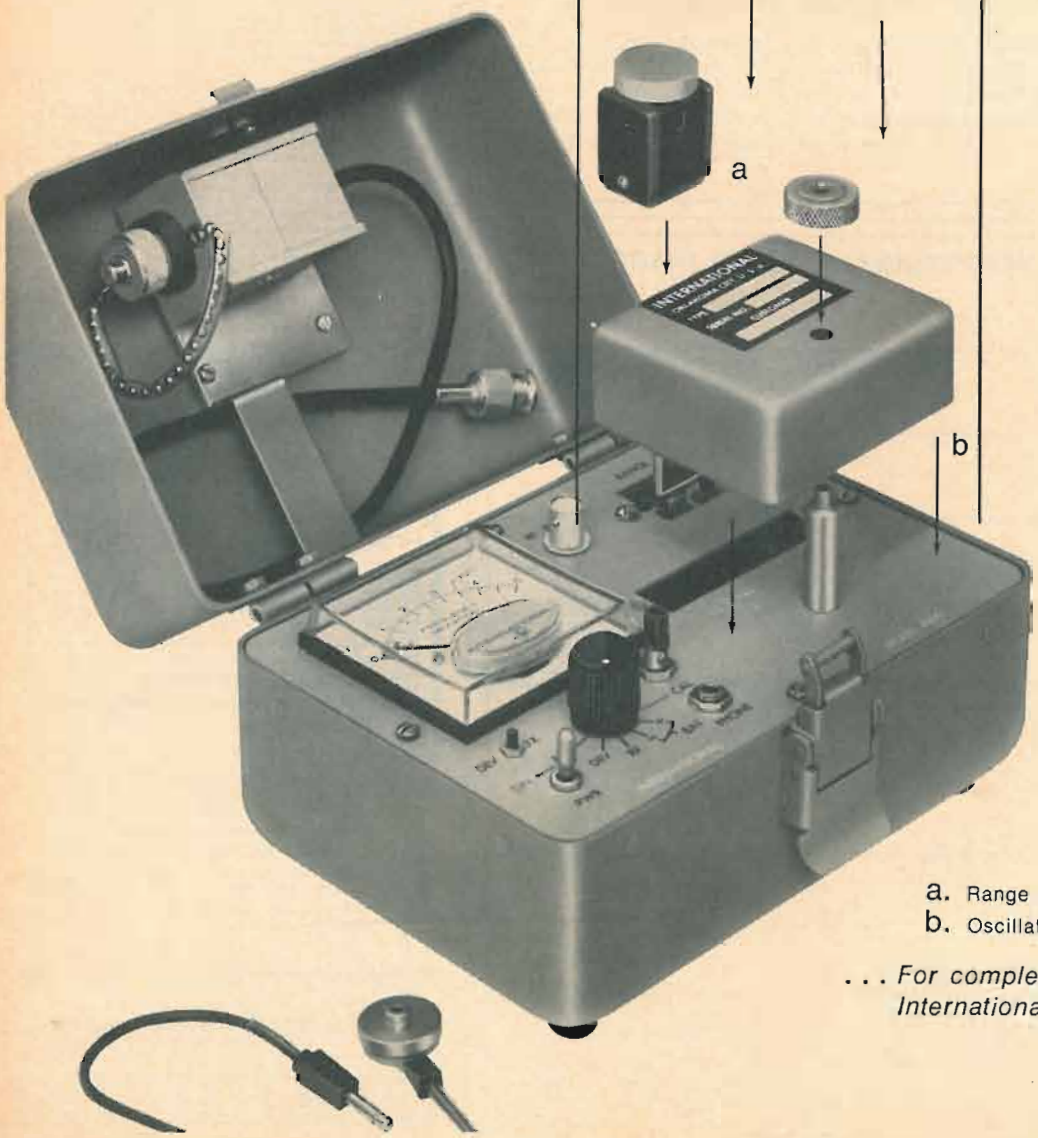

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