60c ■ JUNE 1970

Radio-Electronics

A GERNSBACK PUBLICATION

BUILD R-E'S NEW "RADAR" BURGLAR ALARM

CAR STEREO SPECIALS

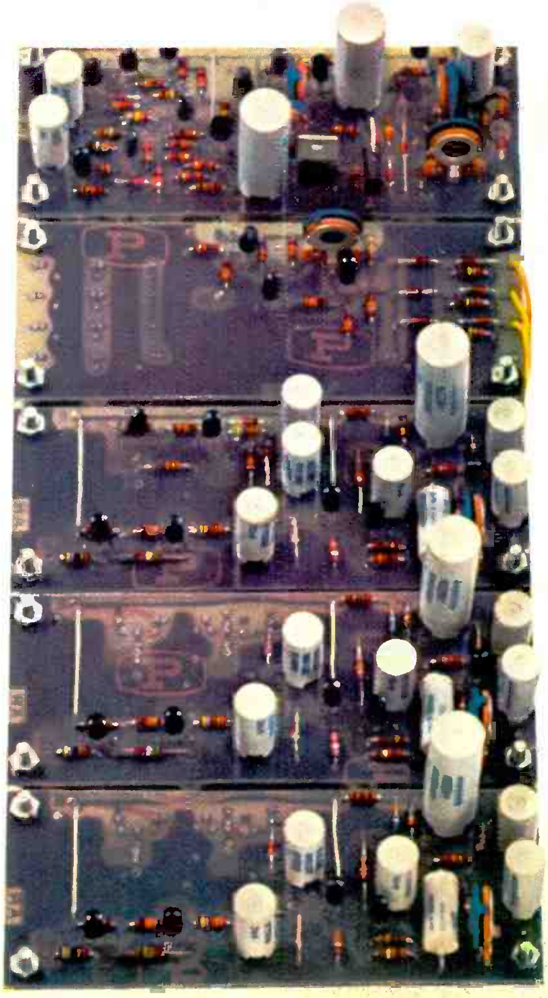
- Stereo tape on wheels
- ABC's of FM stereo in cars

EXPERIMENT WITH

- 20 triac circuits to build
- Using the amplified zener

BONUS FEATURES

- Careers in aviation electronics
- Vectorscope speeds TV repair
- Kwik-Fix™ TV faults




FM
88 90 92 94 96 98 100 102 104
AM 530 600 700 800 1000 1200
VOLUME
POWER
ON
OFF
SPEAKER
REMOTE
OFF
MAIN
BOTH
BASS — TONE — TREBLE
HEADPHONE

NEW & TIMELY

Volume 41 Number 6 RADIO-ELECTRONICS June 1970

PATIENT SYSTEMS LIMITED TO 10 μA

Electrical currents as low as 10 μA can be hazardous in some patient situations in hospitals, according to an article in the March *Hewlett-Packard Journal*. Although 5 mA is considered the maximum current that should be allowed to pass through a human being, when electrical contacts are made inside the body, fluid electrolytes greatly reduce resistance to current flow.

Direct connections to the heart are common in intensive care units, and with multiple probes attached to the patient the chances for leakage currents directly to the heart increase.

H-P patient-monitoring instruments now have circuits that limit current flow to less than 10 μA should the patient contact 115 or 230 volts. Ac coupling of patient probes eliminates any dc connection between the instrumentation input and ground.

Optical coupling for isolation and back-to-back diodes in the leads are other techniques under investigation.

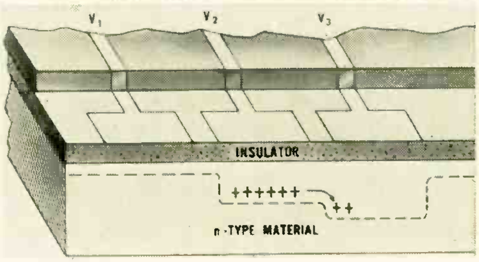
RADIO 'STAKEOUT' GETS FCC APPROVAL

DETROIT—Recent FCC approval of an electronic "stakeout system" here can alert police patrol units that a robbery is in progress within 8 seconds.

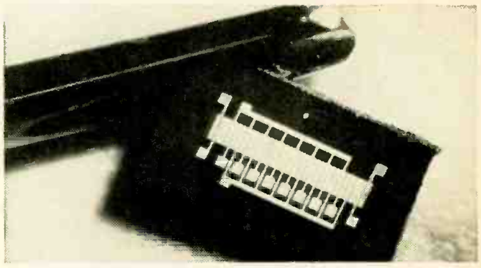
Small activator transmitters will be placed in retail establishments. When a button is pressed on the easily concealed units, a larger radio transmitter concealed in the back of a store sends a prerecorded coded message to the police department's mobile relay station.

The 6-sec code message and 5–9-sec voice transmission is also received at police headquarters and decoded in case the message relayed to patrolmen from the mobile station is indistinct.

UNIQUE SEMICONDUCTOR DEVICE DEVELOPED



Shifting charges to deeper adjacent potential well is accomplished by making V3 more negative than V2.



Experimental 8-bit shift register, larger than produced version would be, still fits in eye of needle.

MURRAY HILL, N. J.—A new class of semiconductor devices suitable for imaging, logic and memory functions has been developed at Bell Labs. The three-layer structure for the CCD's (Charge Coupled Devices) is easily fabricated, and they can perform many functions that complex IC's accomplish.

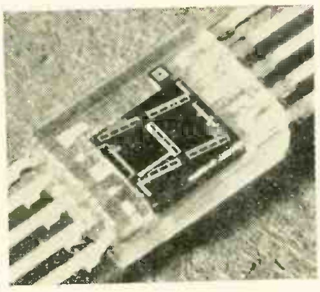
Typically, a silicon dioxide layer is fixed between a metal conductor and a silicon semiconductor base. The CCD creates and stores minority carriers, or their absence, at "potential wells" on the semiconductor surface. This occurs when the metal is made negative with respect to the semiconductor and holes are introduced into the depletion region (by light, avalanche multiplication or other means).

The holes collect at the semiconductor interface, and can be moved from under one electrode to an adjacent electrode by applying a more negative voltage to the adjacent electrode.

As a shift register, minority carriers are stored and moved two dimensionally in precise patterns, and detected and measured at some location. A recirculating memory or delay line can be formed.

NEW DIODE READOUTS

CUPERTINO, CALIF.—A monolithic, light-emitting diode alphanumeric readout is being offered commercially by Monsanto Co. The devices are being used in their new 120A counter/timer.



The readouts, called Man-3's, are formed by zinc diffusion into n-type gallium arsenide phosphide wafers. They emit red light. A visibility of more than 200 foot-lamberts per segment is possible with an 8 mW input. The 0.24 x 0.163-inch units cost $12.45 each (1-9).

LOOKING AHEAD

In this issue the regular feature column by David Lachenbruch is on page 4.

SCHEIBER 4-CHANNEL PROCESS GOES PUBLIC

NEW YORK—A recent discussion and demonstration (see "Looking Ahead") of the Scheiber four-channel process by its inventor gave a few additional hints on the technique used.

Scheiber said, however, that he could only broadly describe his compatible encoding/decoding process until patent questions are settled.

Instead of increasing frequency bandwidth to put more audio information in a recording, Scheiber explained, his system relies on generating phase conditions that provide directional clues to the listener's ear.

According to an engineer familiar with the system, the four separate channels are combined at 45° to one another—unlike the 90° orientation in conventional stereo records. This causes a 3-dB "leakage" into adjacent channels in the playback array. During encoding, passive components assign the four signals their respective directions. The decoding matrix then reassigns the signals to their original positions.

Separation can be further enhanced by an elaborate gain-rising fucntion that can reduce crosstalk to an inaudible level.

(N & T continued on page 6)

***TV-guided Maverick missile** streaks from an F-4E Phantom toward a ground target. The pilot watches a small TV screen on his instrument panel. When the missile's TV camera picks up ground targets, the pilot locks the camera onto a target and fires the Maverick. After launch, the Hughes Aircraft-built missile guides itself to the target.*

Radio-Electronics

June 1970 • Over 60 Years of Electronics Publishing

STEREO IN YOUR CAR

BUILD THIS ONE

TELEVISION

GENERAL ELECTRONICS

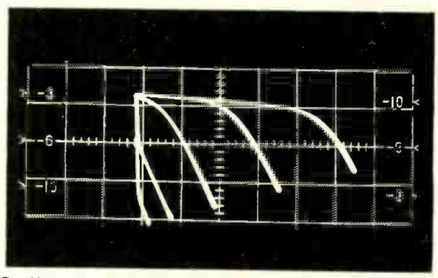
DEPARTMENTS

Build complete protection into your home or shop with R-E's tamper-proof, battery-powered burglar alarm

. . . see page 36

Avionics is an excellent career field. To find out what technicians do and how to get started . . .

. . . see page 48



Ordinary transistor curves? Perhaps, but they're only one of many that can be used to troubleshoot circuits.

. . . see page 54

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LOOKING AHEAD

Volume 41 Number 6 RADIO-ELECTRONICS June 1970

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

Are home videoplayers next?

Is the next major consumer electronic product the home videoplayer? This controversial question has provoked an undercurrent of dispute among the world's consumer electronics manufacturers, as several home see-and-hear record systems near the stage where they can be marketed practically.

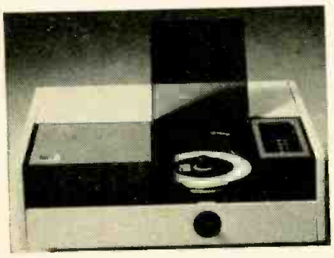
Those on the "pro" side insist that the color videoplayer will be to the LP record what television was to radio—an offspring even more important than the parent—and that the prospect of buying or renting visual entertainment to view at one's own convenience will have strong consumer appeal.

The "cons" argue that the consumer has about all the visual material he can take right now on television—and it's free. They say comparisons with the LP disc are inappropriate, since one can listen to the same record 100 times or more, but there are very few movies or plays worth watching more than twice. And they point to the high cost of prerecorded visual material, both in material and artists' royalties.

Color EVR ready

The most widely publicized videoplayer system is CBS's EVR (for Electronic Video Recording). At its recent premiere showing, the color version performed extremely well. The color system, to be marketed about a year ahead of schedule, will first be offered for educational, industrial and commercial use, but is intended eventually as a home medium.

The EVR player is the size of a large phonograph, which attaches to the antenna terminals of a TV set. A cartridge, which looks like a thick 45-rpm record, is placed on a spindle and the lid closed to play automatically up to 25 minutes of color programming (or 50 minutes of black-and white).



EVR player pipes color or b-w pictures into antenna terminals of set. Initial price is $795.

EVR is an electronic film system. The 8-mm film (with no sprocket holes) contains two series of frames side-by-side. One series looks like conventional black-and-white film and consists of the luminance (black-and-white) signal. Alongside of this track is a series of vertical black-and-white lines, representing the electronically coded chrominance (color) signal. The EVR player uses a flying-spot scanner to pick up the information, which is converted into a standard NTSC color signal.

EVR film is processed from standard color film or video tape by CBS and packed in the special cartridges. The masters are made by an electron-beam printing system, duplicates run off optically on a high-speed printer.

First production deliveries of EVR players are scheduled for Sept. 1 by Motorola, which has an exclusive CBS license to manufacture them until 1972, when, presumably, other manufacturers also may join in with their own versions. The price of the players has been set initially at $795—the same price which Motorola had originally announced for a monochrome-only version.

Movie producers are looking at home videoplayers as a new market for their product. Darryl F. Zanuck, chairman and chief executive officer of 20th Century-Fox, was the first to cast his hat into the ring. He announced that all 20th Century-Fox features will be recorded in EVR format for rental to the public five years after their theatrical release.

Sony's Videocassette

Already coming off production lines in limited quantities, and scheduled for marketing in Japan later this year and in the U.S. in 1971, are Sony's Videocassette players. The Sony player accomplishes the same result as the EVR—producing a high-quality color picture when played through the antenna terminals of a color set—but uses magnetic tape as its medium.

In its production version, the Sony player can accommodate book-sized Videocassettes playing for either 100 or 30 minutes. Like the EVR, the Sony player is self-threading (three mechanical fingers lift the tape from the cartridge and loop them around the head drum).

While CBS appears to lean toward rental of entertainment programs, Sony has another idea: Buy a blank Videocassette for $20, take it to the program supplier and have a program recorded on it. When you're through with it, take it back and have it re-recorded.

Sony's Videocassette player, somewhat more compact than EVR, carries a tentative U.S. price tag of $350, but first models may cost more. Although the player isn't capable of recording from a TV set or camera, Sony says it plans eventually to offer a recorder attachment for $100.

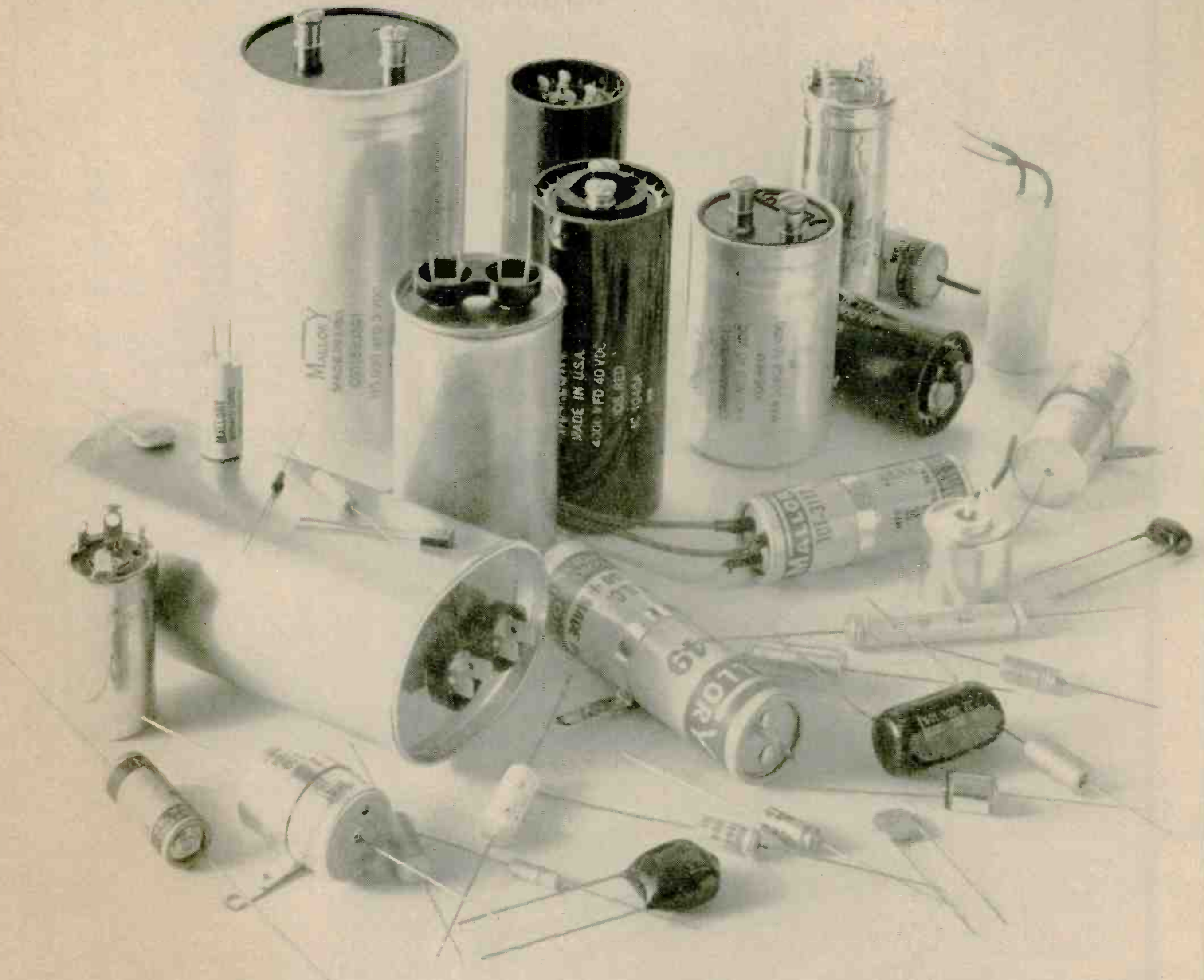
RCA's system, employing holography, is scheduled for introduction in 1972 at less than $400.

More on 4-channel

Interest in four-channel stereo seems to be increasing, particularly by audio manufacturers. Much of the interest centers on the controversial Scheiber system, which produces four-channel sound from an encoded two-channel source (Looking Ahead, February 1970).

The controversy over the system was highlighted in a recent meeting of the New York chapter of the Audio Engineering Society devoted entirely to four-channel stereo. The Scheiber system and other four-channel systems were demonstrated, highlighted by a recording of a Scheiber system FM stereo broadcast from New York, made in Princeton, N.J. 50 miles away. The tape was made on a standard two-channel stereo recorder, and converted to four-channel through a decoder at the demonstration.

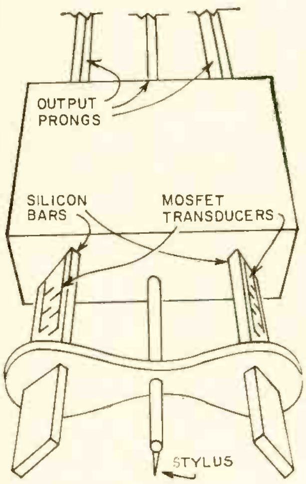
The Scheiber system was described as "psychological"—a word which appeared to make it even more controversial. The meeting was climaxed by an A-B demonstration comparing a four-channel Scheiber disc with a four-track tape of the same material. The engineers were asked to vote, by raising hands, which was the Scheiber disc and which was the tape. Our own estimate indicated the vote was about 100 to 10—the 100 wrong. **R-E**



MOSFET'S USED WITH STRAIN-GAGE CARTRIDGE

PARIS—Add the MOSFET strain gage to the list of hi-fi cartridges. Sescosem, a French firm, showed their prototype strain-gage unit at a recent hi-fi show.

The cartridge, described in the March 16 *Electronics*, has MOSFET's deposited on two silicon bars that are connected to the needle shaft.



Output of the device is 500 mV—enough for direct connection to power amplifiers. Dynamic mass is 0.7 mg with pressure on the grooves only 0.75 grams. Frequency response is 0–30,000 Hz, and compliance (so far) 10^{-5} cent/dyne. Signal-to-noise ration is 40 dB, which Sescosem also hopes to improve.

Actually, each silicon bar has two MOSFET's: one the transducer, the other acts as a load resistor. The company has patented the cartridge.

ALLOYS MAY LEAD TO CONTROLLED FUSION

DALLAS—New alloys that retain their superconductivity in magnetic fields up to 410,000 gauss were described at an American Physical Society meeting recently.

The alloy developments, according to scientists working toward controlled nuclear fusion, are encouraging steps toward creating magnetic fields that can bottle plasma for fusion.

One of the alloys is a combination of niobium, aluminum and germanium that remains superconductive to 38°F above absolute zero. Most superconductors, a recent *New York Times* article pointed out, lose their superconductive properties a few degrees above absolute zero (−459°F).

Whether the new alloys can be formed into wire for magnets and withstand the stress of high magnetic fields is still under investigation.

DEFENSE CUTBACKS SLOW EE RECRUITMENTS

A cutback in defense and aerospace funding combined with the Nixon administration's steps to slow down the economy have reduced job prospects for graduating electrical engineers.

A study based on recruitment advertising reported in *The New York Times* indicates a steady decline in the demand for engineers and scientists since a 1966 peak.

According to another survey by the Engineering Manpower Commission of the Engineers Joint Council, many companies are planning substantial cutbacks this year, and are holding back college recruitment.

Companies with heavy defense orientation are laying off engineers and supporting personnel as contracts expire.

An RCA executive has pointed out that diversified companies such as his has not been badly affected by the economic slowdown.

A low-cost "instant reply" device that uses two highly polished magnetically coated discs to provide immediate access to up to 80 seconds of just-recorded action is being marketed by Ampex. Designed for use in educational, medical, industrial, military and government applications, the DR-10 begins at $8000.

The device allows detailed and lengthy study of recorded pictures, with fast and slow replay.

(N & T continued on page 12)

Radio-Electronics

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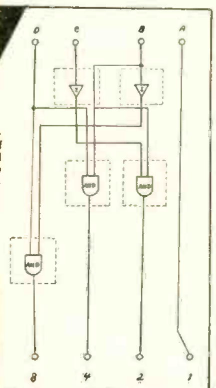
A. Is the number odd?
B. Is the number in the first or third vertical row?
C. Divide the number by four; is the remainder less than two?
D. Is the square number greater than 3?

As he answers each question, you feed the answer into the appropriate inputs ("A", "B", "C", "D"). Each answer is instantly related and/or stored in the transistorized logic blocks. When all the answers have been fed in, you then read the computer output and it tells you exactly which of the numbers the other person had in mind. It never fails; it is infallible and precise, operating as it does on principles of pure logic. In the easy-to-read and easy-to-understand instruction manual which accompanies your Compulogical Tutor, you'll find hundreds of similar problems, and others more interesting and complex.



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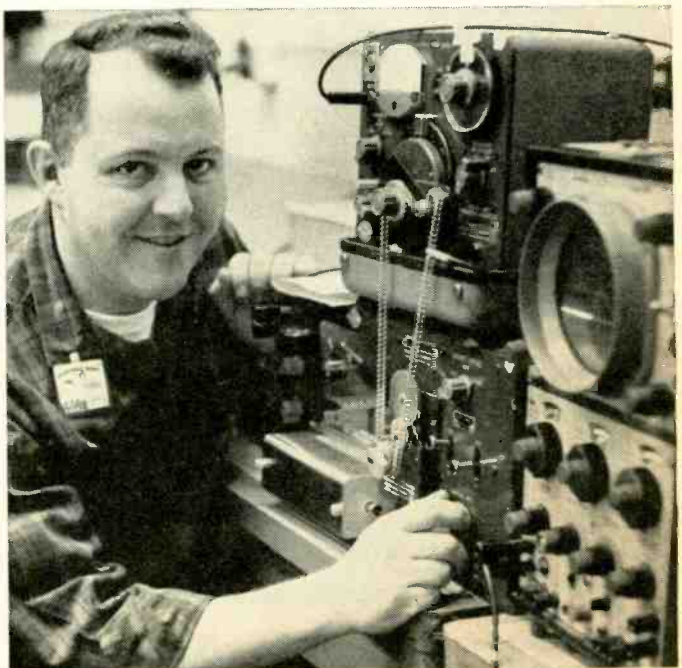
Harry Remmert decided he needed more electronics training to get ahead. He carefully "shopped around" for the best training he could find. His detailed report on why he chose CIE and how it worked out makes a better "ad" than anything we could tell you. Here's his story, as he wrote it to us in his own words.



Harry Remmert on the job. An Electronics Technician with a promising future, he tells his own story on these pages.

By Harry Remmert

AFTER SEVEN YEARS in my present position, I was made painfully aware of the fact that I had gotten just about all the on-the-job training available. When I asked my supervisor for an increase in pay, he said, "In what way are you a more valuable employee now than when you received your last raise?" Fortunately, I did receive the raise that time, but I realized that my pay was approaching the maximum for a person with my limited training.

Education was the obvious answer, but I had enrolled in three different night school courses over the years and had not completed any of them. I'd be tired, or want to do something else on class night, and would miss so many classes that I'd fall behind, lose interest, and drop out.

The Advantages of Home Study

Therefore, it was easy to decide that home study was the answer for someone like me, who doesn't want to be tied down. With home study there is no schedule. I am the boss, and I set the pace. There is no cramming for exams because I decide when I am ready, and only then do I take the exam. I never miss a point in the lecture because it is right there in print for as many re-readings as I find necessary. If I feel tired, stay late at work, or just feel lazy, I can skip school for a night or two and never fall behind. The total absence of all pressure helps me to learn more than I'd be able to grasp if I were just cramming it in to meet an exam deadline schedule. For me, these points give home study courses an overwhelming advantage over scheduled classroom instruction.

Having decided on home study, why did I choose CIE? I had catalogs from six different schools offering home study courses. The CIE catalog arrived in less than one week (four days before I received any of the other catalogs). This indicated (correctly) that from CIE I could expect fast service on grades, questions, etc. I eliminated those schools which were slow in sending catalogs.

FCC License Warranty Important

The First Class FCC Warranty* was also an attractive point. I had seen "Q" and "A" manuals for the FCC exams,

*CIE backs its FCC License-preparation courses with this famous Warranty: graduates must be able to pass the applicable FCC License exam or their tuition will be refunded in full.

and the material had always seemed just a little beyond my grasp. Score another point for CIE.

Another thing is that CIE offered a complete package: FCC License and technical school diploma. Completion time was reasonably short, and I could attain something definite without dragging it out over an interminable number of years. Here I eliminated those schools which gave college credits instead of graduation diplomas. I work in the R and D department of a large company and it's been my observation that technical school graduates generally hold better positions than men with a few college credits. A college degree is one thing, but I'm 32 years old, and 10 or 15 years of part-time college just isn't for me. No, I wanted to *graduate* in a year or two, not just *start*.

If a school offers both resident and correspondence training, it's my feeling that the correspondence men are sort of on the outside of things. Because I wanted to be a full-fledged student instead of just a tagalong, CIE's exclusively home study program naturally attracted me.

Then, too, it's the men who know their theory who are moving ahead where I work. They can read schematics and understand circuit operation. I want to be a good theory man.

From the foregoing, you can see I did not select CIE in any haphazard fashion. I knew what I was looking for, and only CIE had all the things I wanted.

Two Pay Raises in Less Than a Year

Only eleven months after I enrolled with CIE, I passed the FCC exams for First Class Radiotelephone License with Radar Endorsement. I had a pay increase even before I got my license and *another* only ten months later. I'm getting to be known as a theory man around work, instead of one of the screwdriver mechanics.

These are the tangible results. But just as important are the things I've learned. I am smarter now than I had ever thought I would be. It feels good to know that I know what I know now. Schematics that used to confuse me completely are now easy for me to read and interpret. Yes, it is nice to be smarter, and that's probably the most satisfying result of my CIE experience.

Praise for Student Service

In closing, I'd like to get in a compliment for Mr. Chet Martin, who has faithfully seen to it that my supervisor knows I'm studying. I think Mr. Martin's monthly reports to my supervisor and generally flattering commentary have been in large part responsible for my pay increases. Mr. Martin has given me much more student service than "the contract calls for," and I certainly owe him a sincere debt of gratitude.

And finally, there is Mr. Tom Duffy, my instructor. I don't believe I've ever had the individual attention in any classroom that I've received from Mr. Duffy. He is clear, authoritative, and spared no time or effort to answer my every question. In Mr. Duffy, I've received everything I could have expected from a full-time private tutor.

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Circle 19 on reader service card

CORRESPONDENCE
(continued from page 16)

output attenuator. Modulate generator No. 1 with 400 Hz to a deviation of 22.5 kHz. Connect a filter and amplifier to the ratio detector output. Tune the filter to notch out the 400 Hz output. (This notch depth must be at least 46 dB.) Modulate generator No. 2 with 1000 Hz at a deviation of 22.5-kHz. Increase output level of generator No. 2 until 1000 Hz output is at same level as 400 Hz before filtering. The difference in generator output readings is the capture ratio.

(There are several ways of making this measurement. To get a better capture ratio, i.e. a lower number, start with generator No. 1 at 1000 μV. This is a meaningless measurement in any event. It would be more to the point to make threshold measurements, except that FET front ends show up poorly on that kind of a test.)

AM Suppression

Connect a generator through a 300-ohm pad to the receiver input. Modulate the generator with 400 Hz to a deviation of 75 kHz. Set the generator output for 10,000 μV. Measure the output voltage at the receiver at the ratio detector. This is the 0 dB reference. Now modulate the generator to 30% amplitude modulation and measure the output at the ratio detector again. Add +10 dB to this figure to read the AM suppression.

Harmonic distortion

Connect a generator through a 300-ohm pad to the input terminals. Set generator output to 1000 μV; modulate with 400 Hz to 75-kHz deviation. Connect a harmonic distortion analyzer to the output of the ratio detector and measure distortion. (This figure includes the generator distortion, which is extremely difficult to determine accurately.) For minimum generator distortion use the Hewlett-Packard 608D with synchronizer.

Hum and noise

Connect the generator through a 300-ohm pad to the input terminals. Set generator output for 50,000 μV unmodulated. The output at the ratio detector must be at least 70 dB below the noise output with the generator set for zero output.

Spurious response

This measurement is made at quiet spots on the receiver dial at each end of the band as well as near 100 MHz. A shielded enclosure is almost mandatory.

Tune the receiver to a quiet spot near 88 MHz. Set the generator for 75-kHz deviation of a 400-Hz modulating signal. Tune the generator across the 88- to 108-MHz band and record the generator output level for any frequency that causes an output level at the ratio detector greater than 10 dB below the noise reference voltage as measured under "quieting sensitivity."

(continued on page 42)

In the Shop . . .With Jack

By JACK DARR
SERVICE EDITOR

RADIO-ELECTRONIC'S SERVICE CLINIC has a fully equipped service lab. Here, tests are run on TV, radio and audio equipment, and new test equipment is checked out in actual operation. Test methods can also be checked to see which give the best results in the least time.

Detailed notes are kept on each job, for time-and-motion studies ot techniques, equipment and diagnosis methods. These can be very helpful, and also somewhat embarrassing at times. Here are the actual notes on one job, transcribed verbatim from the clipboard.

Set: RCA KCS-169 hybrid TV. 12-22-69;4:35 PM.

Symptoms: No high voltage. Sound okay.

Tests: Neon-lamp rf indicator shows what seems to be normal glow on high-voltage rectifier plate lead. No high voltage at all on 1X2 filament. One wire on wrong pin. Corrected. Still no HV.

Question: Are horizontal output tube and flyback putting out enough to light 1X2 filament? No visible glow.

Test: wind paper clip to make "socket" for No. 222 flashlight lamp. Remove 1X2, tack-solder to filament wires. No glow in pilot lamp.

Test: Set 33GY7 horizontal output tube on cathode-break adapter. Read cathode current. I_k on original tube 150 mA. Schematic says 110 mA. Hmmm. Try new tube. Same; same current, still no light in 1X2. Try new 1X2 and socket, tacked in. Omit 2.2-ohm resistor. Now read about 2 kV on socket. No light on screen.

Check flyback for shorts, in-circuit. Flybacker tester says flyback shorted. Slide chassis out, remove flyback. As anticipated, now tests OK; no shorts. Replace. Disconnect horiz yoke; check. Hmm. Flybacker says shorted. Read dc resistance of yoke. Schematic calls for 30 ohms. Yoke reads 30 ohms. Check resistance of each half from CT; 15 ohms each. Yoke removed from list of suspects. 5:16 PM. Give up—go home.

Second go-round. 12-23-69, 9:20 AM. Check scope waveform loosely coupled to 1X2 plate lead (Fig. 1). Scope shows very low peaks (I *knew* that!) and excessive ringing (I didn't know that). Check boost voltage.

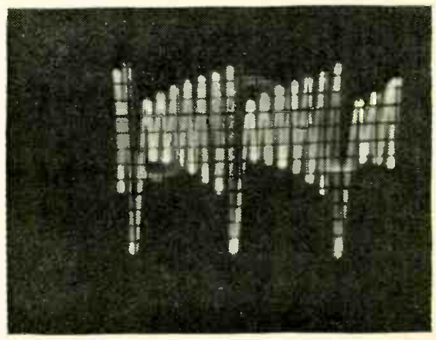


Fig. 1—Excessive ringing at 1X2 plate.

Reads +165 volts. B+ reads +135 volts (normal). Disconnect boost capacitor: checks okay.

Disconnect yoke. Turn set on. High voltage goes up to 5 kV; bright vertical line now appears on screen. I_k 33GY7 now drops to 120 mA. Recheck yoke; still shows shorted on flybacker. Disconnect yoke balancing capacitor; checks okay, naturally. Substitute variable inductor for horizontal yoke. I_k (cathode current) of 33GY7 now drops to 110 mA; high voltage jumps up to 9 kV, vertical screen line very bright.

(This is a very good example of how we can walk right over a key clue without seeing it! Did you? It's easy with our regular 20:20 hindsight, but it was just as obvious when we made the original test! The *test equipment* told me that the yoke was shorted, but I deliberately talked myself out of it and kept on. Right then, I should have stopped and substituted another yoke or the test inductor. Here are the final lines on the clip-board.)

CONCLUSION: When the Flybacker tells you that the yoke is shorted, BELIEVE IT, STUPID! Don't just sit there—*get a new yoke!* **R-E**

TEST EQUIPMENT DATA NEEDED

The Service Editor gets requests for service data on old test equipment at regular intervals. While he has quite a pile of such data he can always use more. Among these are the Solar "Exam-meter" capacitor tester Model 'CF', and a McMurdo-Silver "Sparx" signal-tracer. Any other old instruments would be welcomed. Send copies if possible; if not, they will be copied and sent back if requested.

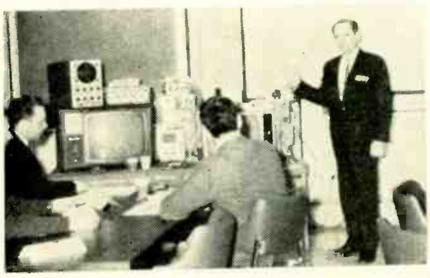
TECHNICIAN TRAINING

NEW YORK, N.Y.—Magnavox's unique setup of regional service training centers is entering its third year of highly successful operation. Centers in Rutherford, N.J., Atlanta, Ga., West Lake, Ohio, Skokie, Ill., Dallas, Texas, and San Francisco and Torrence, Calif. offer free of charge, to qualified and professional technicians, technical training that cannot be presented in the more common seminars and field training sessions.

The facilities, instructors and equipment are integrated in a manner that produces the highest degree of theoretical and practical training in the minimum number of hours. Five training programs consisting of two or more complete courses are scheduled Monday through Thursday. A class-day is 8:00 a.m to 5:30 p.m. with a complementary lunch provided between 12:30 and 1:30 p.m.

The study programs, with some overlap in courses, are set up so the student can select the one most beneficial to him. Progress is gauged by workbooks and quizzes. The programs and their included courses are: Color TV I, courses 120, 201 and 201A: Color TV II, courses 201, 201A and 501; Color TV III, courses 201, 201A and 202; Solid State, courses 130 and 302; Fundamental Color and Solid State, courses 110, 120 and 130.

Course 110, New Technician Indoctrination.—Provides background on Magnavox, its facilities, services and products. Covers product identification, service manuals, replacement parts, etc. Suggested for new dealer or service personnel.

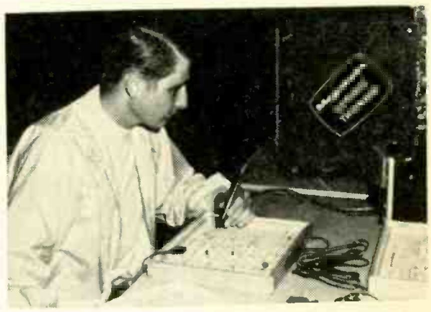


Typical lecture and demonstration period. These sessions are followed by a workshop session to back up the lecture.

Course 120, Basic Colorimetry and Color TV Setup.—For service technicians without prior color experience. Covers degaussing, purity, color temperature, convergence and all other field adjustments. 1 day.

Course 201, Color TV Circuit Analysis and Troubleshooting—For the technician who is now doing or preparing to do bench work. Detailed coverage of circuit operation and a logical approach to troubleshooting bandpass amplifiers and all other color circuits. Workshops are provided on adjustments required in color circuits and troubleshooting actual receiver problems. 2 days. Prerequisite: course 120 or equivalent.

Course 201A, Solid-State Color TV Circuits.—Extension of course 201 covering the TAC (automatic tint control) and the solid-state circuits in the T936 chassis. Includes work periods and solid-state troubleshooting techniques. 1 day. Prerequisites: course 201 and course 130 or equivalent.



Student in a workshop for Course 130. He is becoming familiar with various solid-state devices used in radio and TV sets.

Course 202, Color Television Alignment.—Teaches how to analyze problems resulting from misalignment and the use of sweep alignment equipment as a troubleshooting aid. Workshop session provides experience.

Course 130, Solid-State Components, Their Operation and Application in Solid-State Radios.—Introduces theory and operation of semiconductor components and circuitry in radio and TV sets. Circuit application and component checking is taught by using student workboards.

Semiconductors studied are then examined in a complete AM-FM stereo receiver. Correlation of circuit analysis and symptom analysis is taught in workshop sessions. 2 days. Prerequisite: basic electronics.

Course 302, Solid-State TV Circuitry and Service Techniques.—A study of solid-state devices in specialized TV circuits with emphasis on agc, sync, vertical and horizontal deflection, video and high-voltage circuits. Workshops on solid-state TV trouble-shooting. 2 days. Prerequisite: course 130 or equivalent.

Course 501, Magnavox TV Remote Control Systems.—A complete study of the Magnavox 8-function remote control. 1 day. Prerequisite: courses 130, 201 or equivalent. **R-E**

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Circle 25 on reader service card

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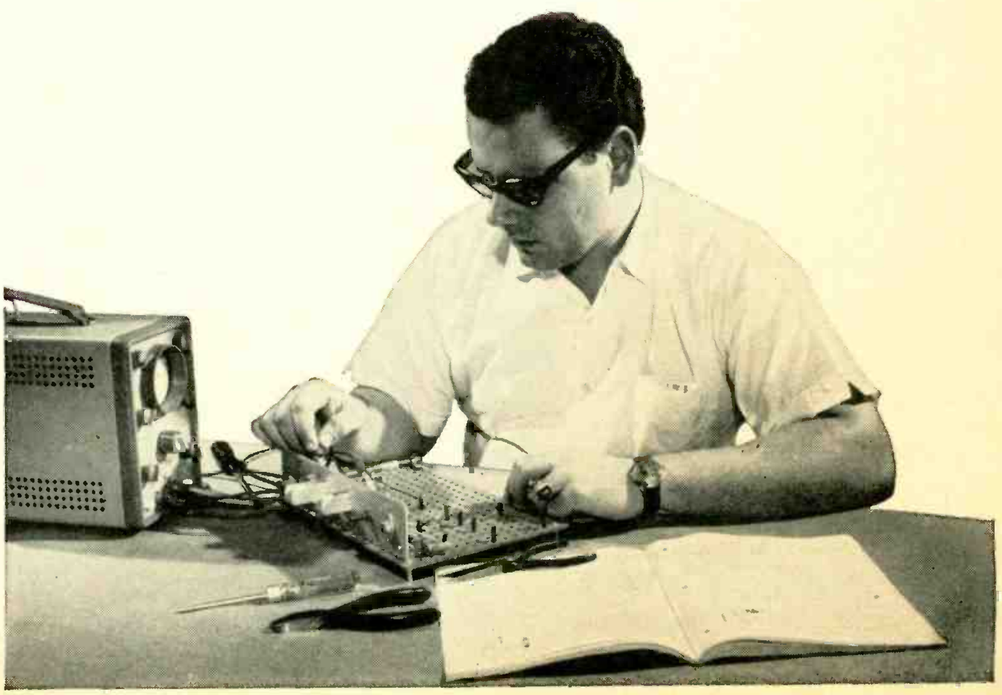

Performing transistor experiments on programmed breadboard—using oscilloscope.

1 LEADER IN ELECTRONICS TRAINING

When you think of electronics, you immediately think of RCA...a name that stands for dependability, integrity and pioneering scientific advances. For over a half century, RCA Institutes, Inc., a service of Radio Corporation of America, has been a leader in technical training.

2 RCA AUTOTEXT TEACHES ELECTRONICS FASTER, EASIER, ALMOST AUTOMATICALLY

Beginner or refresher, AUTOTEXT, RCA Institutes' own method of programmed Home Training will help you learn electronics more quickly and with less effort, even if you've had trouble with conventional learning methods in the past.

3 THOUSANDS OF WELL PAID JOBS ARE NOW OPEN TO MEN SKILLED IN ELECTRONICS

RCA Institutes is doing something positive to help men with an interest in electronics to qualify for rewarding jobs in this fascinating field. Every year, literally thousands of high paying jobs in electronics go unfilled just because not enough men take the opportunity to train themselves for these openings.

4 WIDE CHOICE OF CAREER PROGRAMS

Start today on the electronics career of your choice. On the attached card is a list of "Career Programs", each of which starts with the amazing AUTOTEXT method of programmed instruction. Look the list over, pick the one best suited to you and check it off on the card.

5 SPECIALIZED ADVANCED TRAINING

For those already working in electronics or with previous training, RCA Institutes offers advanced courses. You can start on a higher level without wasting time on work you already know.

6 PERSONAL SUPERVISION THROUGHOUT

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

7 VARIETY OF KITS YOURS TO KEEP

To give practical application to your studies, a variety of valuable RCA Institutes engineered kits are included in your program. Each kit is complete in itself. You never have to take apart one piece to build another. At no extra cost, they're yours to keep and use on the job.

8 FROM RCA INSTITUTES TRANSISTORIZED TV KIT, VALUABLE OSCILLOSCOPE

Those enrolled in RCA's television course or program receive complete transistorized TV Kit. All students receive a valuable oscilloscope—both at no extra cost and only from RCA Institutes.

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CLASSROOM TRAINING ALSO AVAILABLE

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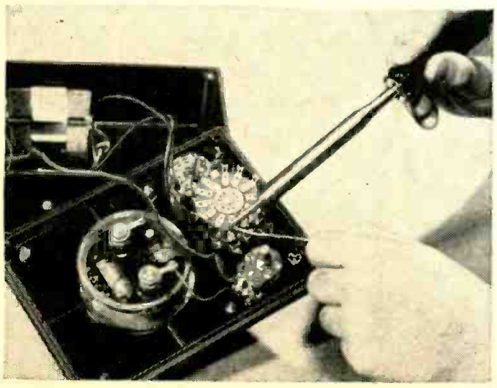
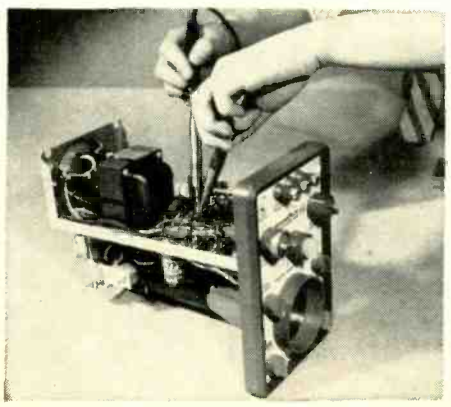
RCA

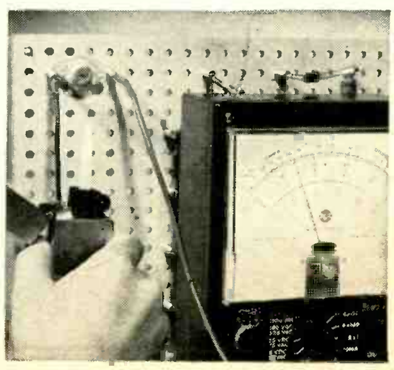
Construction of Multimeter.





Construction of Oscilloscope.

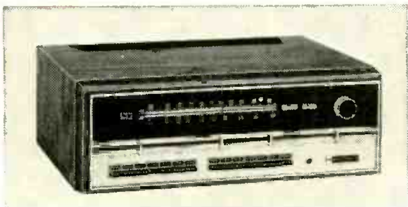
Temperature experiment with transistors.



NEW FOR YOU

Heathkit AR-29 AM/FM Stereo Receiver

For manufacturer's literature, circle No. 35 on Reader Service Card.



THE AR-29 ARRIVED IN A HEFTY BOX crammed with parts. Fortunately, with this kit, the days of the box marked "misc. hardware" are over. There are eight boxes labeled Pack #1 through #8, each containing all components and hardware for each stage of construction. All other components, (preassembled tuner, power transformer, signal and tuning meters and chassis parts) are separately boxed or wrapped.

Construction started with the opening and check-out of Pack #1, the AM-rf circuit board. Heath has taken each board and, in the pictorial, split it into halves or quarters vertically. Then, each group of components (resistors, capacitors, diodes, transistors, etc.) are installed onto the board. This does keep things from getting confusing.

Next comes the AM-FM-i.f. board, the most complicated board in the entire set. This one board took us nearly 3½ hours to complete. The multiplex PC board came next, followed by the power supply board, the input preamplifier board, the two identical output amplifiers and the control preamplifier board.

The chassis came last, with most of the wiring in harnesses. All circuit boards "plug" into the chassis for easy assembly and easy servicing, with the exception of the AM-rf board. This one is mounted and wired to the front end.

One unusual feature of the AR-29 is the test circuitry built around the signal strength meter which allows it to be used as a voltmeter or an ohmmeter.

All boards are checked for proper resistance at different points. Then each board is plugged into the chassis and voltage measurements are made. If incorrect voltages or resistances are encountered, there is a complete troubleshooting chart which will pinpoint the source of the difficulty.

With all boards in place, speakers are connected to each channel and hum injection tests are made on the preamplifier and output stages. Finally the FM antenna is connected and the moment of truth arrives. (AM antenna is a built-in Loopstick.)

FM adjustments are next, and without the usual FM generator! All you need is the signal and tune meters. This alignment procedure really amounts to a touch up, as the i.f. transformers all were very close. Multiplex adjustments follow, using again the signal and tune meters, and the built-in voltmeter. AM alignment just uses the signal meter.

In conclusion, this receiver is easily built, mechanically sound, and most enjoyable to use. FM sensitivity and selectivity are very good. FM stereo reception from stations 100 miles away was loud and clear, and stayed "locked in" well. As an amplifier, we can only describe its performance as distortion-free and clean. With its built-in test set, its owner will be able to do most of his own testing and repairs.—*Mark Gernsback* **R-E**

MANUFACTURERS SPECIFICATIONS

FM (MONO)
Frequency Response: ±1 dB 20–15,000 Hz
Sensitivity: 1.8 μV, 1.5 μV typical
Volume Sensitivity: Below measurable level
Selectivity: Greater than 70 dB
Image Rejection: 90 dB
I.f. Rejection: 90 dB
Capture Ratio: 1.5 dB
AM suppression: 50 dB
Harmonic Distortion: 0.5% or less
IM Distortion: 0.4% or less
Hum and Noise: Better than 60 dB
Spurious Rejection: Better than 90 dB

FM STEREO
Channel Separation:
45 dB av at 1000 Hz 40 dB min
35 dB at 50Hz 30 dB min
30 dB. at 10kHz 25 dB min
25 dB at 15 kHz 20 dB min
Frequency Response: +1 dB from 20 to 15,000 Hz
Harmonic Distortion: 0.5% at 1000 Hz with 100% Modulation
19 kHz and 38 kHz Suppression: 55 dB or better
SCA Supression: 55 dB typical

AM SPECIFICATIONS
Sensitivity:
Ext. antenna
30 μV at 600kHz
20 μV at 1400kHz
Internal rod Antenna
200 μV/Meter at 600kHz
300 μV/Meter at 1400 kHz
Selectivity: Better than 40 dB (alternate channel)
image Rejection: 60 dB at 600 kHz; 45 dB at 1400 kHz
I.f. Rejection: 50 dB
Harmonic Distortion: Less than 2%
Hum and Noise: 35 dB

AMPLIFIER
Dynamic Power Output per channel: 50 watts (8-ohm load); (4-ohm load 65 watts); (16-ohm load 30 watts)
Continuous Power Output per channel: 35 watts (8-ohms); (4-ohm load 35 watts); (16-ohm load 25 watts)
Frequency Response: (1 watt level) −1 dB, 7Hz to 60 kHz−3dB, 4 Hz to 100 kHz
Harmonic Distortion: Less than 0.25% from 20 Hz to 20 kHz at 35 watts; Less than 0.1% at 1000 Hz with 1 watt output
IM Distortion: Less than 0.2% with 35 watts output, using 60 and 6,000 Hz mixed 4:1; Less than 0.1% at 1 watt output
Input Sensitivity: Phono—2.2 mV; Tape—180 mV; Aux—180 mV; Tape Mon—180 mV
Hum and Noise: Phono—(10 mV reference) −65 dB Tape and Aux—(0.25 V reference) −75 dB
Channel Separation: Phono 50 dB; Aux, Tape and Tape Mon. 60 dB or better

IT'S NOW STEREO ON WHEELS

by **LARRY STECKLER**

MANAGING EDITOR

AMERICANS LOVE THEIR CARS. THEY ALSO LOVE STEREO. To combine these two loves it is now possible to put stereo into cars. Tape is one medium that makes it happen. . . 8 tracks in cartridges and 4 tracks in cassettes.

FM multiplex radio is another way to add stereo to a car and is also growing rapidly. In some instances the way to add FM stereo to a cartridge tape player is to buy a plug-in adapter (it goes where the tape cartridge fits).

Where does it go?

But no matter which way you use to add stereo to your car there are some important rules to observe. First: where will the tape player go?

The most common place for mounting the tape player is under the dash in the center of the car. This makes the player convenient to the driver. It also puts it right in the way of anyone seated there. So you may be trading stereo for a passenger seat.

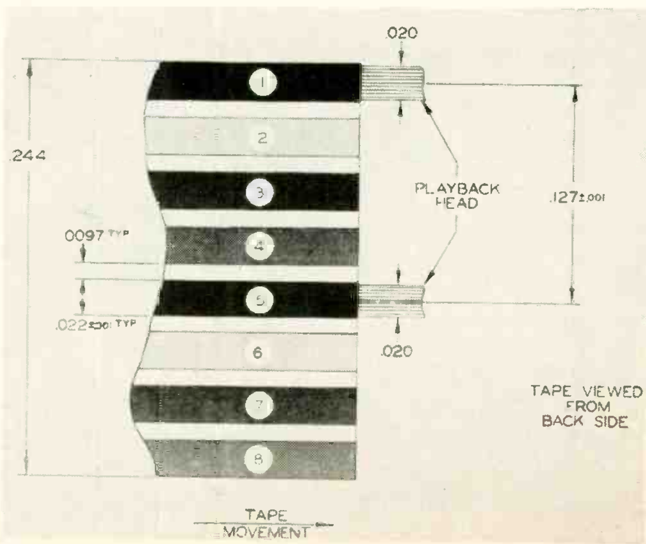
Second: you must add speakers. The speakers now in your car are not suitable for stereo. At a minimum you need two, one on each side of the car. You can add more pairs of course, but they must be balanced. They can go in the doors or front side panels or they can be surface-mounted. If possible use the built-in approach—it leaves more leg room.

Third: decide now—cassette or cartridge. Both are available and both have advantages so you must make the choice yourself. But here are some points to keep in mind while making that choice.

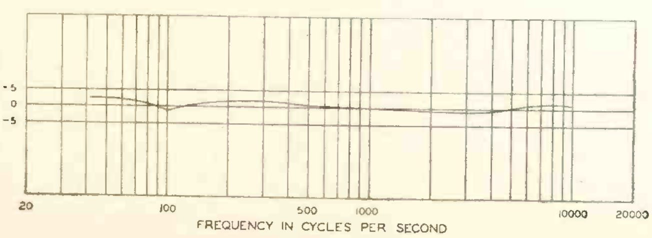
The cartridge offers four bands of material so while it is playing you can select any of these four bands to listen to. By contrast the cassette offers only two bands. Playing time is about equal, however, and so is tape cost.

Cassettes are smaller than cartridges and you can store more casettes in the same amount of space. The

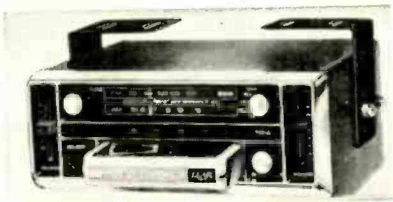
Eight-track cartridge tape is approximately $\frac{1}{4}$-inch wide. This sketch shows how it is divided up into 8 separate tracks. (Sketch courtesy RCA)



With compensated playback this is the electrical frequency response curve that can be attained with an 8-track stereo cartridge tape.
(Sketch courtesy RCA)



RCA Stereo 8 cartridge plugs into player in a modern car. Four 2-channel stereo program tracks are provided.



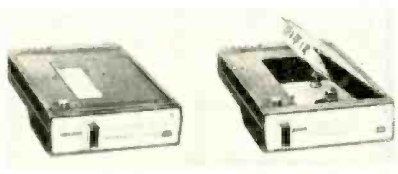
Lear Jet A-130 is an add-on cartridge player. It also has an AM-FM stereo radio.

Typical cassettes used in cassette players. These are not prerecorded. Mallory Duratape.

Panasonic CX-451 is an 8-track cartridge tape player.

Muntz 9200 add-on cassette unit will record as well as play back tapes.

Aiwa TPR-2011 plays prerecorded cassettes. Has push button controls.



Cassette adapter pack makes possible playing cassettes in cartridge tape player. Panasonic model CJ-980.

Motorola TF800S is a cartridge machine that includes an FM stereo receiver.

Lafayette RK-210 tape player-recorder uses cassettes.

ratio is about 2 cassettes in the space needed by one cartridge There is a new cartridge just announced that folds in half when not in use. It is still just a trifle larger than the cassette, but a lot more competitive in size.

There are home players for both cassettes and cartridges so you can double the use of either tape. However, in home machines there are cassette changers. There aren't any cartridge changers.

Both cartridge and cassette players for cars offer some machines with recording capability. Watch this feature carefully. Some of the machines that record will record in *mono* only. So while you are buying a stereo player, don't try to make your own stereo tapes.

When recording, a cassette is probably a bit easier to use than a cartridge. When you reach the end of cassette there is no doubt about it—the tape just can't go any further. At the end of a cartridge, however, the tape keeps right on going. And if you are still recording at this point you'll start erasing whatever material you had at the beginning of the cartridge.

Cartridge—Cassette differences

Other than the number of tracks there is one basic difference between the cartridge and the cassette—the cartridge is a continuous tape: the cassette is a reel-to-reel tape. The difference is pressure and tension on the tape. Much greater tension and therefore, greater wear is imposed upon the cartridge tape. To alleviate some of this, cartridges use lubricated tape.

Cartridge tape is wider than cassette tape—about twice as wide. But since cartridge tape has twice the number of tracks on it, the tracks—cartridge or cassette—are about the same width and therefore have about the same audio characteristics.

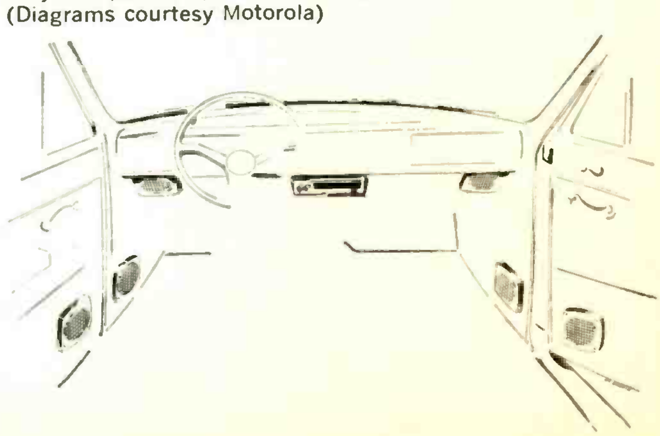
About frequency response

You are not likely to get better than 10 kHz as the top frequency from the prerecorded tapes you buy. The main reasons being the limitations on the speakers in the car and the frequency range actually put on the tape. The graph of the preceding page indicates the equalized frequency response you can expect from a stereo tape cartridge. This is the *best* you can get because this is what the tape maker is putting onto the tape.

Somewhat better response is possible with a cassette. But again, in the car the speakers will become the limiting factor. And even in the home, 12 kHz is the practical limit to expect today.

Tape hiss may be noticeable. There is little you can do about this problem. It is inherent in the tape speed, 3¾ ips,

How to clean car tape cartridge players. (right) Note use of cotton swab with isopropyl alcohol, NOT carbon tetrachloride. Add-on tape player and speaker mountings are shown below. Only one pair of speakers is needed; three locations shown. (Diagrams courtesy Motorola)



used in these machines. As better tapes (high-density like the new Bell & Howell and TDK) or the new chromium dioxide tapes become available, this problem is reduced. Electronic systems, like versions of the Dolby equalization circuit also reduce tape hiss of this type.

Headphones too?

One of these days headphones for car stereo listening will be available. One headphone manufacturer Superex, has already announced such a system. It is intended for all passengers, but *NOT* for the driver.

If you should want to install such a system yourself, it shouldn't be too difficult. Set up plug-in terminals for each passenger and provide a set of headphones. Just make sure you doublecheck impedance matching with the output of the amplifier.

Tape player maintenance

Car tape players, like home machines, require regular maintenance if they are to operate properly. The largest single cause of improper operation is oxide build-up on the tape head or capstan. In normal operation, as the tape goes through the deck, iron-oxide particles wear off the tape. Accumulation of this material degrades playback and can cause the tape to slide up and down. Therefore the head and capstan should be cleaned regularly. This can be done without removing the tape player from the car.

Follow the procedure shown in the illustration below. Use a cotton swab and head cleaner or isopropyl alcohol to remove oxide accumulations. Then wipe dry with a clean dry swab. Clean the leaf contacts on the track switch at the same time.

When cleaning the tape head be extremely careful. Do not allow any cleaner fluid to touch plastic parts.

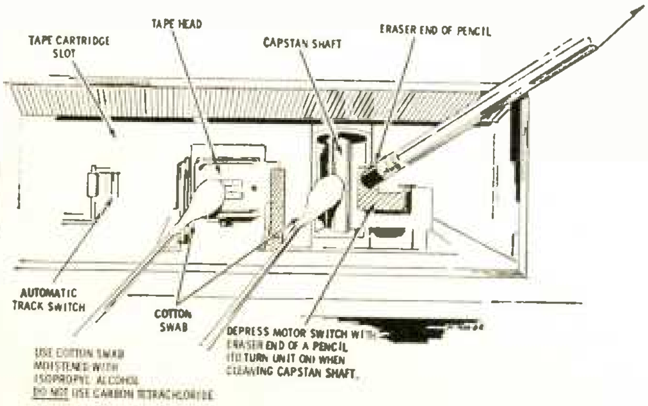
Special cartridges and cassettes containing a cleaning tape are sold. If used regularly they can help keep tape heads clean and in good working order.

In normal use, the tape heads may pick up a bit of residual magnetism. Any tape head that becomes magnetized shows a loss of high frequency response and an increase in noise. To demagnetize the heads in your machine use a commercial tape head demagnetizer, following the instructions packed with the unit.

R-E

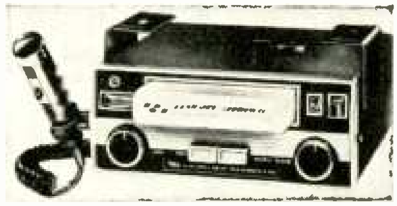
TAPE PLAYER MAKERS

A list of names and addresses of tape-player manufacturers is available from Radio-Electronics. Just send a stamped, self-addressed envelope to Tape Player List, Radio-Electronics, 200 Park Avenue South, New York, N. Y. 10003. The list will be on its way back to you by return mail.

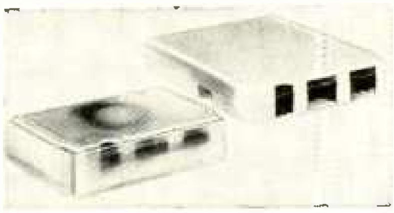


Ampex Micro 42 is a cassette machine. Has mono recording and stereo playback.

Sony model 20 cassette player features push-in loading and automatic eject.



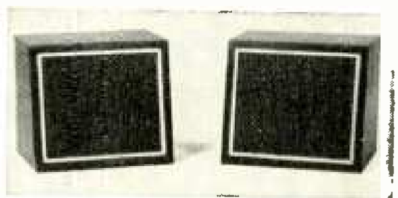
Lear Jet A-260 is a cartridge record/play machine for cars.



Mini-cartridge (left) folds in half to reduce storage-space needs. It's made by Lear Jet.

Hitachi CS-204 has dustproof door to protect player mechanism when not in use.

Norelco 2602 Stereo cassette player automatically shuts off at the end of a tape.



Add-on speakers for car stereo players have walnut finish cabinets. Mount on rear window deck. From Eastern Specialties.

Automatic Radio ACS-6000 cassette player is for cars, trucks or boats. Shuts off automatically.

by **KENNETH F. BUEGEL**

Senses intruders 45 feet away by detecting changes in reflected load on 400-MHz oscillator—part 1

FEW PROJECTS ARE AS FASCINATING IN operation as intrusion alarms. A variety of circuits may detect the actual intrusion; others make "decisions" and provide useful time delays.

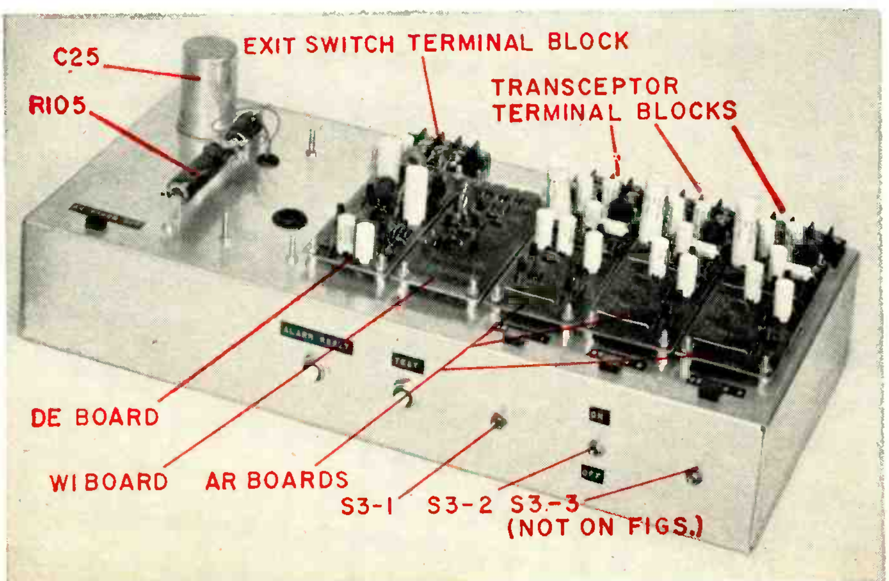
Most alarm systems described as "radar," "microwave" and "Doppler radar" sense intrusion by noting the effect of changes in reflected load on a flea-power oscillator. The oscillator operates at low power for two reasons: first, to avoid radiation of a field beyond FCC limits; second, to keep sensitivity high. The radiated field sets up a reflection at the boundary of two materials of different dielectric constants. The reflection is strongest where the difference is largest, such as air to metal.

The system described here is well suited for outdoor use. Ultrasonic types cannot be used where the surrounding air may have temperature or velocity fluctuations.) Also, this alarm reliably detects movement at 40 to 45 feet, which is more than can be expected of ultrasonic types.

Circuit operation

Transistor Q1 oscillates near 400 MHz (Fig. 1). The frequency is determined by L1 and the capacitance of the printed circuit (transceptor) itself. A tap on L1 is coupled to an antenna through C3. The collector current for Q1 is supplied from a Zener-stabilized source. Resistor R5 and C4 remove the Zener noise components.

Reflected load variations cause a current change through R4. This voltage drop across R4 is applied to two-stage amplifier O2–O3. Except for C5 the entire amplifier is direct-coupled to maintain low-frequency response. The lower frequencies are caused by slow movement.



OPERATING

Battery operation—"Float" charged from ac line. Two weeks operation after power loss. Signals loss of ac power. Reliable source of power to trip alarms.

Wiring alarm—Instantly signals deliberate or accidental damage to sensor heads or wiring.

Time delays—Adjustable to accommodate installation needs—usually available only as options in commercial versions.

Signal sequencing—Minimizes "false" alarms when operating at the highest sensitivity.

Operating range—Can be set to in-

The output of the transceptor head (TC1) is from emitter follower Q4. Output is derived from voltage divider R14–R15, whose purpose is, not to attenuate the signal, but to permit the output point to be grounded without destroying Q4. The effective output impedance is 900 ohms. This allows TC1 heads to be used 50 feet from the control unit with unshielded leads or 300 feet with shielded leads.

An Alarm Receiver (AR) board is required for each TC1 head used in the system. Transistor Q5 amplifies with the gain set by R21 in the emitter circuit (Fig. 2) Capacitor C10 provides negative feedback at all frequencies above a few Hz. Resistor R19 and C11 are a low-pass filter to restrict the input to amplifier Q6 to lower frequencies. Most motion will appear in the range 0.1 to 10Hz.

All detected motion affects two channels in the system. One channel is a latching light circuit Q8 and Q9, which indicates the TC1 head being disturbed. The other channel (Q10–Q11) is nonlatching and furnishes the alarm signal. The alarm-signal channel does not need to be completely duplicated on other AR circuit boards.

The D5 diodes on all AR boards may be tied together at point X to furnish drive for the alarm circuit. For certain applications where the rest of the system is not needed, the relay may be connected to point RY. If R38 is installed, the alarm circuit will latch once triggered. Temporarily grounding point RR will restore the circuit to a ready status.

Diodes D3 and D4 rectify the alarm signal at the emitter of Q7 and forward-bias Q8, which turns on Q9. Resistor R32 provides a positive feed-

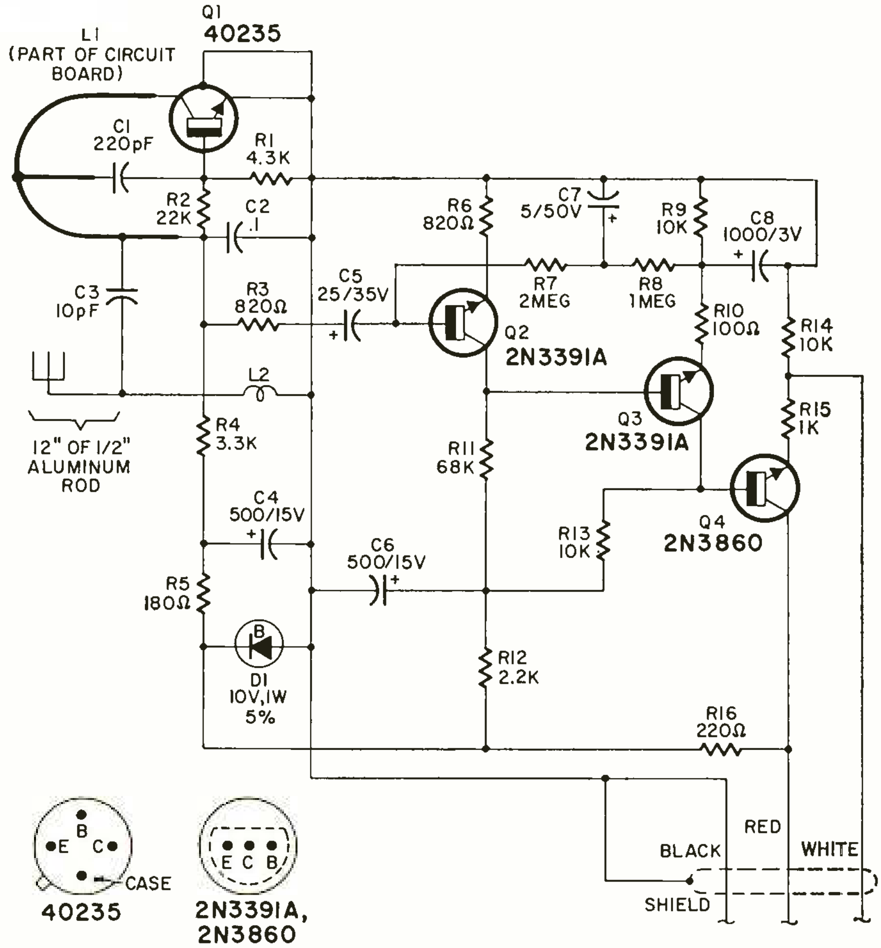


Fig. 1-a—Transceptor head circuit. You can use several of these units as external sensors to cover large areas.

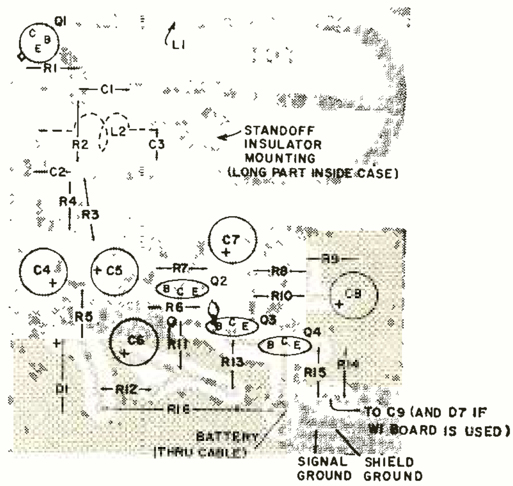


Fig. 1-b—Parts layout on the transceptor head circuit board. Full side foil pattern will be shown next month.

FEATURES

dicate movements from 10 to 45 feet.

Sensor heads—Use "fail-safe" circuitry. Low-impedance outputs allow placement hundreds of feet from control and alarm chassis. Up to fifteen sensor heads may be used with each control and alarm chassis.

Type of operation—Measures reflected load changes on micropower oscillator. Not disturbed by air movement or sudden temperature changes. Well-suited for outdoor use. Can be installed to provide discrimination between indoor and outdoor movements.

PARTS LIST

TC1 Transceptor Head

All resistors 1/4w, 5% unless noted (throughout).

R1—4300 ohms
R2—22,000 ohms
R3, R6—820 ohms
R4—3300 ohms
R5—180 ohms
R7—2 megohms
R8—1 megohm
R9, R14—10,000 ohms
R10—100 ohms
R11—68,000 ohms
R12—2200 ohms
R15—1000 ohms
R16—220 ohms

Capacitors
C1—220 pF, mica
C2—0.1 μF, 10V, ceramic
C3—10 pF, ceramic
C4, C6—500 μF, 15V electrolytic (Mallory MTV 500 DN15)
C5—25 μF, 35V electrolytic (Mallory MTV 25CB35)
C7—5 μF, 50V electrolytic (Mallory MTV 5CB50)
C8—1000 μF, 3V electrolytic (Mallory MTV 1000 DN3)

Semiconductors
Q1—40235 transistor (RCA)
Q2, Q3—2N3391A transistor
Q4—2N3860 transistor
D1—10V, 1W, 5% Zener diode

Other parts
L2—2T No. 18, 1/2"-dia. 1/2"-long coil
Antenna—1/2" aluminum rod, 12" long, tap & thread one end 10-32
1—Feedthrough insulator (E F Johnson 135-45)
*TC1 circuit board, $2.25; *TC-1K, complete kit except for antenna, $11.55

back path for the lamp driver so that LM1 remains lit once energized. Grounding point RL will extinguish LM1 until another signal is applied.

However, when the system gain is at its highest, as determined by the setting of R21, any disturbances would soon cause all lamps to light. In a multiple-sensor system the alarm might sound and indicate security violations at all points. This is a very remote possibility.

Therefore all RL points are periodically connected to ground for about 0.2 sec every 4 sec. This reset (RE) signal is furnished by the RE board (Fig. 3). Unijunction transistor Q28 pulses the astable multivibrator formed by Q29 and Q30. Capacitor C24 and R99 determine the output pulse length of the astable multivibrator. Transistor Q31 saturates during this pulse length and, through the D21 diodes, connects each RL point to ground (see Fig. 4)

If the alarm trip point is reached, however, a positive voltage from the alarm circuit will be applied to point C. This will cause Q27 to saturate, thus discharging C23 and preventing any further lamp resets. When the alarm triggers, the lit lamp shows where the intrusion is taking place.

The signal appearing at point RY on the AR board is fed to delay and timing board (Fig. 5). The DE board provides the required system time delays. The alarm signal, now a pulse of battery voltage, is applied through D13 and R51 to charge C17. A variable discharge rate on C17 is set by R53. The only load on C17, other than R52 and R53, is the reverse-biased gate of FET Q15. Current will flow in the drain circuit of Q15 only when the charge on C17 is greater than the gate–source voltage set by R58.

When Q16 is turned on by the drain current of Q15, then D10 and R54 apply the collector voltage of Q16 to further charge C17. This circuit is now latched up and, because of saturation of Q16, the full battery voltage appears at point C. This point C is the same as point C on the RE board, and now prevents the lamp-reset circuit from operating. Even though a valid alarm has been generated, it is *usually* not desirable to immediately operate the relay to activate an external siren, buzzer, etc.

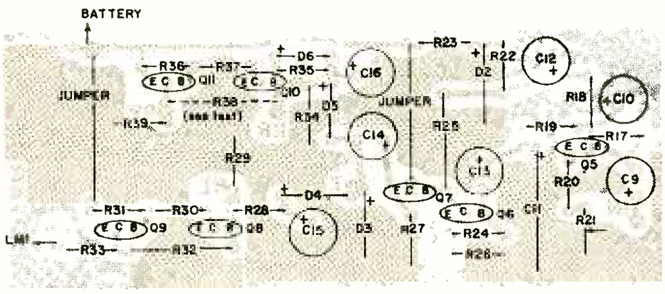
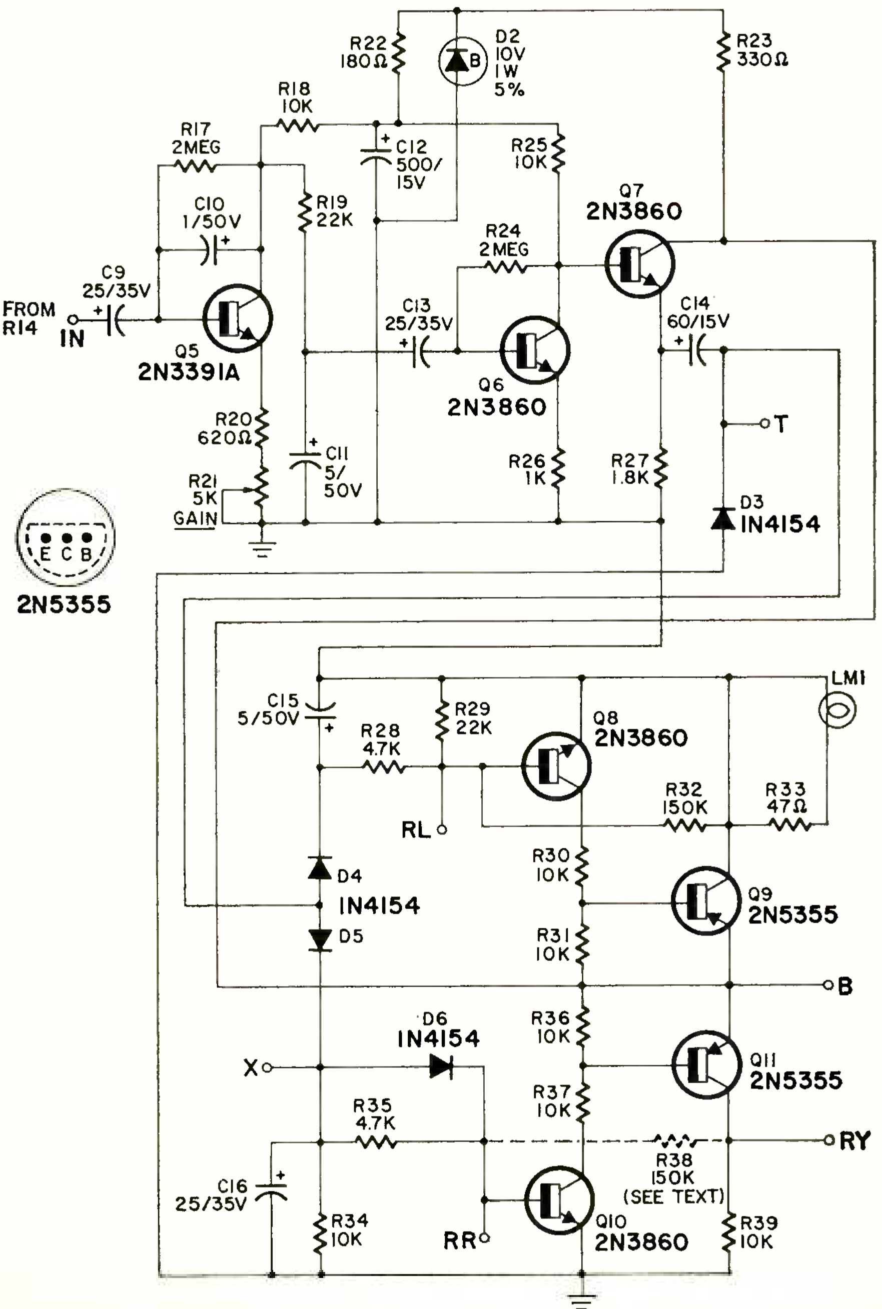


Fig. 2-a—Alarm receiver circuit. One of these circuits is needed for each transceptor head.

Fig. 2-b—Parts layout on the alarm receiver board. Full size foil pattern will be shown in July.



PARTS LIST

AR Alarm Receiver

R17, R24—2 megohms
R18, R25, R30, R31, R34, R36, R37, R39, R106 (1 per channel)—10,000 ohms
R19, R29, R34—22,000 ohms
R20—620 ohms
R21—¼W, 5000-ohm trimmer (CTS type X201R502B)
R22—180 ohms
R23—330 ohms
R26—1000 ohms
R27—1800 ohms
R28, R35—4700 ohms
R32, R38—150,000 ohms
R33—47 ohms
C9, C13, C16—25 μF, 35V electrolytic (Mallory MTV 25CB35)
C10—1 μF, 50V electrolytic (Mallory MTV 1CB50)
C11—5 μF, 50V electrolytic (Mallory MTV 5CB50)
C12—500 μF, 15V electrolytic (Mallory MTV 500DN15)
C14—60 μF, 15V electrolytic (Mallory MTV 60CB15)
C15—5 μF, 50V electrolytic (Mallory MTA 5D50)
Q5—2N3391A transistor
Q6, Q7, Q8, Q10—2N3860 transistor
Q9, Q11—2N5355 transistor
D2—10V, 1W, 5% Zener diode
D3, D4, D5, D6, D22 (1 per channel)—1N4154 diode
D21—1N270 diode, 2 per channel
LM1—12–14V, 25–40 mA pilot light
*AR circuit board, $2.75; *AR-K, complete kit, $13.75; *AR-L, complete, less relay driver parts, $11.65 (includes D_R, D_T, and R_T)

If the circuit immediately triggered the alarm, how could you enter your property without becoming a public nuisance? Therefore, the alarm signal now starts to charge C18 through R60. Source voltage Q17 is again varied by adjusting R64 to set the time delay before Q18 latches up Q17 and turns on the alarm through Q19. This delay can be set from about 4 to 90 seconds by R64.

Thus, when you return home you have time to unlock doors, enter, and disable the alarm without arousing the community. So far, so good. You can get back in, but how do you get out without setting off the alarm? Obviously, a means to disable the system *temporarily* is needed.

Note that Q20 is kept on by bias current supplied through R69; thus Q20 is saturated and its collector voltage is very near ground potential. Capacitor C19 will momentarily turn off Q20 when the exit switch is closed, discharging C19 and providing reverse bias to Q20.

Thus a single positive pulse will appear at the collector of Q20. Once C19 discharges, Q20 again turns on. This pulse, about 0.5 sec in duration, turns on Q21 and in turn Q22. Positive feedback via R71 latches up the combination. While it is latched up, the gate on silicon controlled rectifier SCR1 is triggered.

SCR1 now completely discharges C17 through D9 and prevents any alarm activation. At the same time C21 is being charged through R78. Resistor R82 sets the gate–source voltage at which Q23 will have enough drain current flow to turn on Q24. When Q24 is turned on, its collector furnishes positive feedback to R83 and also turns on astable multivibrator Q25–Q26.

Transistor Q26 will furnish a positive output pulse of about 0.5 sec to the gate of SCR2, which pulls the junction of R75 and R76 to ground. This turns off gate drive to SCR1 and again allows alarm signals to charge C17.

Conduction by SCR2 discharges C21 through D15 until the current falls below the holding current of SCR2; then SCR2 turns off since gate drive has already been removed. Any remaining charge on C21 is dissipated to ground through R78, R76 and R77. The exit time delay may be set from about 4 to over 90 sec.

After an alarm is received it can be neutralized by momentarily grounding point RA by a switch contact.

The final circuit board will probably not be needed in most residential installations, but is highly desirable in a business system.

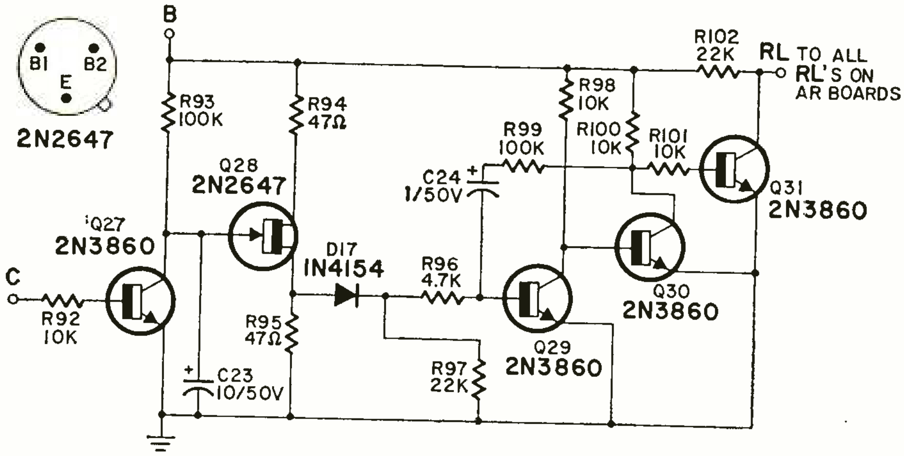
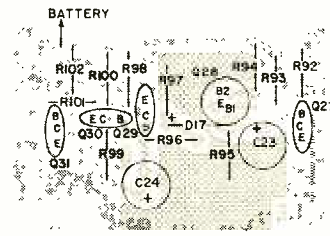


Fig. 3—Lamp reset circuit is shown above. Parts placement on reset board below. Full size foil pattern will be presented next month.

PARTS LIST

RE Lamp Reset

R92, R98, R100, R101—10,000 ohms
R93, R99—100,000 ohms
R94, R95—47 ohms
R96—4700 ohms
R97, R102—22,000 ohms
C23—10 μF, 50V electrolytic (Mallory MTV 10CB50)
C24—1 μF, 50V electrolytic (Mallory MTV 1CB50)
Q27, Q29, Q30, Q31—2N3860 transistor
Q28—2N2647 unijunction transistor (GE)
D17—1N4154 diode
*RE circuit board, $1.40; *RE complete kit, $4.85



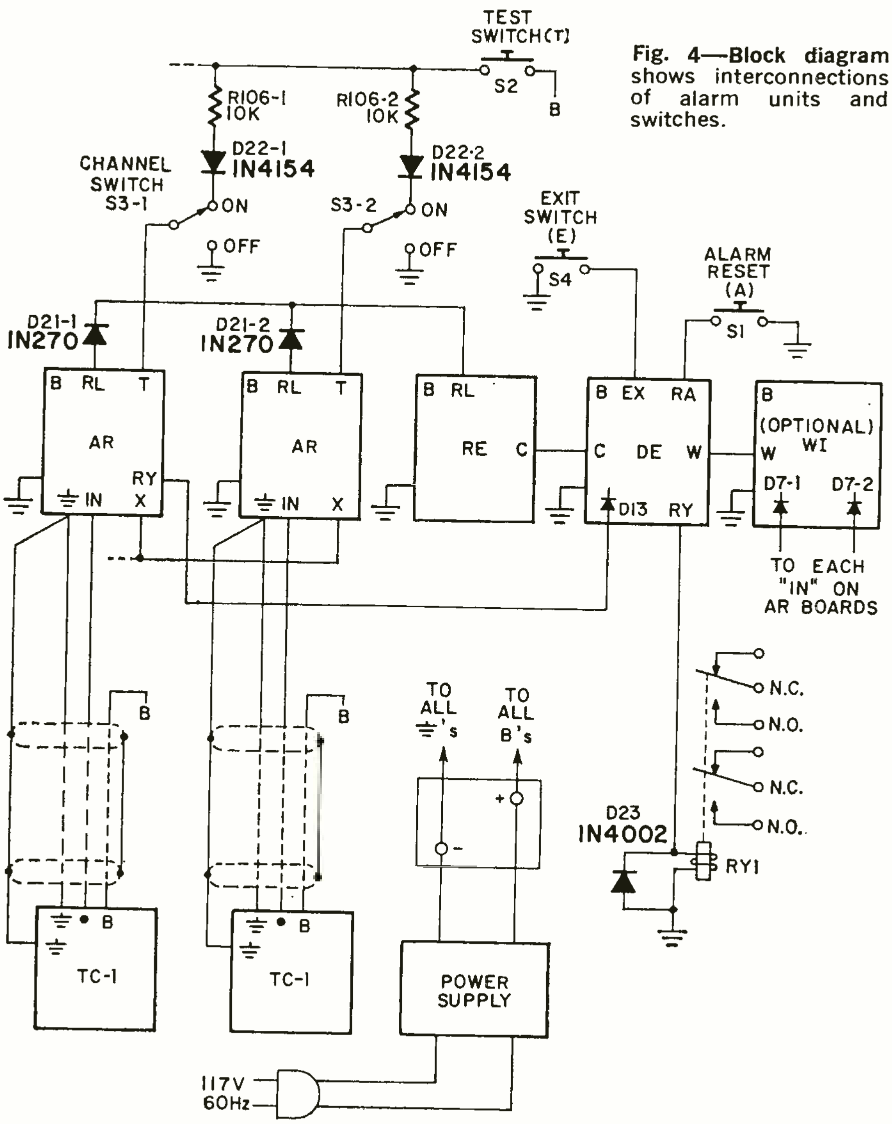
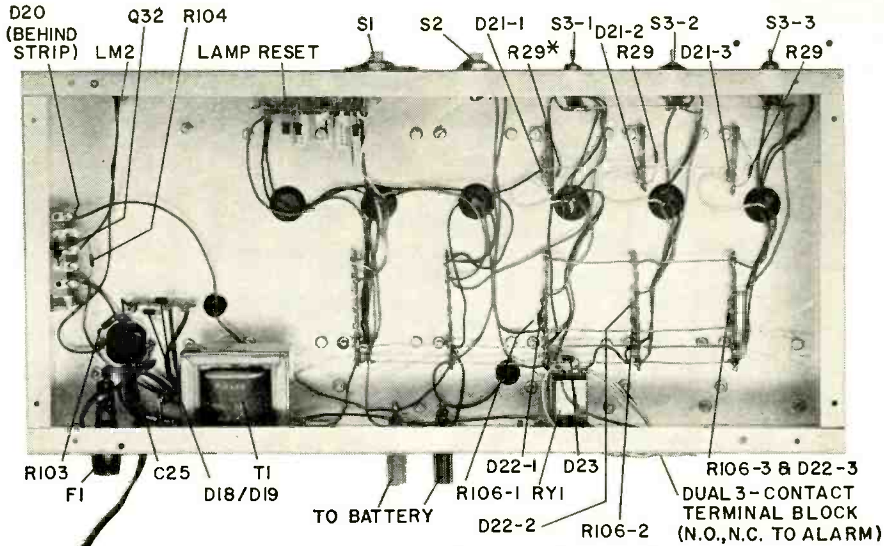


Fig. 4—Block diagram shows interconnections of alarm units and switches.

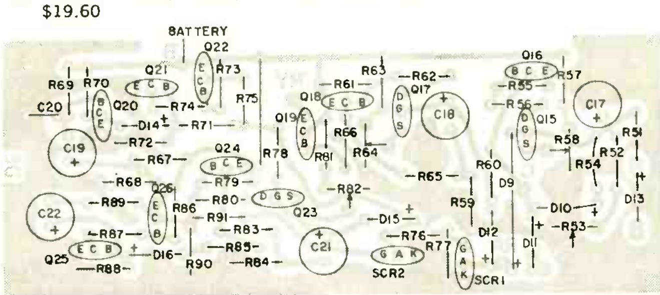
PARTS LIST
DE Delays and Timing

R51, R52—220,000 ohms
R53—1/4 W, 1-megohm trimmer (CTS type X201R105B)
R54, R68, R71, R89—100,000 ohms
R55, R56, R61, R62, R65, R73, R74, R75, R76, R77, R79, R80, R83, R85, R86, R87, R90, R91—10,000 ohms
R57, R63, R70, R81—4700 ohms
R58, R64, R82—1/4 W, 10,000-ohm trimmer (CTS type X201R103B)
R59, R84—330 ohms
R60, R78—150,000 ohms
R66—2200 ohms
R67, R69—470,000 ohms
R72, R88—22,000 ohms
C17—10 μF, 50V electrolytic (Mallory MTV-10CB50)
C18, C21—500 μF, 6V electrolytic (Mallory MTV500DJ6)
C19, C22—1 μF, 50V electrolytic (Mallory MTV1CB50)
C20—.05 μF, ceramic
Q15, Q17, Q23—2N3819 n-channel FET transistor (TI)
Q16, Q18, Q22, Q24, Q26—2N5355 transistor
Q19, Q20, Q21, Q25—2N3860 transistor
D9, D10, D11, D12, D13, D14, D15, D16—1N4154 diode
SCR1, SCR2—C106Y1 silicon controlled rectifier (GE)
*DE circuit board, $3.80; *DE complete kit, $19.60



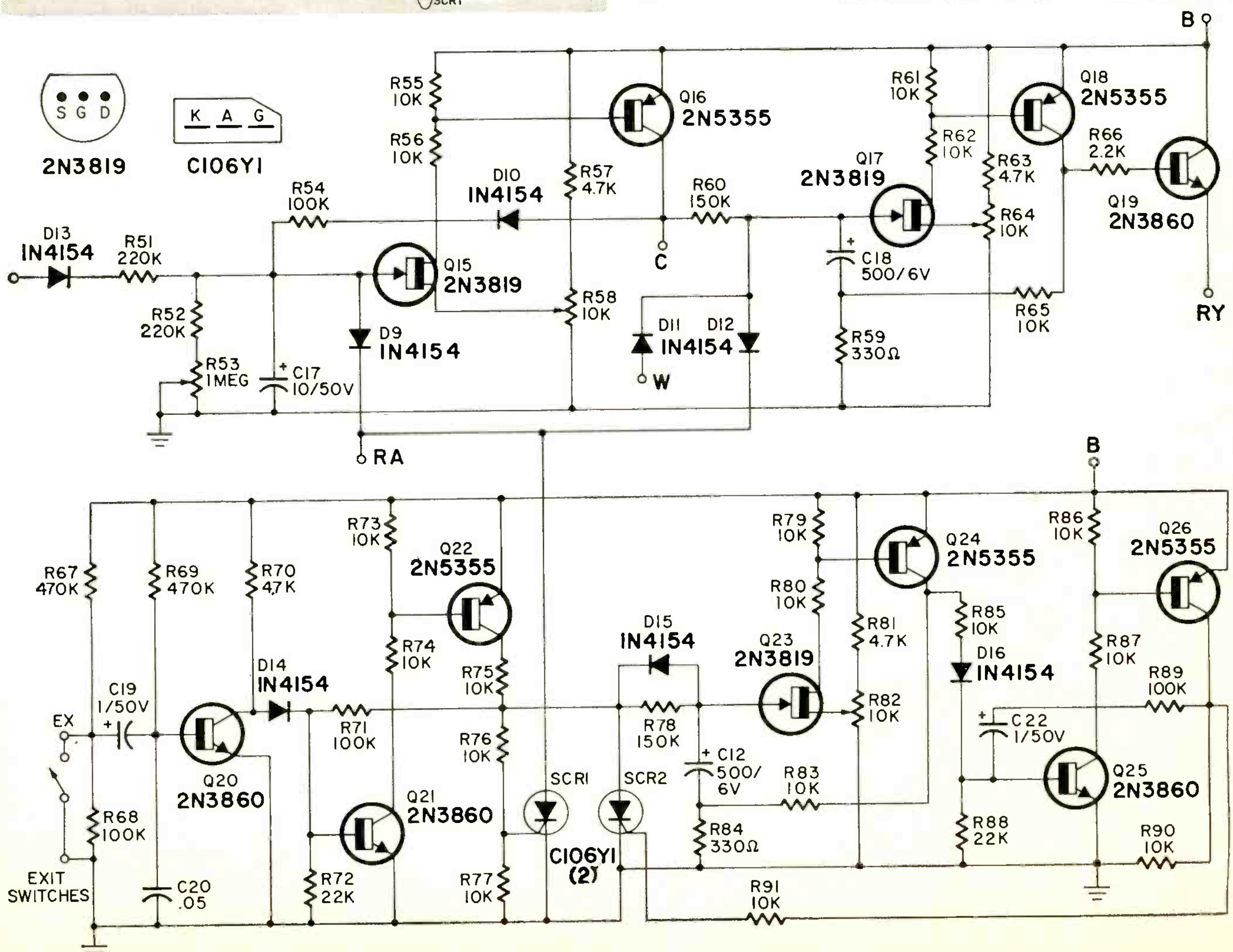
*PROTOTYPE ONLY, INSTALL ON ALARM RECEIVER BOARD AS SHOWN IN PC DRAWINGS.
• NOT SHOWN IN FIG.4

Asterisked items are available from: TRANSI-TEK, P. O. Box 98205, Des Moines, Wash. 98016. Items are sent postpaid. Washington state residents include 4.5% tax.



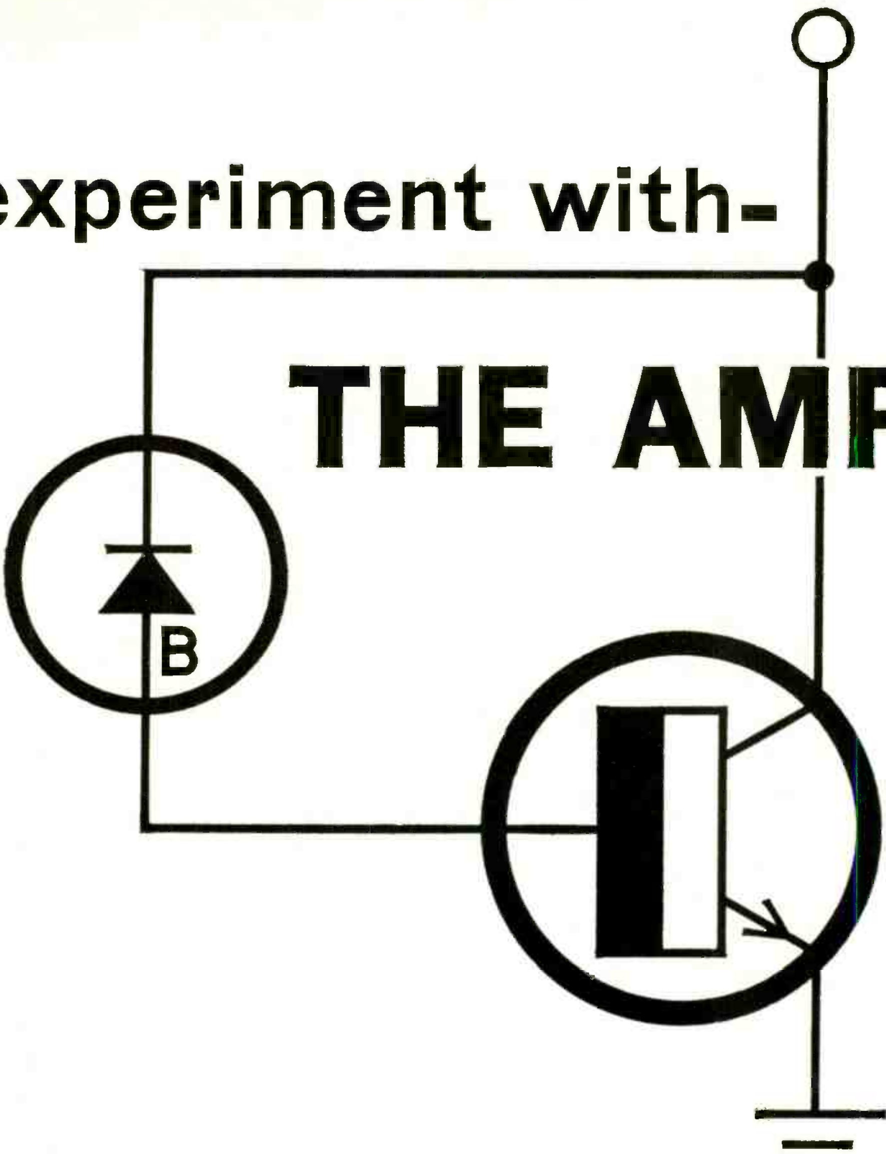
Under-chassis view of main alarm section is shown in photo above. Parts layout for the delay board is to the left. Fig. 5 below is the circuit for the delay and timing section.

NEXT MONTH
The remaining (optional) section of the alarm and the power supply will be presented next month. Actual-size PC patterns, construction details and test-adjustment procedures will also be shown.



experiment with–

THE AMPLIFIED ZENER



by JIM ASHE

A simple transistor circuit lets you use low-power Zeners for high-wattage applications

REACH FOR A LITTLE ZENER THE next time you need a big one, but pull out a silicon power transistor, too. This pair will replace the larger Zener at reduced cost, if used as described.

You pay no performance penalty. In fact, if you add a few inexpensive components you come out ahead. An improved "amplified Zener" can be reliably free of Zener noise. And, unlike the simpler single-Zener circuit, it can be adjusted very near whatever regulating voltage you need. If necessary, this circuit can be used to make up the equivalents of 50- or 100-watt Zeners.

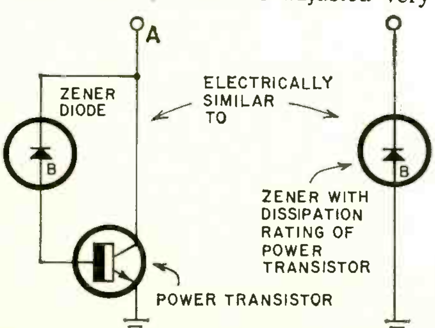


Fig. 1—Ready-to-use amplified Zener circuit has good regulating ability.

How it works

One simple view of the amplified Zener has it as a Zener diode reinforced by a transistor amplifier which works according to the Zener's dictates (see Fig. 1). In another perspective, we can view the Zener as fixing the voltage from A to ground, with the transistor passing whatever current is required to hold that voltage. A key point is that the voltage from A to ground will always be the Zener breakdown voltage plus the base-emitter voltage of the transistor. And since about the same voltage appears across the transistor as across the Zener, the transistor will dissipate more power than the Zener if it carries a larger current.

This gives us an insight into how the circuit works. A transistor's dc beta is its current amplification factor. If the transistor has a beta of 50, its collector current will be 50 times its base current. In this circuit it should dissipate 50 times as much power as the Zener. We can observe this in the simple bench test setup of Fig. 2.

The Zener used is a good-quality ¼-watt variety, of unknown ancestry. It controls a General Electric D27C plastic silicon power transistor. The D27C, rated at 8 watts when well

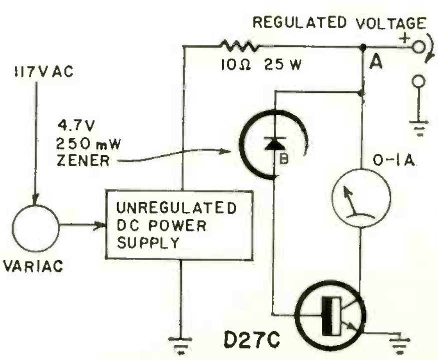


Fig. 2—Test setup to check amplified Zener. D27C beta fixes part of current.

heat-sinked, was chosen as a good example of modern transistor design. Its particular virtue is a very weak beta/collector current dependence. This very important point reappears later. Zener current is adjusted by varying voltage applied through a fixed series resistance, but a fixed voltage and variable resistance works as well if no Variac is available.

Initially, applied voltage is below the Zener breakdown value. Transistor collector current is only that due to leakage, which is very small indeed in the D27C. Looking into point A, the circuit resembles any good Zener looking back at less than its breakdown voltage.

At a higher voltage the Zener begins to conduct, but carries very little current. This small current, flowing into the D27C base, invokes a much larger collector current, which also flows down through point A. At this and higher currents, the circuit acts like a Zener diode because any small voltage change results in a large current change. The transistor does the work, with the Zener setting the voltage scale. Results of this test are summarized in Fig. 3.

At the end of the test, the transistor was dissipating about 5 watts, but the Zener only 75 mW. Since its spec is 250 mW the Zener runs very cool, and a smaller one could have been used here. Or we might have chosen a larger transistor. The components used here were picked mainly because they were on hand for the test.

Working with amplified Zeners

To design an amplified Zener circuit, we work out the extremes. The intermediate conditions shift for themselves. Maximum dissipation occurs at high power line voltage coupled with least circuit demand. Some transistors show a drop in beta under heavy load, which increases Zener dissipation. The D27C beta curve of Fig. 3 is included to illustrate an actual transistor beta dependence.

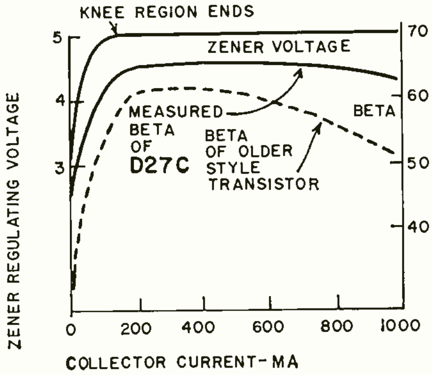


Fig. 3—Amplified Zener performance. Flatness above knee indicates low dynamic resistance. Middle curve, against 0–70 beta scale, shows transistor beta measured at same collector currents in a transistor tester. Dotted line indicates beta with strong current dependence.

The opposite extreme occurs at maximum circuit demand coupled with low line voltage. Under these conditions the Zener must not go into its knee region, and again the transistor beta dependence upon current gets a close look. If this starvation condition allows the Zener to drift into its knee region, regulation will be poor with increased hum and noise. Since supply resistance will rise, a high-gain audio circuit may go into oscillation.

Trouble is avoided in most practical circuits simply by choosing a Zener with a sharp, low-current knee, and using a modern silicon power transistor whose beta current dependence is weak. Its power rating should not be very much greater than required for the circuit.

Sometimes an amplified Zener circuit will be very noisy for no clear reason. A tendency to self-generated noise is why most Zener regulators are shunted with a large capacitor. The noise is more nuisance than defect, and is controlled by adding a capacitor as shown in Fig. 4. At today's

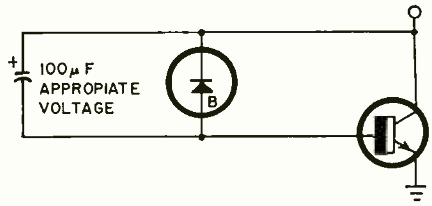


Fig. 4—Zener noise is eliminated by capacitor across the amplified Zener.

capacitor sizes and prices a 100-μF capacitor seems appropriate.

This capacitor has another effect. Its influence, like the Zener's, is amplified by the transistor. The working circuit will act as if it has a much larger capacitor in it.

Now we come to the strongest argument favoring the amplified Zener. Its regulating voltage can be adjusted. As shown in Fig. 5, one or

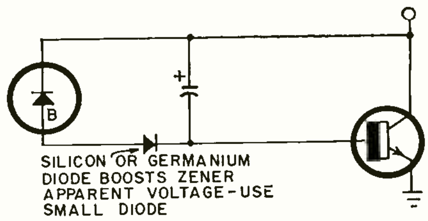


Fig. 5—Series diode in circuit can increase apparent Zener voltage in steps.

two diodes can be added in series with the Zener to increase its apparent voltage. A germanium diode adds about 0.2 volt, a silicon diode about 0.7 volt. The diode carries the same current as the Zener, but it points along the direction of the current while the Zener points upstream. Because the current is small, a germanium point-contact diode works. **R-E**

CORRESPONDENCE

(continued from page 22)

Image rejection

Tune the receiver to a quiet spot near 100 MHz. Using a frequency counter, set the generator to 121.4 MHz. With the generator output unmodulated, increase the generator output until the ratio detector noise output voltage drops 10 dB. Record this output voltage. Correct for the 300-ohm pad attenuation.

Half i.f. response

Connect the generator through a 300-ohm pad to the receiver input terminals. Tune the receiver to a quiet spot near 100 MHz. Tune the generator exactly 5.35 MHz higher in frequency. Increase the generator output until the ratio detector output voltage is 10 dB less than with the generator attenuator set to zero. Correct for the 300-ohm pad attenuation and record this output voltage.

Alternate channel selectivity

Tune the receiver to a quiet spot near 100 MHz. Connect two generators through a 300-ohm hybrid mixer to the receiver input terminals. Set generator No. 1 exactly on frequency, with a CW output and with an input to the receiver of 10 μV. Set generator No. 2 for 75-kHz deviation with a 400-Hz modulating signal on a frequency 200 kHz higher than generator No. 1. Increase the output of generator No. 2 until the ratio detector output increases 1 dB. Correct the output reading of generator No. 2 for the attenuation of the 300-ohm pad and record this voltage. Repeat with generator No. 2 exactly 200 kHz lower than generator No. 1.

(This is not a standard measurement, although it shows good correlation with overall receiver operation.)

Overload sensitivity

Connect the generator to the receiver through a 300-ohm pad. Set the generator for 75-kHz deviation of a 400-Hz modulating signal. Tune the generator to the receiver frequency and increase the generator output until a distortion analyzer connected at the ratio detector output shows 1% distortion. Correct the generator output reading for the pad attenuation and record voltage.

In almost all cases it is necessary to make these measurements in a screen room with at least 60 dB plane-wave attenuation between 50 MHz and 300 MHz. A filtered power line is mandatory. Instrument calibration must be accurate, especially where two generators are used.

The multiplex measurements are standard.

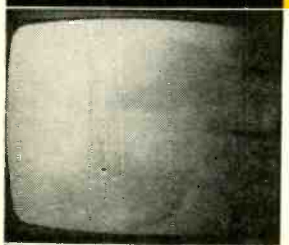
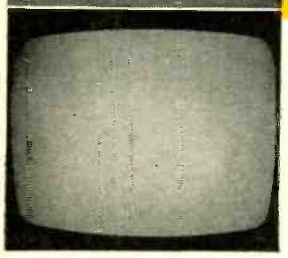
KENNETH E. BUEGEL
Kent, Wash.

Hybrid Y section in color receiver—tube/transistor/tube

NEW R-E EXCLUSIVE

Kwik-Fix™ picture and waveform charts

by Forest H. Belt & Associates*

SCREEN SYMPTOMS AS GUIDES		WHERE TO CHECK FIRST		
SYMPTOM PIC	**DESCRIPTION**	**VOLTAGE**	**WAVEFORM**	**PART**
	Pic smeared and flecked. Brightness low.	V2-grid-pin-2	WF5 shows blanking only	R3 L1
	Severe streaking. Lower left of pic blanked out.	Q1 base	WF5	R4 L2
	Raster dark. Controls don't work. Heavy retrace lines.	Not much help	WF5 shows weak video, no blanking	R6
	High brightness, no pic. Smearing. Jitter.	Q1 collector	WF5	C3
	Pic very dark. Brightness control has no effect.	Q1 collector V2-grid-pin-2	Not much help	R7
	No pic. Raster dim. Brightness control has no effect.	V2-grid-pin-2	Not much help	R9

NOTES:

Use this guide to help you find which key voltage or waveform to check first.
Study the screen and the actions of the three controls.
Most helpful clues to the fault are found at the key test points indicated in voltage or waveform column.

Make the voltage or waveform checks indicated for symptoms you see on the screen.
Use the Voltage Guide *or* Waveform Guide *to analyze results.*
For a quick check, test or substitute the parts listed as the most likely cause of the symptoms.

THE STAGES

THIS Y (VIDEO) SECTION IS SIMILAR TO THESE IN SEVERAL HYBRID Color Receivers. The Y section amplifies (and delays) the brightness component of the color signal. Chassis with this arrangement split the Y signal from the chroma, amplify each separately and matrix them back together in the color picture tube.

The cathode-follower triode matches the impedance of the video detector circuits (not shown) to the delay line. There is no voltage gain in this stage.

The transistor is a common-emitter amplifier, with a gain or two or three. Horizontal and vertical blanking pulses are applied through R6, but the grating diodes that feed the pulses in are not shown. The diodes are also dc ground return for the Q1 emitter.

In versions that don't have the triode tube, the transistor is the splitup point for video and chroma. Color signals in some are taken off at the emitter, and video signals at the collector. In those chassis, blanking is usually added somewhere in the stages that handle color.

The output tube, V2, is a high-gain pentode. Its cathode and plate circuits have peaking components to enhance video response, even though a peaking network is also included in the triode stage. The contrast control is the ordinary cathode pot-and-capacitor type used in most b-w and color sets.

The brightness control is part of the output-tube grid circuit. Because coupling is dc throughout this section, altering the average dc voltages anywhere changes the picture tube brightness. Potentiometer R10 varies bias on the tube grid, and thus plate current in V2. Consequently, it controls average cathode bias on the color picture tube. That sets the beam current and hence the brightness of the raster.

This dc coupling is important to remember. A change in dc at any point in the stages affects screen brightness. When you do find dc voltages wrong, you have to track down the source of the trouble; it may not be exactly where you first notice the incorrect voltage.

SIGNAL BEHAVIOR

Video signal comes from the video detector through a 4.5-MHz trap (not included here). It is fed to the grid of V1. There is no amplification in V1.

Video is peaked by C1 and R2 in the cathode circuit of V1. The signals are differentiated slightly to sharpen the edges. This makes picture images crisper. R2 is adjustable for the viewer's taste.

Delay Line L1 slows down the Y signal by about 1 μsec. Otherwise, the Y signal would get to the picture tube ahead of the demodulated color information. The color would be offset from the video picture by a fraction of an inch. L2 and L4 are a matched load for the delay line.

Both horizontal and vertical blanking are applied to the emitter of Q1 by R6. R5 and C2 shape the horizontal pulses. (Some designs have only vertical blanking fed into the Y section.) These positive-going pulses bias the transistor completely off for their duration. That makes high-amplitude, negative-going pulses in the collector. The output stage inverts them again. They go to the CRT cathodes as high positive pulses, and cut off the CRT beams during vertical and horizontal retrace. You can see the pulses in waveforms that follow the transistor. (You see only horizontal pulses, because all the waveforms in this *Kwik-Fix*™ are at horizontal rates.)

Output load for Q1 is R7. Capacitor C3 couples the Y signal to the grid of V2. Resistor R9 maintains dc coupling. The grid load is R11 and a portion of R10; they have another function: biasing the grid.

A degenerative type of contrast control is used. Its slider inserts more or less of the bypass action of C4 across the cathode resistor. The greatest shunting action is with the R12 slider at the top—toward the cathode. That's the least degenerative position; contrast is highest.

The screen grid of V2 is decoupled completely by electrolytic capacitor C5. There should be almost no signal at V2's screen (pin 8) in case you scope that point.

The output load for V2 isn't shown in the diagram. It is a trio of drive controls that feed preset amounts of the Y signal to the CRT cathodes. Peaking networks like L4–R15 are used liberally in the output circuit, but only one is shown here.

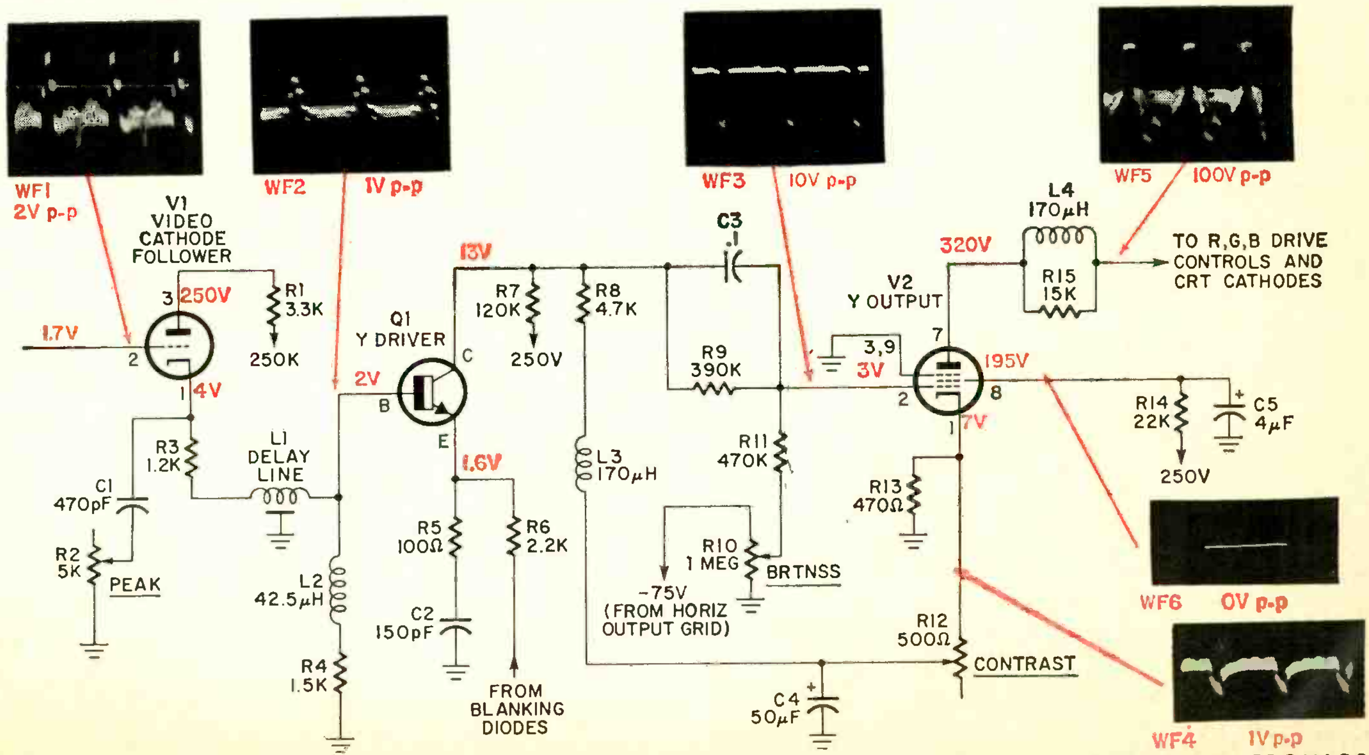
DC VOLTAGE DISTRIBUTION

Plate voltage comes to V1 through 3.3K resistor R1. The cathode return path is through R3, delay line L1, and delay-line load L2–R4.

There is a dc path from the cathode of V1 to the base of Q1. Therefore, base bias on Q1 depends on cathode voltage at V1. The delay-line load network is also the dc return for the transistor base. Emitter dc return is through R6 and the unseen blanking diodes.

Voltage for the collector of Q1 is lowered considerably across 120K resistor R7. The 250-volt supply is too much for the transistor. But the high value of R7 has another advantage: it develops an output waveform with rather high amplitude.

Plate voltage for V2 comes through the drive controls you can't see. Screen voltage is supplied through R14 from the 250-volt source. (text continued on page 47)



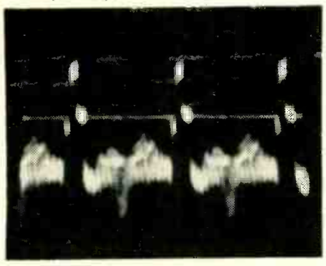
DC VOLTAGES AS GUIDES

Voltage change	to zero	very low	low	slightly low	slightly high	high
V1 cathode, pin-1 **Normal 4 V** Develops across R3, L1, L2, R4. Varies with white content of picture.				R3 low, shorted R4 low, open L2 open	R4 high	R3 open L1 open
V1 plate, pin 3 **Normal 250 V** Applied through R1 from 250 V.	R1 open					
Q1 base **Normal 2 V** Comes from R4–L2 portion of V1 cathode voltage.	R3 open R4 shorted L1 open		R3 high R4 low	R3 low R7 open	R3 shorted Q1 faulty	R4 open R4 high L2 open
Q1-emitter **Normal 1.6 V** Develops across R6 (blanking diodes are ground).	R3 open R4 shorted LI open		R3 high R4 low		R7 open	R3 shorted R4 open R4 high L2 open
Q1 collector **Normal 13 V** Developed by divider R7–R8–L3–R13.		R4 open R7 open, high R13 shorted L2 open	R4 high	R3 low, shorted L4 open	R3 open, high R10 open L1 open	R4 low, shorted R8 open* R13 open, high L3 open*
V2 cathode, pin-1 **Normal 7 V** Develops mainly across R13; can be affected by voltage from L3–R8–Q1.	R7 open R13 short	R7 open R14 open	R4 open L2 open L4 open	R3 low R7 high R11 low	R3 open, high R4 high L1 open	R4 shorted, low R7 low R8, R10, R11 open R13 open, high C3 shorted L3 open
V2 grid, pin-2 **Normal 3 V** Developed mainly by R10–R11 from horizontal output grid. Value determined by setting of R10 and by Q1 voltage through R4.	R7 open	R7 open R13 shorted	R3 low R4 open R7 high R11 low R14 open L2 open	R3 open L1 open	R3 high R4 high	R4 low, shorted R7 low R8, R10, R11 open R13 open, high C3 shorted L3 open
V2 plate, pin-7 **Normal 320 V** Supplied through drive controls (not shown). Varies widely with R10 setting, slightly with station signal, none with video whites.		R8 open C3 shorted L3 open L4 open	R4 shorted R10 open R11 open	R3 open, high R4 low L1 open	R7 open R11 low	R13 open, high R14 open
V2 screen, pin-8 **Normal 195 V** Comes from 250-volt line through R14.	R14 open	R8 open C3 shorted L3 open L4 open	R4 low, shorted R11 open	R3 open, high R10 open L1 open	R7 open R11 low	R13 open, high

NOTES:

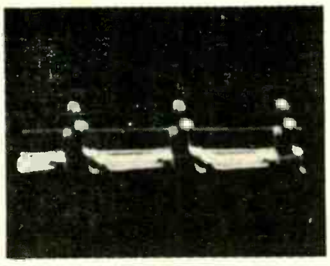
Use this guide to help you pinpoint the faulty part.
Clamp the agc line if symptoms are affecting agc.
Measure the nine key voltages with a vtvm.
For each, move across to the column that describes the change you find.
Finally, notice which parts are repeated in whatever combination of voltage changes you find.
Test those parts individually for the fault described.
Look for additional clues in the Waveform Guide.
**May ruin transistor.*

WAVEFORMS AS GUIDES



WF1 Normal 2V p–p

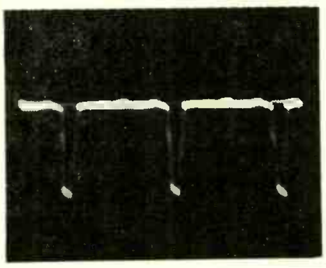
Shown for reference only. Taken at V1's grid (pin-2). This is the waveform from the video detector. It comes from the detector diode, through a 4.5-MHz trap and several peaking circuits. You can see the burst during color programs, riding the back porch of the horizontal sync pulse. Burst is later eliminated.



WF2 Normal 1V p–p

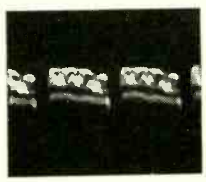
Video waveform after passing through the cathode follower and delay line. Taken easiest at the base of Q1. Burst has in most cases been swamped out by peaking network C1–R2. There's no significant change in shape from WF1 (the lesser video shown here is caused by a different picture from the station). Polarity is the same, but overall p–p voltage is slightly lower.

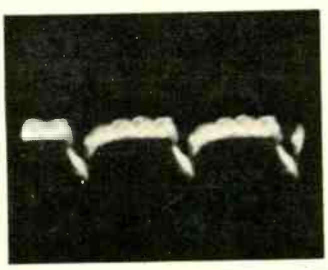
V p-p low	V p-p high	V p-p zero			
R1 open		R3 open L1 open C1 shorted			



WF3 Normal 10V p–p

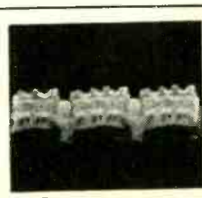
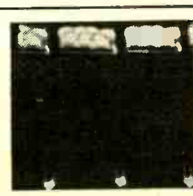
Taken at V2's grid (pin-2). Blanking pulses dominate the video. The waveform shown happens to be taken during a "fade to black" at the station; the scene doesn't contain much video white. This signal is coupled to the output stage by C3 after inversion and amplification in Q1. The high amplitude is blanking, not video. Faults affect amplitude more than shape, so no changed waveforms are shown below.

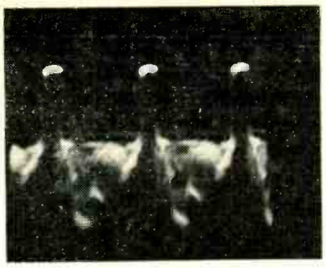
V p-p low	V p-p high	V p-p zero			
C3 open R6 open C2 shorted Q1 faulty	C2 open R5 open	R3 open R7 open Q1 faulty	 2 V p–p Scope turned up to show video		



WF4 Normal 1V p–p

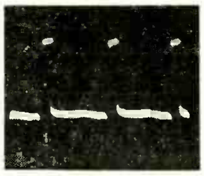
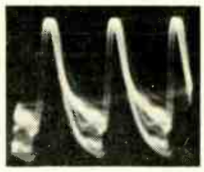
This is the cathode waveform of V2. Amplitude is variable from zero to maximum (about 4V p–p) with the contrast control. Again, shape doesn't change much with defects—only amplitude does. Waveforms up to this point aren't very indicative of faults. Waveforms below show effects of varying the contrast control.

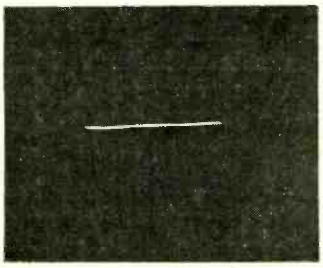
V p-p low	V p-p high	V p-p zero			
			 Contrast max. 0.2 V p–p	 Contrast min. 4 V p–p	



WF5 Normal 100V p–p

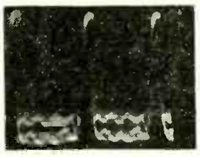
Output waveform of V2. This is the signal fed to the drive controls and then to the CRT cathodes. Polarity is reversed again by amplification in V2. The relationship between blanking amplitude and video level is closer; video got the most amplification. This waveform is excellent for clues to troubles; it may be the only one you'll worry much about. Positive-going blanking drives the CRT into cutoff during retrace intervals. Video is applied almost equally to the CRT cathodes.

V p-p low	V p-p high	V p-p zero			
C3 open R14 high		Q1 faulty R7 open C5 shorted R14 open	 75 V p–p R3 open	 50 V p–p R4 open L2 open	 75 V p–p C3 open



WF6 Normal 0V p–p

Shown for reference, this is a zero waveform when everything is normal. However, it is included so you can see what happens when the screen bypass capacitor opens up (photo below).

V p-p low	V p-p high	V p-p zero			
			 100 V p–p C5 open		

NOTES:

Use this guide and the Voltages Guide *to help you pin down fault possibilities.*

Clamp the agc line if picture symptoms appear to be affecting agc.

With the low-capacitance probe of the scope, check the waveforms at the points shown. (Only a couple of them give trouble clues worth following up.) The scope sweep should be set at H or aoout 5 kHz, to show three cycles of the waveform.

Note amplitude. If it's missing, low, or high, check the parts indicated under those columns.

Note waveshape. If there's a change from normal, despite amplitude, check the parts indicated.

Cathode voltage is developed mainly across R13. However, a dc connection through L3–R8 and contrast-control R12 lets Q1's collector voltage and V2's cathode voltage interact slightly. Part of the effect is to keep brightness and contrast adjustments from throwing each other off.

Grid bias for V2 is applied through R11. It comes from potentiometer R10, which is a divider across the negative bias source. The –75 volts is taken from the horizontal output grid. (If you reason out this relationship, you'll find it helps keep high-brightness scenes from causing high-voltage blooming.) For main control of brightness, the control sets bias on V2, controlling plate current and thus plate voltage. That dc voltage, applied to the crt cathodes, affects CRT beam current and thus raster brightness.

QUICK TROUBLESHOOTING

First, if the agc appears affected, clamp it. That way, the i.f. stages will let video through. You can then trace the trouble to its true source.

For video symptoms, the scope is your best helper. A missing, weak or compressed video waveform is a sure clue to the fault. The input to this section, from the video detector, must be a clean video waveform at least 1 volt p–p.

You'll find gain from input to output of the triode tube. The transistor imparts a small voltage gain. The pentode should put out a strong video signal—at least 100 volts p–p. Blanking pulses should appear much higher than that.

Also scope across power-supply filters (not shown) and the screen bypass capacitor. There should be no video across them.

If there is no raster, check high voltage first. If it's okay, the CRT is probably biased off. That means *too much* positive voltage at the CRT cathodes. An uncontrollably bright raster means there *isn't enough* positive voltage on the CRT cathodes.

Make voltage measurements with your voltmeter in the brightness circuits—the grid of V2. Also check the cathode dc voltage. If V2 is cut off, or conduction seriously reduced, high plate voltage is passed on to the cathodes as cutoff bias. Don't forget the V2 screen circuit when you're measuring.

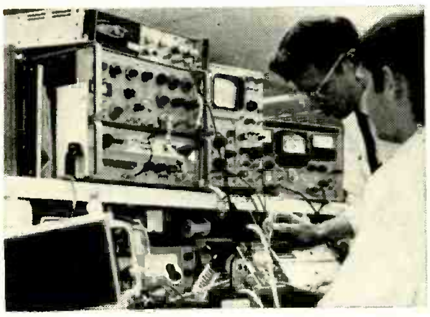
There's another dc troubleshooting method. Try voltage-clamping. Apply the correct voltage to the cathode of V2. If that restores normal brightness (including normal control action), the fault is in the cathode circuit.

Next clamp V2's grid voltage at its labeled value. If the right voltage there doesn't correct brightness on the CRT screen, check the tube and its plate and screen circuits. Varying the clamp voltage should have the same effect as turning the BRIGHTNESS knob.

Clamp the emitter and then the base of Q1. Troubles in this stage and in V1 can affect brightness, but cannot blank it completely or keep brightness control from varying it. **R-E**

Like the transponder, DME also functions on uhf signals. In operation, DME transmits a pair of pulses to a ground station which fires back pulses in response. Since radio waves travel at a known velocity, the time for the pulses to travel back and forth is easily computed as distance, or miles, from the station. The intriguing aspect of DME is that dozens of aircraft may interrogate one ground station simultaneously. How does one aircraft know it's getting *its* pulse responses—and not those intended for another plane? The technique is an electronic "jitter." Each aircraft's DME transmitter is modulated by a random "jitter" signal that imparts a unique identity to its pulses. Only when the transmitted and received "jitter" patterns agree will a DME receiver accept and read out the signal to the pilot.

These are not all the electronic devices now aboard aircraft, but they represent the heart of today's avionics. Additional equipment is more complex, or a derivation of these basic packages. There is weather radar, for example, to help the pilot circumnavigate the deadly turbulence of thunderstorms, and instrument landing systems which provide electronic guidance down to a fog-bound runway. A very recent addition is the "area navigation" computer. It enables aircraft to fly away from standard airways to alleviate air-traffic congestion between larger cities.



Avionics test bench at King Radio Corp., a major manufacturer. Airplane makers also employ technicians for in-plant installations.

What does a newcomer have to know to enter the field as an avionics technician? Mr. Baker (the AEA official) says the beginner should acquire a background in basic electronics. A formal electronics education should include at least a two-year program. It's desirable to learn about the basic aircraft structure and its systems, as well as avionics. Mr. Baker believes that avionics, which today covers almost every frequency from dc through microwave, offers an interesting and challenging career with plenty of opportunity.

Yet, the availability of specialized avionic training is still sparse. Purdue University is one of the few exceptions; it offers a two-year undergraduate college program called Aviation Electronics Technology leading to an Associate Degree in Applied Science. It covers everything from elementary mathematics and aircraft electricity, through to navigation systems and automatic flight control. Although the program offers practical technician training, many students do not ultimately sit at an avionics repair bench. They continue their studies and win a regular 4-year B.S. degree, then join the airlines to work in a management or supervisory position.

In fact, the university has a "co-op" program with three major airlines—American, Pan Am and United. After two years of electronics training, a student can gain managerial training with an airline (with pay) while continuing his education. At this time there are co-op work assignments at airline stations in Dallas, Chicago, New York, San Francisco, Los Angeles and Frankfort, Germany. For details write: Department of Aviation Technology, Purdue University, Lafayette, Indiana 47907.

But if you want to start at the bottom rung, the "ticket" to a first job may be an FCC Second Class Radiotelephone License. It's not an absolute requirement (you can work under the supervision of a ticketholder) but it's good evidence of a basic electronics background. You might land a job at an avionics shop as an "in-and-out" man—to pull ailing radios from aircraft and re-install them after they've been repaired. In bigger shops the job may be called "line technician."

After acquiring some experience, the tyro might move up to installation or bench technician. (Such separation of job function tends to disappear in smaller shops.) An installer must have a good grasp of how various avionics systems operate and their interwiring. The bench technician must know most about circuitry inside the black boxes since he'll perform the internal troubleshooting. He'll often specialize and become an "ADF" or "DME" man.

The gap in avionics training closes somewhat after the technician acquires his basic background and experience. Avionics manufacturers conduct their own training programs on theory, operation and trouble-shooting on major pieces of equipment as they're introduced. In many instances, shop technicians travel to the manufacturer for factory "seminars." Some educational material also appears in elaborate maintenance manuals prepared by manufacturers for new equipment. The latest technique is an audio-visual presentation. Manufacturers have devised 35-mm slide shows with cassette tapes (for audio) that can be sent to shops around the country. There is, for example, one 3-hour course on the transponder. It discusses theory, block diagram, schematics, service and alignment.

To see what's happening in the airline field, we spoke to Leland Reilly, chief of avionics for American Airlines at New York's LaGuardia. He has 44 avionics people working for him and is now looking for 15 more. Why the shortage? One reason he points out is that the FAA licenses people who work on airframes and powerplants, but has no license provision for avionics technician. He believes if there were such a requirement, more schools might train people specifically for the ticket. Mr. Reilly emphasized his remarks by noting that 43% of airliner troubles don't occur in the airframe or powerplant—but somewhere in the avionics.

To beat the technician shortage, American Airlines (as well as other carriers) is doing its own training. It started a 7-week school at Ft. Worth and trains its own aircraft mechanics who show an inclination toward the avionics field. Other airlines offer apprenticeship programs for newcomers with electronic aptitude, still others expect the beginner to study for an FCC second class license on his own.

The rewards of a career in aviation electronics can be agreeable for a technician willing to grow with technological developments. The starting salary at American Airlines for a man with an FCC second class license is $4.62 per hour (which increases to $5.01 in two years). Reports of $10,000 per year for a qualified technician in independent shops are not unusual, and top men, according to the Aircraft Electronics Association, might realize $18,000 to $20,000 in management positions. For the novice entering avionics, the future may take him up up-and-away.

FEDERAL REGULATIONS ON AVIONICS SERVICING

FAR 145 "Repair Stations" (40¢)

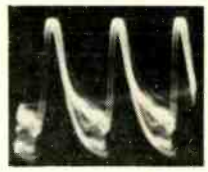
FAR 65 "Certification Other Than Flight Crew-Members" (35¢)

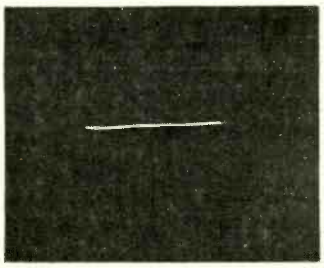
FAR 43 "Maintenance, Preventive Maintenance, Rebuilding and Alteration" (55¢)

These federal air regulations are obtainable from US Gov't Printing Office, Washington, D.C. 20402 **R-E**

WF5 Normal 100V p–p

Output waveform of V2. This is the signal fed to the drive controls and then to the CRT cathodes. Polarity is reversed again by amplification in V2. The relationship between blanking amplitude and video level is closer; video got the most amplification. This waveform is excellent for clues to troubles; it may be the only one you'll worry much about. Positive-going blanking drives the CRT into cutoff during retrace intervals. Video is applied almost equally to the CRT cathodes.

V p-p low	V p-p high	V p-p zero			
C3 open R14 high		Q1 faulty R7 open C5 shorted R14 open	 75 V p–p R3 open	 50 V p–p R4 open L2 open	 75 V p–p C3 open



WF6 Normal 0V p–p

Shown for reference, this is a zero waveform when everything is normal. However, it is included so you can see what happens when the screen bypass capacitor opens up (photo below).

V p-p low	V p-p high	V p-p zero			
			 100 V p–p C5 open		

NOTES:

Use this guide and the Voltages Guide *to help you pin down fault possibilities.*

Clamp the agc line if picture symptoms appear to be affecting agc.

With the low-capacitance probe of the scope, check the waveforms at the points shown. (Only a couple of them give trouble clues worth following up.) The scope sweep should be set at H or aoout 5 kHz, to show three cycles of the waveform.

Note amplitude. If it's missing, low, or high, check the parts indicated under those columns.

Note waveshape. If there's a change from normal, despite amplitude, check the parts indicated.

Cathode voltage is developed mainly across R13. However, a dc connection through L3–R8 and contrast-control R12 lets Q1's collector voltage and V2's cathode voltage interact slightly. Part of the effect is to keep brightness and contrast adjustments from throwing each other off.

Grid bias for V2 is applied through R11. It comes from potentiometer R10, which is a divider across the negative bias source. The −75 volts is taken from the horizontal output grid. (If you reason out this relationship, you'll find it helps keep high-brightness scenes from causing high-voltage blooming.) For main control of brightness, the control sets bias on V2, controlling plate current and thus plate voltage. That dc voltage, applied to the crt cathodes, affects CRT beam current and thus raster brightness.

QUICK TROUBLESHOOTING

First, if the agc appears affected, clamp it. That way, the i.f. stages will let video through. You can then trace the trouble to its true source.

For video symptoms. the scope is your best helper. A missing, weak or compressed video waveform is a sure clue to the fault. The input to this section, from the video detector, must be a clean video waveform at least 1 volt p–p.

You'll find gain from input to output of the triode tube. The transistor imparts a small voltage gain. The pentode should put out a strong video signal—at least 100 volts p–p. Blanking pulses should appear much higher than that.

Also scope across power-supply filters (not shown) and the screen bypass capacitor. There should be no video across them.

If there is no raster, check high voltage first. If it's okay, the CRT is probably biased off. That means *too much* positive voltage at the CRT cathodes. An uncontrollably bright raster means there *isn't enough* positive voltage on the CRT cathodes.

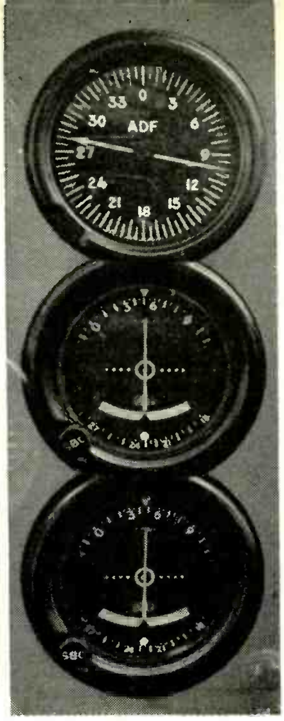
Make voltage measurements with your voltmeter in the brightness circuits—the grid of V2. Also check the cathode dc voltage. If V2 is cut off, or conduction seriously reduced, high plate voltage is passed on to the cathodes as cutoff bias. Don't forget the V2 screen circuit when you're measuring.

There's another dc troubleshooting method. Try voltage-clamping. Apply the correct voltage to the cathode of V2. If that restores normal brightness (including normal control action), the fault is in the cathode circuit.

Next clamp V2's grid voltage at its labeled value. If the right voltage there doesn't correct brightness on the CRT screen, check the tube and its plate and screen circuits. Varying the clamp voltage should have the same effect as turning the BRIGHTNESS knob.

Clamp the emitter and then the base of Q1. Troubles in this stage and in V1 can affect brightness, but cannot blank it completely or keep brightness control from varying it. **R-E**

An automatic direction-finding receiver.



CAREERS in

An upsurge of avionics gear means some 4500 technicians are needed by 1975. Are these high-paying jobs for you?

ADF dials (left) and autopilot (above).

by **LEN BUCKWALTER**

THE SMALL AIRPLANE SEEN ABOVE WAS RECENTLY PURchased for $7,800. This is not unusual for a 4-passenger Cessna of five-year-old vintage. What is exceptional is the electronics installation. It's worth about half the price of the whole airplane! What is more, the new owners are planning to add about $1000 more in electronic gear.

Does the craft ferry around executives with six-figure incomes? Not at all. It is owned by a flying club whose members mostly venture aloft an hour or two on weekends. Why, then, do they invest heavily in what pilots reverently call "the black boxes?"

It's because aviation—from Piper Cub to jumbo jet—is moving higher, faster and in greater numbers. The skies are growing more crowded as some 125,000 aircraft navigate U.S. airspace. And forecasters say their numbers will double within the decade. The consequence of burgeoning growth is that airplanes are flying less by seat-of-the-pants feeling and more by electronic guidance. If Baron Von Richthofen landed a Fokker at San Francisco International on a foggy day, he'd be fined for not having a two-way radio, have his epaulets ripped off for penetrating a high-density area without a transponder—and drummed out of the Korps for failing to have an instrument rating.

Commercial airliners, as you may suspect, are aerial electronic palaces. Although fewer than 3,000 airliners now ply commercial routes, they carry an awesome load of communications, navigation and flight control gear. The day of dead reckoning by iron compass (railroad tracks) is being replaced by navigation via satellite reference. Hands-off, automated landings are now a reality and avoiding mid-air collisions will be done by ticking off accurate time slots on an atomic clock. Although the electronics hasn't yet reached half the cost of the complete airliner, the trend is clear. Someday "TWA" may mean "Transistors, Wires and Amperes."

In addition to private planes and big Boeings there's a fleet of in-between aircraft; air taxis, commuter airlines and business aircraft. Not only are they, too, growing fast, but they use a significant chunk of electronics. Just how much was suggested in a speech by H. E. Wood, chief pilot for the Gillette (razor) Co. He said electronics will be "in the neighborhood of one-third the total cost of the medium-size twin-engine aircraft used for business purposes." Time may prove the estimate to be on the low side.

Who's going to install, maintain and troubleshoot this sky full of electronic equipment? You can—if you're willing to bring the right skills—or develop them—in a field that's becoming known as "avionics." As it grows by leaps and bounds, it's suffering a severe shortage of technicians. Opportunities abound for the serious-minded individual. With pilots and passengers trusting their lives to reliable electronics, one manufacturer says, the field is no place for the idle tinkerer or hobbyist. It requires a strong combination of electronic theory, practical know-how, plus a willingness to crawl behind an instrument panel and (as it's been said) "work with rudder pedals sticking in your back."

Another ingredient to success, says an industry spokesman, is a willingness to keep on learning. Avionics equipment is transitioning to solid-state and microcircuitry and it's bringing the downfall of the tube jockey who can't follow a schematic. To see where the opportunities lie, let's take a closer look at the industry.

The aviation field (excluding the military) divides into two basic categories: the commercial airlines—United, American, Pan Am, etc.—and "general aviation," which covers private and business aircraft. Electronic servicing of this equipment also follows the same basic division. The commercial carriers generally conduct their own maintenance operations, while the repair of general aviation planes is often done by independent shops. There are now about 500 facilities around the country selling, installing and maintaining electronics in smaller, non-airline, planes. They are usually located on an airport as an independent shop or a division of a larger operation devoted to other aircraft services, such as engine and airframe maintenance.

There are other technician employers as well. Much electronics is installed at the factory at the time an aircraft is assembled (much as you'd order a radio for a new automobile). These companies are the "airframe" manufacturers, and number such names as Cessna, Piper and Beech. About 20 such general aviation manufacturers hire electronic personnel. Although many new civil aircraft are delivered with a single radio, this radically changes for larger business planes. They are generally ordered with customized avionics and require elaborate engineering and installation.

According to the Aircraft Electronics Association, an industry group, the avionics field now employs between 2500 and 3000 technicians. An additional group is hired by about 40 manufacturers of avionics equipment (Narco, King, RCA, Bendix and others). Mr. Gene Baker, an AEA

AVIATION electronics

official, states that general aviation has grown faster than 10 percent a year for the past five years and he estimates the industry will require some 3000 new avionics technicians over the next five years. It is estimated that the airlines would like another 1500 technicians to keep their equipment flying.

The hardware you'll see

That's the industry—from the small shop servicing the private flier to the large repair facility maintaining the big jets. Although equipment grows sophisticated in heavy aircraft, much of the hardware and technology is quite similar throughout aviation. Consider the major pieces of electronic equipment you'll be expected to learn about and maintain:

Transceiver: The basic two-way radio in aviation is a vhf transceiver operating from about 120-135 MHz. Circuits are relatively conventional: superheterodyne receiver and AM transmitter controlled by crystals. The circuits become specialized mainly in the oscillator circuits; hundreds of channels (at 50-kHz spacing) are often required and the designer may resort to frequency synthesis to reduce the number of crystals. Aircraft transceivers usually transmit a few rf watts for light planes, and several times that for the large craft. Transmitter power isn't too critical because antennas are high and communications range limited by the earth's curve. (The radio range of a jet at 30,000 feet on vhf is some 200 miles.)

Overseas flights, however, also rely on hf transceivers to provide long-range communications. These sets, in the 3- to 30-MHz band, can transmit via "skip" through the ionosphere. When a transatlantic airline captain at mid-ocean sees a call-light illuminate on his panel, the message could be from Newfoundland or Ireland, many hundred miles away. Some low-frequency communications (under 3 MHz) might still be in operation, but today's standard is vhf for continental operations and hf for long-haul work.

"Omni" (VOR): This is the most important air navigational system within the country—used by everyone from home-made rag-wings to Sinatra's $890,000 Learjet (that's with custom interior). "Omni" is the popular term for "Vhf Omnidirectional Range," also abbreviated to "VOR." There are about 900 unmanned VOR stations spotted around the country by the FAA (Federal Aviation Administration) to form the nation's aerial roadways. The VOR system operates on vhf (from about 108 to 120 MHz) and is virtually immune to atmospheric disturbances which plagued older, low-frequency systems. VOR operates by transmitting fixed and rotating signals that are oriented to magnetic north. The receiver in the aircraft compares the phase of the two arriving signals and can read out their difference in magnetic degrees.

ADF: "Automatic Direction Finding" is another major aid. It operates on either low- or medium-frequency ground stations (including standard broadcast) in the frequency range of about 190 to 1700 kHz. As you can see (top center, page 48), it has a compass-type dial and an indicator. The needle constantly points toward the station and supplies the pilot with a line of position to the station. It's done with a highly directional loop antenna mounted on the skin of the airplane, plus a "sense" antenna to resolve a 180-degree ambiguity which occurs in the bi-directional pattern of the loop antenna.

The devices described thus far compromise the basic "navcom" (navigation-communications) package found in many light and medium aircraft. As the airplane grows larger, and for commercial reasons must operate safely in bad-weather conditions, the electronics complement broadens to include:

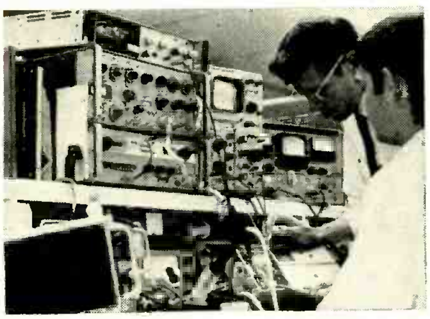
Transponder: This is a small receiver-transmitter operating on uhf (about 1 GHz). It greatly enhances an aircraft's target on ground radar screens. Conventional radar ("primary" type) sends a pulse which passively reflects from an aircraft skin. It could produce a weak echo and be overlooked by the ground controller. Further, the returning echo carries no identifying signature to isolate one aircraft from another.

A transponder aboard the plane resolves these problems. When it receives a radar pulse from the ground, it transmits back a powerful response that paints a bright target on the radar screen. Also, a controller can sort out the maze of air traffic by saying to a pilot, "squawk ident." The pilot presses a button and his transponder fires back coded pulses. They appear on the radar screen as an extra dab of light and the airplane is easily spotted by the controller.

DME: Meaning "Distance Measuring Equipment," DME is another important electronic aid. It eases the pilot's workload by reading out the number of miles he is from a ground station (the VOR's mentioned earlier). DME is also useful when an aircraft is ordered into a holding pattern during landing delays. It helps define a racetrack course in the sky that a pilot can follow without seeing outside the cockpit.

Like the transponder, DME also functions on uhf signals. In operation, DME transmits a pair of pulses to a ground station which fires back pulses in response. Since radio waves travel at a known velocity, the time for the pulses to travel back and forth is easily computed as distance, or miles, from the station. The intriguing aspect of DME is that dozens of aircraft may interrogate one ground station simultaneously. How does one aircraft know it's getting *its* pulse responses—and not those intended for another plane? The technique is an electronic "jitter." Each aircraft's DME transmitter is modulated by a random "jitter" signal that imparts a unique identity to its pulses. Only when the transmitted and received "jitter" patterns agree will a DME receiver accept and read out the signal to the pilot.

These are not all the electronic devices now aboard aircraft, but they represent the heart of today's avionics. Additional equipment is more complex, or a derivation of these basic packages. There is weather radar, for example, to help the pilot circumnavigate the deadly turbulence of thunderstorms, and instrument landing systems which provide electronic guidance down to a fog-bound runway. A very recent addition is the "area navigation" computer. It enables aircraft to fly away from standard airways to alleviate air-traffic congestion between larger cities.



Avionics test bench at King Radio Corp., a major manufacturer. Airplane makers also employ technicians for in-plant installations.

What does a newcomer have to know to enter the field as an avionics technician? Mr. Baker (the AEA official) says the beginner should acquire a background in basic electronics. A formal electronics education should include at least a two-year program. It's desirable to learn about the basic aircraft structure and its systems, as well as avionics. Mr. Baker believes that avionics, which today covers almost every frequency from dc through microwave, offers an interesting and challenging career with plenty of opportunity.

Yet, the availability of specialized avionic training is still sparse. Purdue University is one of the few exceptions; it offers a two-year undergraduate college program called Aviation Electronics Technology leading to an Associate Degree in Applied Science. It covers everything from elementary mathematics and aircraft electricity, through to navigation systems and automatic flight control. Although the program offers practical technician training, many students do not ultimately sit at an avionics repair bench. They continue their studies and win a regular 4-year B.S. degree, then join the airlines to work in a management or supervisory position.

In fact, the university has a "co-op" program with three major airlines—American, Pan Am and United. After two years of electronics training, a student can gain managerial training with an airline (with pay) while continuing his education. At this time there are co-op work assignments at airline stations in Dallas, Chicago, New York, San Francisco, Los Angeles and Frankfort, Germany. For details write: Department of Aviation Technology, Purdue University, Lafayette, Indiana 47907.

But if you want to start at the bottom rung, the "ticket" to a first job may be an FCC Second Class Radiotelephone License. It's not an absolute requirement (you can work under the supervision of a ticketholder) but it's good evidence of a basic electronics background. You might land a job at an avionics shop as an "in-and-out" man—to pull ailing radios from aircraft and re-install them after they've been repaired. In bigger shops the job may be called "line technician."

After acquiring some experience, the tyro might move up to installation or bench technician. (Such separation of job function tends to disappear in smaller shops.) An installer must have a good grasp of how various avionics systems operate and their interwiring. The bench technician must know most about circuitry inside the black boxes since he'll perform the internal troubleshooting. He'll often specialize and become an "ADF" or "DME" man.

The gap in avionics training closes somewhat after the technician acquires his basic background and experience. Avionics manufacturers conduct their own training programs on theory, operation and trouble-shooting on major pieces of equipment as they're introduced. In many instances, shop technicians travel to the manufacturer for factory "seminars." Some educational material also appears in elaborate maintenance manuals prepared by manufacturers for new equipment. The latest technique is an audio-visual presentation. Manufacturers have devised 35-mm slide shows with cassette tapes (for audio) that can be sent to shops around the country. There is, for example, one 3-hour course on the transponder. It discusses theory, block diagram, schematics, service and alignment.

To see what's happening in the airline field, we spoke to Leland Reilly, chief of avionics for American Airlines at New York's LaGuardia. He has 44 avionics people working for him and is now looking for 15 more. Why the shortage? One reason he points out is that the FAA licenses people who work on airframes and powerplants, but has no license provision for avionics technician. He believes if there were such a requirement, more schools might train people specifically for the ticket. Mr. Reilly emphasized his remarks by noting that 43% of airliner troubles don't occur in the airframe or powerplant—but somewhere in the avionics.

To beat the technician shortage, American Airlines (as well as other carriers) is doing its own training. It started a 7-week school at Ft. Worth and trains its own aircraft mechanics who show an inclination toward the avionics field. Other airlines offer apprenticeship programs for newcomers with electronic aptitude, still others expect the beginner to study for an FCC second class license on his own.

The rewards of a career in aviation electronics can be agreeable for a technician willing to grow with technological developments. The starting salary at American Airlines for a man with an FCC second class license is $4.62 per hour (which increases to $5.01 in two years). Reports of $10,000 per year for a qualified technician in independent shops are not unusual, and top men, according to the Aircraft Electronics Association, might realize $18,000 to $20,000 in management positions. For the novice entering avionics, the future may take him up up-and-away.

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20 TRIAC CIRCUITS

Quadracs and triacs are solid-state power switches. This two-part feature shows how they work, how to use them

by R. M. MARSTON

TRIACS ARE SOLID-STATE ELECTRONIC power "switches" that can be turned from the OFF to the ON state with low-power trigger signals. They are members of the thyristor or silicon controlled rectifier (SCR) family. The SCR and triac are both three-terminal devices. They pass a major current between two terminals, and are triggered through the third.

SCR's however, are unidirectional devices and pass current in one direction only. That is, they can act as a closed switch only on positive inputs. Thus SCR's can be used to switch ac loads only by wiring two SCR's in inverse-parallel, or by first full-wave-rectifying the ac and using a single SCR to switch the resulting rough dc.

Triacs, on the other hand, are bidirectional devices, and pass major currents in either direction between their two main terminals. They can act like a closed switch to both positive and negative half-cycles of an ac input. The triac is thus ideally suited to ac power-switching applications, and can thus be used in a wide range of automatic and semiautomatic ac switching circuits—house-lighting control, electric motors, heaters, etc.

A quadrac is simply a special type of triac for use in phase-triggered variable power control applications; it can be used in lamp-dimmer and drill-speed controller circuits, etc.

In this two-part series we'll show you the basic characteristics of both the triac and the quadrac, and describe some 20 practical circuits in which these amazing solid-state devices can be used.

Triac characteristics

The triac is a three-terminal device. Its symbol is shown in Fig. 1-a. Notice this symbol resembles two ordinary rectifiers connected in inverse parallel between Main Terminal 1 (MT1) and Main Terminal 2 (MT2). An additional gate terminal is wired to the MT1 end of the combination.

When the triac is turned on with a suitable gate-trigger signal, it acts just as though it were two silicon rectifiers connected this way between MT1 and MT2. That is, it's a virtual short circuit that can pass current in either direction.

But when a trigger signal is not applied at the gate, the device acts as though both rectifiers are open-circuit, and passes negligible current in either direction—it acts like an open-circuit switch. Triacs are generally wired in series with a load and connected across an ac supply (Fig. 1-b). Referring to this diagram, here are the general characteristics of a triac:

1. Normally, with no gate signal applied, the triac is off, and acts (between MT1 and MT2) like an open-circuit switch; it passes negligible current in either direction.

2. If MT2 is more than about 1.5 volts positive or negative relative to MT1, the triac can be turned ON (so it acts as a very low impedance between MT1 and MT2) by applying a suitable trigger signal or bias to the gate. The device takes only a few microseconds to switch from the OFF to the ON state.

3. Once the triac has been turned on initially via its gate, it becomes self-latching. (It remains ON as long as a current flows between its main terminals, even if the gate signal is completely removed after turn-on has been initiated.) Thus, only a brief gate trigger pulse is needed to turn the triac ON.

4. Once the triac has latched on, it can be turned off again only by briefly reducing its main-terminal currents to near-zero or below a value known as the "minimum holding current" (typically a value of a few mA). Thus, when the triac is used as an ac switch, turn-off occurs automatically at the zero-crossing point at the end of each half-cycle as the main-terminal currents momentarily fall to zero. The triac can not be turned off via its gate.

5. The triac can be turned ON with either a positive or negative gate pulse or bias voltage, irrespective of the polarities of the main terminal voltages. The actual gate potential needed to trigger the device is only about 1 volt, but trigger-current sensitivity depends on the polarities of both the gate signal and MT2.

Typically, a 6-amp triac needs a gate current of only about 10 mA if the gate and MT2 are of the same polarity, but needs twice this current if the gate and MT2 are of opposing polarities. (If MT2 is positive, relative to MT1, the triac can be triggered via a gate current of +10 mA or −20 mA. If MT2 is negative, it can be triggered via a gate current of +20 mA or −10 mA.) In either case, a very considerable power gain is available between the device's gate and its main terminals.

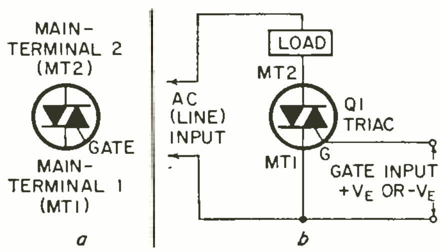
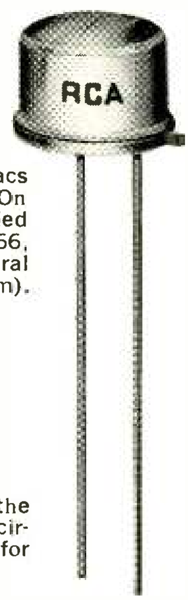


Fig. 1-a—Symbol for the triac. b—Typical ac circuit connections for triac.

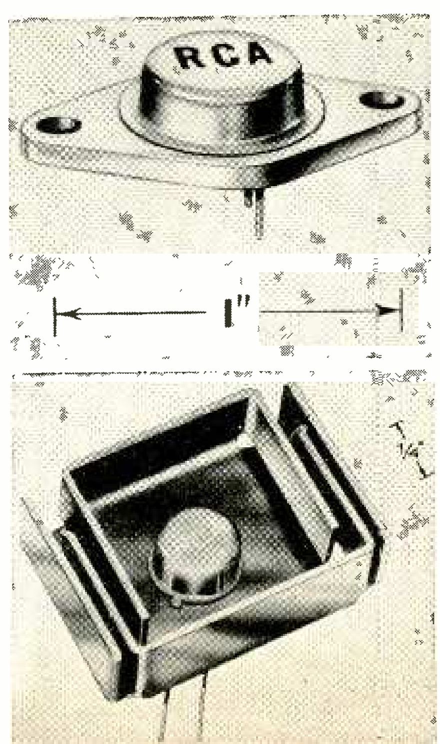
6. The gate-to-MT1 path of a triac exhibits characteristics similar to those that might be found if two silicon diodes were connected in inverse parallel between the gate and MT1. (A low-impedance path exists in either direction between the two points, and the gate is inevitably held at a potential within a volt or so of that of MT1—just as the base of a transistor is inevitably held at a potential close to that of its emitter.)

7. When the triac is ON, less than 1.5 volts is developed across its main terminals, even at high operating currents. Thus, if the device is used to switch a 6-amp load from a 240-volt rms supply, negligible power is developed in the load or the triac under the OFF condition. But under the ON condition about 1440 watts is developed in the load and only 9 watts in the triac. The triac thus acts as an efficient switch for ac loads, and can be used in a variety of line-switching applications.

The basic circuit of a dc-triggered



Package styles for triacs are shown in photos: On the right is a modified TO-5; below is a TO-66, and a TO-5 with integral heat radiator (bottom).



triac ON/OFF switch is in Fig. 2. With S1 open, no current flows to the gate of the device, so the triac is OFF, and virtually zero power is developed in the load. When S1 is closed, BATT supplies a current of about 40 mA to the triac gate via R2. The triac is driven ON as soon as MT2 becomes positive or negative to MT1 by more than about 1.5 volts. So the triac is virtually turned ON permanently, and almost the full available line power is developed in the load.

The circuit can be used with either 120-volt or 240-volt, 50-Hz or 60-Hz supply lines, and can handle maximum load currents up to 6 amps. On 120-volt lines an RCA 40429 triac should be used, and maximum permissible load power is limited to 720 watts. On 240-volt lines an RCA 40430 triac should be used, and maximum permissible load power is 1440 watts.

The trigger-current sensitivity of this circuit can be raised, if required, by using a simple transistor switch in place of S1. Note that this circuit draws a continuous gate current of about 40 mA.

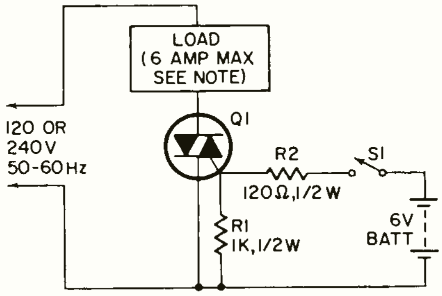
The basic circuit of a self-triggered triac ON/OFF switch is in Fig. 3. Here, with S1 open, no current flows to the gate, so the triac is OFF. On the other hand, if S1 is closed, the triac is OFF at the very start of each half-cycle, since there is zero voltage difference between MT1 and MT2 at this moment. Shortly after the start of the half-cycle, however, the MT2 voltage becomes high enough (5 or 6 volts) to supply the necessary trigger current to the gate via R1, so the triac is triggered ON.

As the triac goes on, its MT2-to-MT1 voltage falls to only 1 volt or so, removing the gate drive via R1. This has no effect, since the triac passes substantial main-terminal currents as soon as it is triggered and thus latches ON for the remainder of the half-cycle. At the end of the half-cycle the ac supply voltage and the main terminal currents again fall momentarily to zero, so the triac automatically turns OFF.

The whole process starts over again on the following half-cycle, the triac triggering ON again just after the half-cycle starts. This process repeats as long as S1 is closed, so the triac is ON almost permanently, and virtually the full available line power is developed in the load.

Note in this circuit that the gate trigger polarity is always the same as that of MT2, so the triac operates at maximum gate sensitivity. Also note that only a brief low-power trigger "pulse" flows to the gate through R1, so this resistor can be a low-wattage unit. The circuit is very economical in its gate trigger-power requirements, and S1 can be replaced by a low-current relay contact if preferred. This relay contact must be able to withstand the full available line voltage.

An ON/OFF circuit allows the triac to be triggered from an electrically isolated input (Fig. 4). Notice LDR and LM1 are sealed together in a light-excluding tube. The lamp is connected to



Q1 = 40429 (RCA) ON 120 VAC
= 40430 (RCA) ON 240 VAC

NOTE:-
LOAD = 6A MAX (720 WATT ON 120V, OR 1440 WATT ON 240 V) IF Q1 CASE TEMPERATURE IS KEPT TO 75°C OR LESS BY A HEAT SINK. IF Q1 IS NOT MOUNTED ON A HEAT SINK, MAX LOAD CURRENT IS APPROX. 1.5A AT 25°C AMBIENT. BOTH TRIACS CAN HANDLE PEAK SURGE CURRENT UP TO 100A (NON-REPETITIVE) FOR ONE CYCLE OF THE SUPPLY LINE; THIS FACTOR ENABLES HIGH CURRENT INCANDESCENT LAMP LOADS (WHICH TYPICALLY HAVE TURN-ON SURGE CURRENT 12 TIMES GREATER THAN THEIR NORMAL OPERATING CURRENTS) TO BE USED

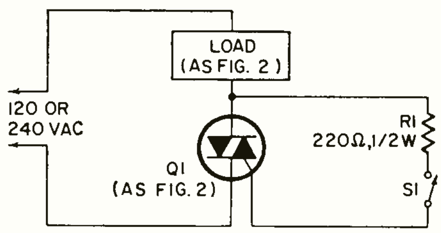


Fig. 2 (top)—Basic dc triggered triac circuit is gated on by 40 mA from BATT. Fig. 3 (above)—Self-triggered triac ON/OFF switch is gated on by line ac.

the remote S1–BATT circuit, and the LDR (a cadmium sulphide photocell) is connected between MT2 and the triac gate.

When S1 is closed, the lamp lights, illuminates the face of the LDR, and causes LDR resistance to fall to a low value (typically a couple of hundred ohms), so the triac turns ON and operates in exactly the same way as the circuit of Fig. 3.

When S1 is open, the lamp is off, so the LDR acts as a very high resistance (typically about 1 megohm) and prevents the triac from triggering. The triac is OFF under this condition.

The LDR can be any low-power cadmium sulphide photocell that offers a low "bright" and a high "dark" resistance, and can withstand the full applied line voltage.

An alternative method of triggering the triac from an isolated input is in Fig. 5. Here the unijunction transistor (UJT) acts as an oscillator when S1 is closed, and applies a continuous train of trigger pulses to the triac gate via T1. The UJT oscillates at about 2 kHz, so these pulses occur at 500-μsec intervals. Because this interval is very short relative to the period of a half-cycle of supply-line voltage, the triac is inevitably triggered ON very shortly after the start of each half-cycle. The triac is thus effectively turned on almost permanently, and almost the full available

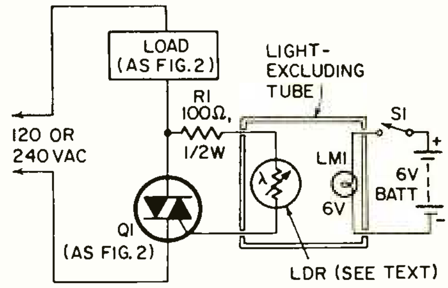


Fig. 4—Isolated-input triggering works when LM1 lowers LDR resistance enough.

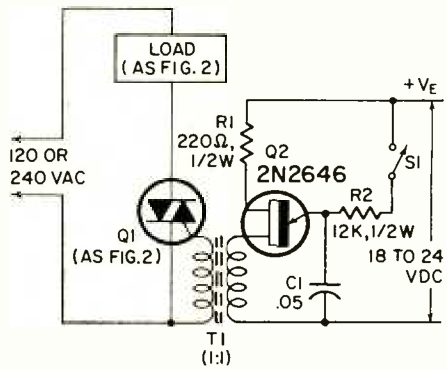


Fig. 5—Transformer isolates input from the 2-kHz UJT oscillator gating circuit.

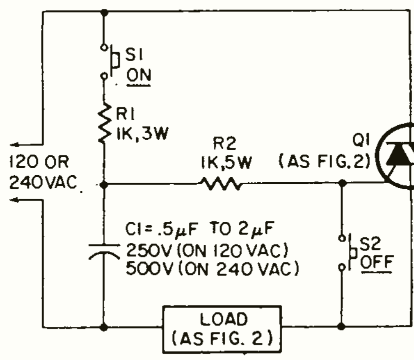


Fig. 6—Self-latching circuit. After S1 turns it on, S2 is closed to stop operation.

line power is applied to the load.

When S1 is open, the UJT oscillator is inoperative, the triac is OFF and negligible power is applied to the load.

In this circuit the UJT oscillator can use any supply in the 18- to 24-volt range. The supply can be derived from either batteries or a line-driven power unit. The supply can be grounded, if required. Transformer T1 can be any small 1:1 unit that can withstand full line voltage between its two windings.

Switch S1 has to handle a current of only 2 mA or less, and can be replaced by a simple transistor switch in many applications. This means that the triac can be effectively operated by light, heat, sound, water, etc., as required in the application.

Finally, Fig. 6 shows the basic circuit of a self-latching triac ON/OFF switch in which the triac goes ON when S1 is momentarily operated, and then stays on indefinitely until S2 is operated, at which point the triac turns OFF again.

Suppose initially that the triac is

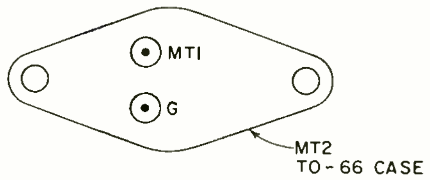
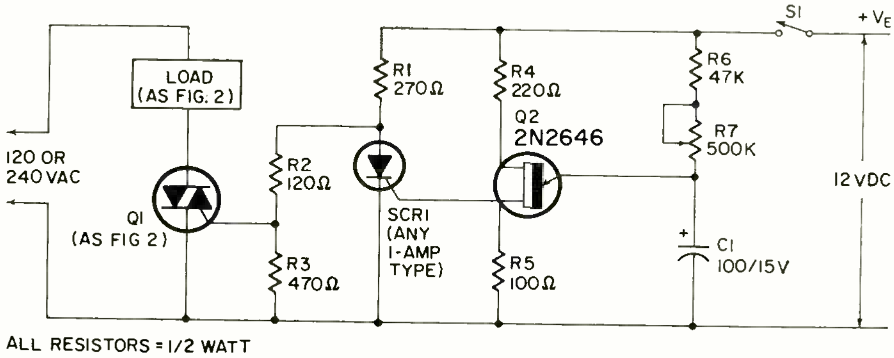
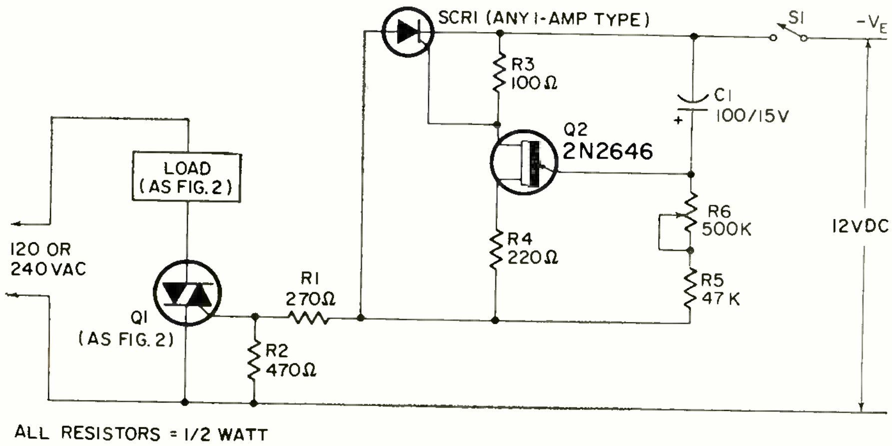
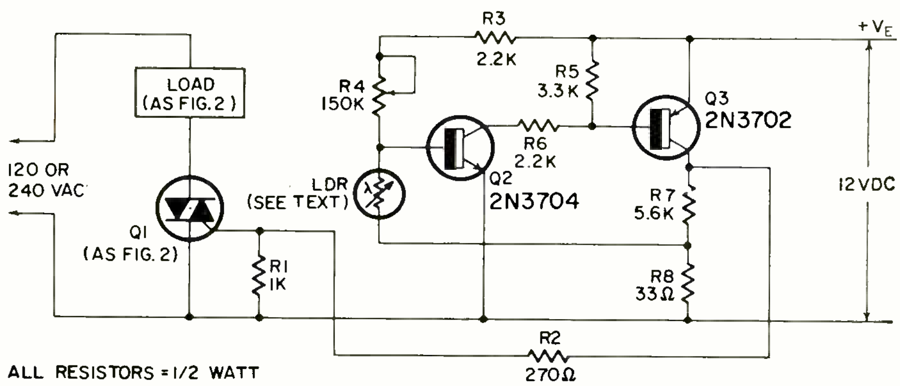


Fig.7 (left)—**TO-66 case** lead configuration. **Fig. 8 (below)—Automatic-turnoff** circuit shuts off load after set delay. **Fig. 9 (middle)—Delayed turn-on** line switch goes on after 8–80-sec delay. **Fig. 10 (bottom)—Light-operated** circuit turns on load when light falls below a preset value, off when light increases.







OFF—full line voltage appears between MT1 and MT2. When S1 is operated briefly, gate drive is applied to the triac via R1 and R2, the triac goes ON, and the line voltage then appears across the load. The gate of a triac is inevitably held at a potential within a volt or so of that of MT1; therefore, this line voltage also appears across the C1–R2 combination, and C1 charges via R2 and the gate of the triac. At the end of the first half-cycle, line voltage falls momentarily to zero, so the triac turns OFF and C1 starts to discharge via the triac gate.

At the start of the next half-cycle, however, gate current is still flowing from the discharging C1, so the triac is automatically turned ON again shortly after the half-cycle starts. As soon as it turns on, C1 starts to charge again in the reverse direction. This process continues indefinitely, so the triac is virtually permanently turned ON and the full line power is developed in the load.

Once the triac has latched in, it can be turned OFF again only by briefly closing S2, thus discharging C1 and breaking the operating cycle.

In this circuit C1 must be a reversible type of capacitor, with a value between 0.5 μF and 2 μF. It must withstand the full applied line voltage.

The five basic circuits we have looked at so far all use either RCA 40429 or 40430 triacs. The base connections of these particular units, which are housed in TO-66 cases, are in Fig. 7.

Having looked at these basic circuits, let us now examine a few interesting applications of ON/OFF triac circuits that you can build.

Auto-turnoff line switch

The circuit of an auto-turnoff line switch is in Fig. 8. The triac goes ON as soon as S1 is closed, but goes OFF again, automatically, after a preset period. The delay period can be varied between about 8 and 80 seconds with R7.

The time-delay circuit is powered from a 12-volt dc supply (batteries for testing purposes, or an ac line-operated power supply).

When S1 is first closed SCR1 is off, so the gate of the triac is connected to the 12-volt positive line via R1–R2, and the triac is driven ON by about 30 mA of gate current.

Simultaneously, as S1 is closed, power is applied to the Q2 UJT timer circuit, and a timing cycle starts. At the end of this timing cycle (which can be varied between 8 and 80 seconds by R7) the UJT fires, and applies a positive trigger pulse to the gate of SCR1.

This trigger pulse drives SCR1 ON, causing it to self-latch. The SCR's anode thus falls to near-zero volts, and breaks the drive to the triac gate; therefore, the triac turns OFF. The triac then remains off until S1 is briefly opened, permitting the Q2–SCR1 circuit to reset, and then closed again, allowing a new timing cycle to start.

Delayed-turn-on line switch

A delayed-turn-on line switch (the triac does not go ON until some time after S1 is closed) is in Fig. 9. The turn-on delay can be varied between 8 and 80 seconds with R6.

When S1 is closed, the SCR is off. Almost 12 volts appears between its anode and cathode and is applied to the UJT timer circuit. The UJT circuit draws less than 2 mA from the supply via R1, therefore gate current is insufficient to trigger the triac, and the triac is OFF.

As soon as power is applied to the UJT circuit, a timing cycle is initiated. At the end of this cycle the UJT fires and triggers SCR1 on and makes it self-latch. As the SCR turns on, it effectively connects the triac gate to the 12-volt positive line via R1, so the triac goes ON.

Simultaneously, the SCR1 anode-to-cathode voltage falls to nearly zero. This removes the drive to the UJT timer, disabling it. The triac remains ON as long as S1 is closed.

Light-operated switch

The circuit of a very sensitive light-operated line switch is in Fig. 10. In this arrangement the triac goes ON when the light level falls below a preset value. It goes OFF again when the light level rises above that value.

Transistors Q2 and Q3 are wired as a complementary Schmitt trigger, in which either both transistors are ON or both transistors are OFF, depending on the amount of base drive applied to Q2 via potential divider R4–LDR.

LDR is a cadmium sulphide photo-

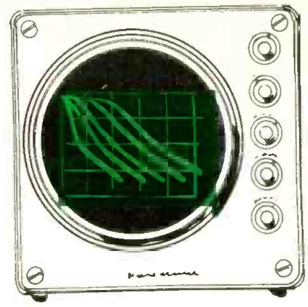
(continued on page 97)

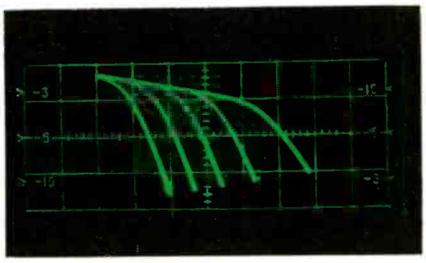
TROUBLESHOOT COLOR TV WITH—

transistor curve tracer

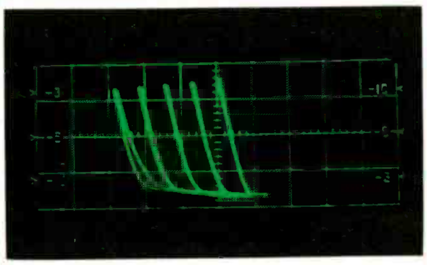
New TV repair technique promises faster, easier way to find bad transistors in a solid-state color TV receiver

by JUD WILLIAMS*

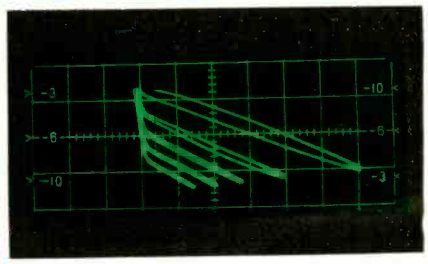




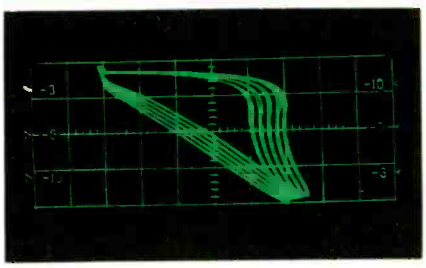
First video amplifier.



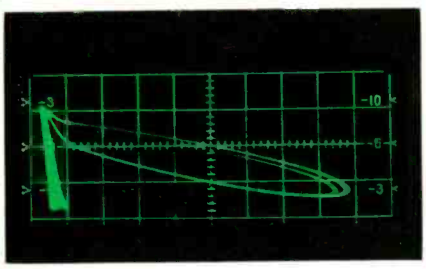
Second video amplifier.



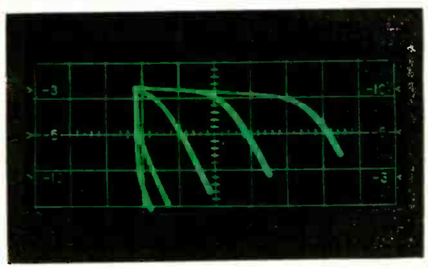
Chroma output.



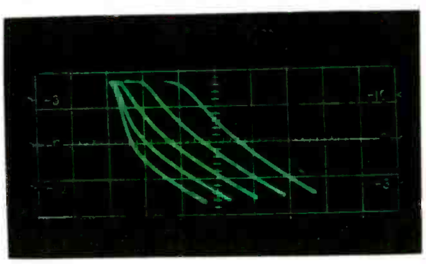
First video i.f.



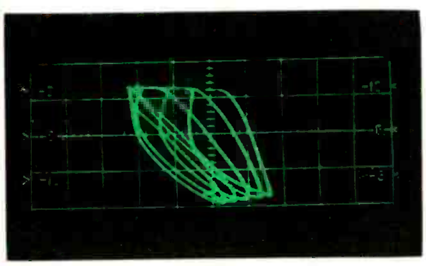
Video output.



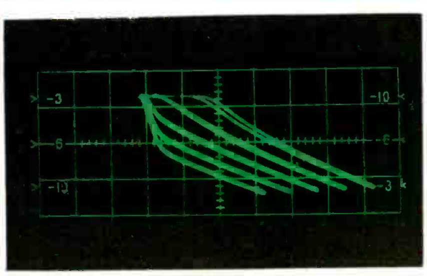
X demodulator.



Second video i.f.



First chroma amplifier.



Second chroma amplifier.

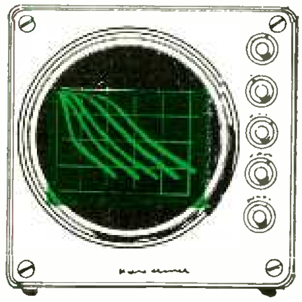
THE AGE OF TRANSISTORS IS UPON US and with it the ticklish problem of how to service solid state equipment quickly and efficiently. Various modern methods use meters, oscilloscopes and in-circuit transistor checkers, none of which can *positively* identify defective transistors without first removing them from the circuit.

One way to locate defective transistors is to check the base-to-emitter voltage which usually measures from several tenths of a volt to slightly less than a volt. A second check is the voltage drop across the load resistor to see if current is flowing. Either a sensitive meter or a dc-coupled oscilloscope may be used to make these measurements.

If an in-circuit transistor checker is used it connects the transistor under test into an oscillator circuit which results in a simple go, no-go test. Unfortunately, the loading effects of the components in the circuit being tested will often defeat this method. Also, improper connection to the transistor may result in its destruction.

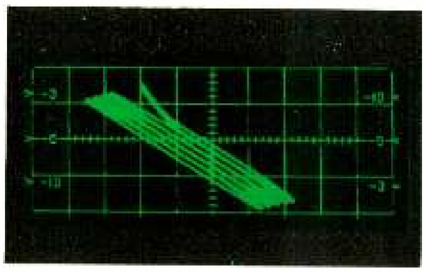
Of course the transistor can be physically removed from the circuit and subjected to several tests. An ohmmeter will detect shorts and opens between the base-to-emitter or the base-to-collector junctions. Simple out-of-circuit transistor checkers will give an indication of leakage and beta. But this is useful only to a limited degree because it is a static test.

For many years an instrument called a "dynamic transistor curve tracer" has been used by engineers and quality-control people to test and classify transistors. To use a curve tracer a transistor is plugged into a test

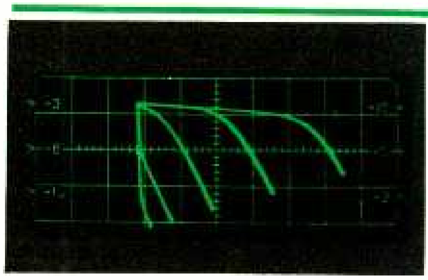


socket and its collector-to-emitter junction is swept by a 120-Hz pulsating dc voltage. Synchronized with this is a staircase generator supplying the base with calibrated steps of current. This turns the transistor "on" and displays, on an oscilloscope, a family of characteristic curves.

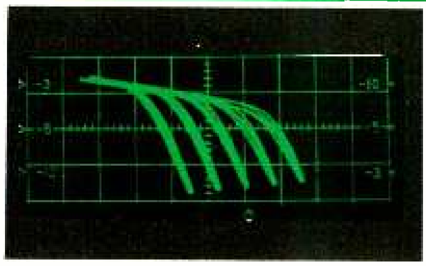
The pulsating dc collector-to-emitter voltage starts at zero and rises to



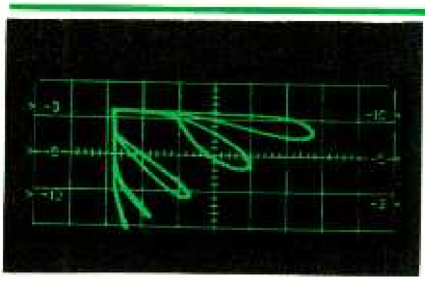
Z driver.



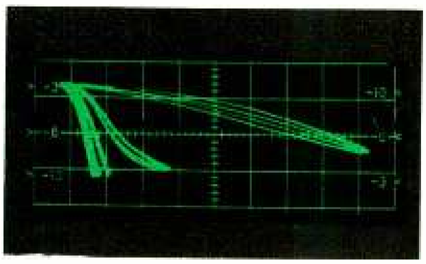
Z demodulator.



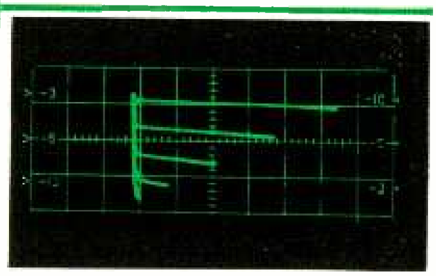
X driver.



Color killer.



3.58-MHz oscillator.



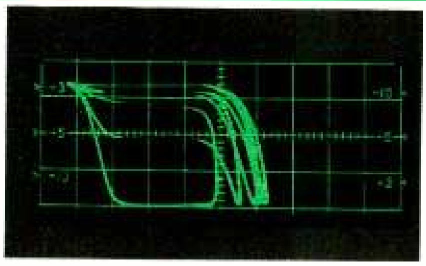
Noise gate.

its maximum test voltage and then returns to zero at a 120-Hz rate. It is the usual waveform seen at the output of a full wave rectifier. At the beginning of each sweep cycle the base is turned on by the current level produced by one step of the staircase generator. Since the steps operate at a 120-Hz rate they are synchronized with the voltage sweeping across the collector-to-emitter.

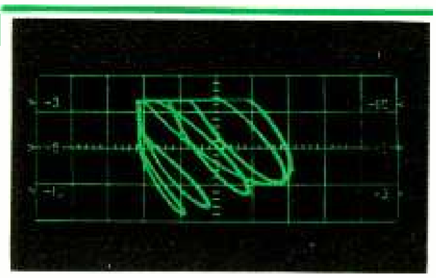
The staircase generator is usually calibrated in microamperes or milliamperes per step and may produce from 4 to 12 steps. Each step produces one curve in the family of curves and because the system operates at a 120-Hz rate all the curves appear simultaneously.

The oscilloscope is operating as an XY scope when used with a curve tracer and the vertical divisions on the scope face represent the collector current. This current is proportional to the voltage drop across a resistor in series with the emitter using Ohms law. The horizontal divisions represent the voltage that is swept across the collector-to-emitter. It may be varied from zero to as much as 200 volts.

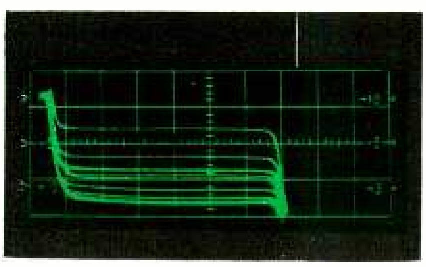
Engineers use characteristic curves to determine transistor gain, which is the ratio of collector current to base current. Since we feed various current levels to the base, the ideal bias voltage for the particular transistor under test can be determined easily. Remember, transistors bearing the same type number do not necessarily have the same characteristic curves. There can be and is quite a "spread". This is why many manufacturers use selected or matched transistors to satisfy particular circuit requirements.



First audio amplifier.



Sync separator.



Audio output.

The "selected" transistors bear the manufacturers own part number which limits the sources for replacements. This is particularly true in the TV industry where replacement transistors are becoming a problem. It is not always convenient for a service technician to get a replacement from the manufacturer. By using a curve tracer, the technician may be able to locate a transistor to satisfy his replacement needs from the supply he normally keeps on hand. A curve tracer usually has two test sockets so transistors can be easily matched by comparing one to the other. This is very useful when one transistor is used as a standard.

Recently, I discovered a new use for the "dynamic transistor curve tracer." I found that the instrument could be used as an in-circuit transistor checker in a way that has never been tried before. It is the only method I know that will *positively* identify a defective transistor without removing it from its circuit!

The method is called "interpretive diagnosis." It is foolproof and will work in virtually any type of circuit—rf, audio or digital. The curve tracer probe is connected to the suspect transistor and if it is working, a family of curves appears on the scope. If the transistor is open, a single horizontal line is displayed. If it is shorted, a drooping or vertical line appears. It's as simple as that!

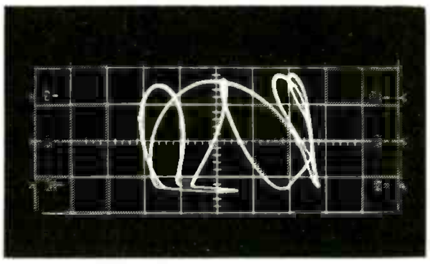
Since the transistor is still in the circuit while it is checked, the peripheral components will affect the shape of the curves. The influences of loading, capacitance and inductance will alter the curves and they take on the shape or loops or may droop or take on some other peculiar form. But as long as a distinct number of curves appears it is certain that a "live" transistor is in the circuit!

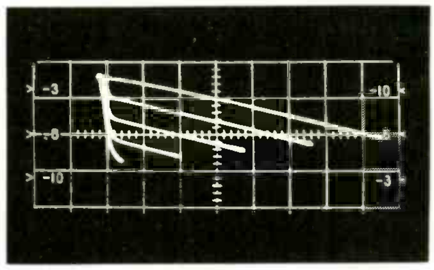
While these tests are performed, the equipment under test must be unplugged from its source of power. No external signals are used so the procedure is electrically safe.

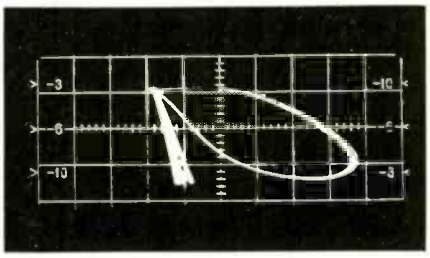
The curve tracer is not limited to only this kind of test. Those intimately familiar with transistors know that they are made up of diode junctions. By connecting collector-to-emitter leads of the curve tracer across each of the junctions the tracer will display the characteristic diode "knee". This is useful in determining which of the junctions is defective. You can use this same test to locate defective diodes in circuit.

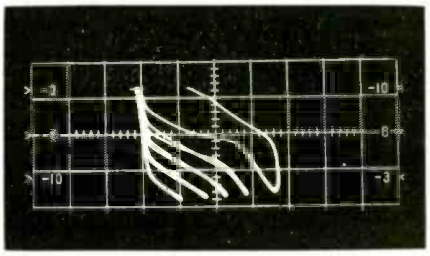
The procedures described here have been tested extensively on the Sylvania Gibraltar color TV chassis. Several photographs of the curves found in various circuits are shown. These photos show the curves produced by a transistor under test and their peculiar shapes.

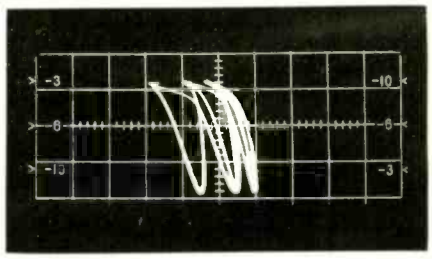
As this technique wins acceptance, future schematics may show the "dynamic curves" of each transistor used. It appears to be the safest in-circuit technique available, as the transistor under test is never in danger of destructive voltage or currents. The technique seems to work with any circuit so its use can be expected to have universal application. **R-E**

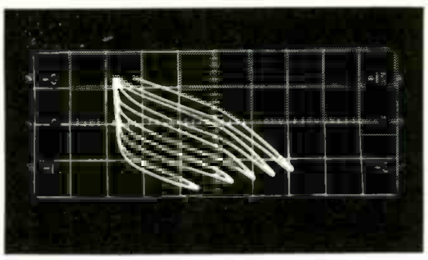

Acc amplifier.

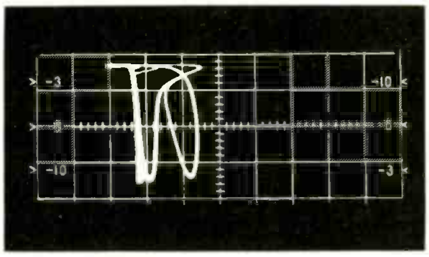

Frequency regulator


Agc amplifier.


Agc gate.


20-volt filter.


Blanker.


Apc amplifier.

TOOLS FOR ELECTRONICS

by TOM HASKETT

This issue, starting on the facing page, is the next part of our new series of articles on tools for electronics. It is the second part of our description of nutdrivers and a new section on alignment tools. Next month we will continue the series with an article on Using Meters Effectively. We believe you will find all this material a handy, practical addition to your R-E Reference Manual. If you wish you can purchase a special hardcover binder to keep your Reference Manual pages together. It has a dark blue fabric cover and is gold stamped Radio-Electronics Reference Manual. The cost is $1.00, postpaid. Order from N. Estrada, 17 Slate Lane, Central Islip, L.I., N.Y. 11722.

Toggle switches usually have a serrated locknut on the panel side, and it's difficult to properly turn this nut. Stevens Walden's 3480 driver, with an internally serrated tip will do the job (Fig. 13). So will

Fig. 13—Toggle switches are easy to remove with this special tool to handle the mounting nut. It comes in several sizes. Stevens Walden.

GC's 9357. Both are available in several sizes.

Another Stevens Walden exclusive is their line of **Grip Spintite nut-holding drivers** (Fig. 14). Each has a movable collar around the driver

Fig. 14—Moveable collar adjusts this Stevens Walden nutdriver quickly and easily. Can be used to retain nuts to reach difficult corners.

shaft, and the socket is split. You put the nut in the socket and move the collar toward the tip, compressing the split hex and retaining the nut. It's a very useful tool for working nuts in difficult locations.

Another unique tool is Xcelite's PN-716 **external hex hollow-shaft** nutdriver (Fig. 15). It's used for removing and installing nuts on bal-

Fig. 15—External hex hollow-shaft nutdriver is made by Xcelite. It's used to remove and install nuts of controls on Arvin and Philco portable stereo sets.

ance controls, on-off switches, and volume-control shafts of Arvin and Philco portable stereo sets. The external hex is 7/16 inch and the hollow shaft is 6 inches deep.

Turning nuts can be easy with the tools described so far, but starting them can be a problem. One solution is GC's 9147 **dual nut starter,** which holds the nut until you get it started. It handles 1/4-inch and 5/16-inch hex nuts.

to remove the sharp point. Now slip a hollow-shaft nutdriver over the cut end and remove the nut carefully. The nut will straighten out the marred threads. If the bolt has a hex head, clamp it in a vise and work the nutdriver. If the bolt has a screw head, clamp the nut in the vise and use a screwdriver to work the bolt (or machine screw) out.

Nutdriver care

You cannot repair a nutdriver, for its socket must be an exact size for proper mating with the nut. If the driver is plated, you have nothing to worry about. If it is bare tool steel, work it over with an oily rag now and then. If a driver shaft does rust or gets dirty or grimy, clean it with sandpaper, emery cloth, steel wool, or a wire brush until it's bright. Then rub it with a slightly oily cloth.

You'll probably want to avoid magnetized drivers, as they can foul up color TV, tape heads, and other magnetically sensitive circuits. You can demagnetize a nutdriver by passing it through a color-TV degaussing coil, or through the loop of a solder gun.

ALIGNMENT TOOLS

Throughout all electronics—home-entertainment servicing, hobby and construction, broadcasting, industrial servicing, audio and ham radio—**alignment** is necessary from time to time. Critical circuits in receivers, transmitters, audio, video, and instrumentation tape recorders, test instruments, and filters must be readjusted for optimum performance from time to time. What you need to make such adjustments is the subject of this part of the series.

As you probably know, when you **align** a circuit, you adjust a variable component until the circuit performs the way you want it to. Generally only three types of components are capable of being adjusted over a range of values: resistors, capacitors, and inductors. When you align a receiver i.f. system, you adjust the slugs in each i.f. transformer until that transformer's maximum response occurs at the design-center frequency.

For example, in a typical AM receiver, you align the i.f. system by adjusting the position of a threaded powdered-iron slug within the primary (or secondary) winding (or both) of each transformer. What you

How to buy nutdrivers

The two most useful nutdrivers, as mentioned before, are Nos. 8 and 10, and these should be your first purchase. When you are ready to round out your tool box a little more, get Nos. 6, 12, 14, 16, 18, and 20. Only if you are doing a lot of work will you need the other, more unusual, sizes.

Buy drivers with color-coded handles; you'll find it easier to grab the correct tool in a hurry.

It's probably more useful to buy long-hollow-shaft nutdrivers, since you can then work both long bolts and recessed nuts. You might also get a couple of midget drivers (Nos. 8 and 10). What if you have to turn an odd-sized nut in a tight space where the long-shaft driver won't fit? This situation occurs so seldom it's more practical to use a small right-angle wrench.

If you do a lot of field work, buy a handle-and-blade kit, preferably one including screwdriver blades. Remember that you can use the kit in the shop, too.

Nutdrivers with plated shafts are better than those with bare steel, as they don't rust.

Tips on nutdriver use

Be sure you seat the driver socket firmly on the nut or bolthead before you start turning it. If you force the nutdriver and it slips off the nut, you'll deface the internal hex surface of the driver. If you are removing a nut from a bolt and the nut jams in the driver socket, don't try to work it out with an awl or icepick. Carefully screw the nut back on the bolt a short distance, and then remove the driver. You can then unscrew the nut with your fingers. If the bolt is dirty, back the nut onto a fresh bolt.

If a nutdriver starts slipping on nuts, the internal hex surfaces have probably become rounded from being forced on the wrong-sized nut. Inspect the driver socket carefully and try it on some new nuts. If it looks defaced or slips repeatedly, replace it.

If you want to shorten a bolt by cutting the end off, do this: Run a mating nut down the bolt past the point of cut, then clip off the end with bolt cutters, lineman's pliers, or heavy-duty dikes. When you clip the bolt you mar the threads. With the nut still on the bolt, file the bolt tip

are doing is varying the inductance of that winding, and in turn varying the resonant frequency of the LC combination. In some receivers, the inductance of each i.f. transformer is fixed, and you adjust the spacing of the capacitor plates in the LC combination. The result is the same in each case—you vary the resonant frequency.

In most cases, you can adjust a variable resistor with your hand by twisting the knob or shaft of the pot. Variable resistors are seldom used in tuned circuits, and bringing your hand near one won't usually affect circuit performance.

That isn't true of capacitors and inductors, and especially most tuned transformers. Your hand, or a metal screwdriver blade, will nearly always detune an LC circuit. So to align these circuits, you've got to use nonconductive, nonmagnetic, and noninductive tools. They are called **alignment tools.**

What they're made of

Back in the beginnings of radio, alignment tools were made of bakelite simply because very few strong, durable plastics were available. Even wood was used occasionally. Today many tough, resilient plastics are used to make alignment tools—vinyl, Lucite, polyester fiberglass, Nylon, Delrin, glass-filled polymer plastic, and even bone fiber.

Some are perhaps more durable than others, but what's more important is that all are relatively inexpensive and readily available. Thus you really don't need to take as good care of a plastic alignment tool as you should of a tool-steel screwdriver. If you deface or lose an alignment tool, you can buy another cheaply.

Once in a while you have to break loose a frozen screw or slotted bolt, and no kind of plastic will take that kind of punishment long. In such cases, the thing to use is a metal-tipped alignment tool. Brass, iron, spring steel, and beryllium copper are all used for the tips of plastic alignment tools. Such metals give you the tough working edge you need to loosen a metal adjustment, without adversely affecting the tuned circuit. Iron is an exception, but there's a special reason it's used. More about this later.

What they contact

Variable resistors are adjusted by their shafts, which may have a knob or be knurled or slotted to take a screwdriver blade. If the pot is in a sensitive or hot circuit, you may have to use a nonconductive flat-bladed alignment tool.

Plate-to-plate spacing of a variable capacitor (such as a mica trimmer) is usually adjusted via a slotted-head machine bolt or screw.

The inductance of a variable inductor (or transformer winding) is usually varied by changing the position of a powdered-iron slug within the winding. Sometimes the slug has a recessed slot or hex at one end. Now and then a headless machine bolt is anchored in the slug, and the end of the bolt is split or slotted.

As you can see, to perform alignment properly, you must have tools which will mate exactly with the adjustments they are to contact. If you use the wrong size blade to adjust a trimmer capacitor, you may strip the screw head. What's worse, if you use the wrong tool to adjust a recessed-slot, powdered-iron slug, you may break the slot away, making it nearly impossible to adjust the slug.

Handles and shanks

The three most common types of alignment tools are shown in Fig. 1. The **standard straight type** (about 7″ long) often has a different tip at each end, and is useful where you don't need much torque to make the

Fig. 1-a—Standard straight alignment tool usually has a different tip at each end. Unit shown is GC's model W2520.

Fig. 1-b—Add a handle and you get a lot of added torque. Also helps to fine tune a coil. Shown is GC W2522.

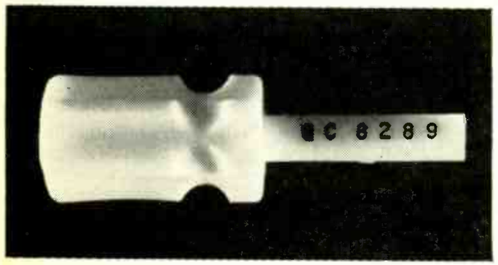


Fig. 1-c—Stubby alignment tool is great in tight corners. Also it delivers maximum torque. GC 8289 shown has recessed blade.

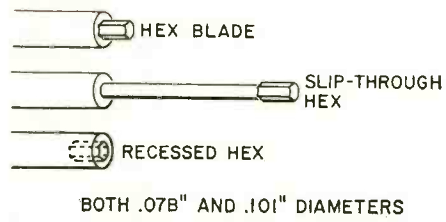


Fig. 4—Three kinds of hex-head alignment tools. All are needed at one time or another.

but more useful is the **slip-through hex**, as the restraining shoulder is some distance back from the tip. This feature allows you to slide the hex through the top slug on a double-tuned i.f. transformer and adjust the bottom slug, then pull back and adjust the top one. Often you can't work a can from both sides of the chassis, and thus the slip-through hex is invaluable. The **recessed hex type** is used for male hex shafts. All hex tips are available in 0.078 and 0.101 inch widths.

In Fig. 5 you see the two types of square tips—the **blade** and the recessed. Both are useful now and then for certain special types of adjustment shafts.

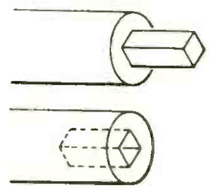


Fig. 5—Square tips are also called for. Here both blade and recessed types are shown.

The **round crossbar** shown in Fig. 6 is useful for aligning nested iron core slugs in some TV receivers. The **flat crossbar** is used to adjust piston-type variable capacitors.

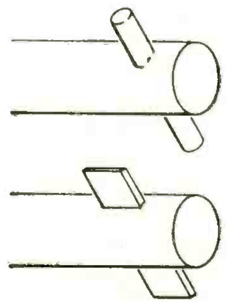


Fig. 6—Round and flat crossbar shafts are used in some special alignment applications.

adjustment. A tool with a **driver handle** supplies more torque, and is also useful when you want to fine-tune an adjustment slowly. The stubby (about 2″ long) is for tight jobs.

Tip of the tool

The most common alignment-tool tip is the **flat screwdriver type blade** (Fig. 2). The **plastic blade** can be used almost anywhere unless

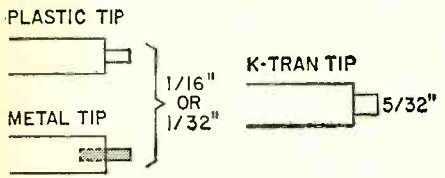


Fig. 2—Flat screwdriver type blade is the most common tip (top left). Metal tips (bottom left) are used for ceramic trimmers. K-Tran tip (right) is needed to adjust K-Tran i.f. transformer slugs.

you need more torque. Then you use a **metal-tipped** tool. The metal tip is nonmagnetic, but is used mainly for ceramic trimmer capacitor screws, and not for inductive circuits.

A popular i.f. transformer is known as the **K-Tran**, and its slug must be adjusted with the flat-blade tip shown at the bottom of Fig. 2. The blade is 5/32″ thick by contrast with the usual 1/16″ or 1/32″ of the others.

Two types of recessed tips are in Fig. 3—the **recessed blade** (a male blade within a tubular recess), and the **recessed slot,** which is a

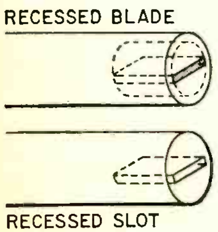


Fig. 3—Two kinds of recessed tips. Top is a recessed blade, bottom is recessed slot. Both are needed often.

female blade. The recessed blade is very useful for slipping over a threaded headless bolt used in many i.f. cans, as it can't slip off. The recessed slot is a must for adjusting a tabbed bolt or shaft, such as screws and studs used in auto radios and some TV sets.

Several tuned circuits have hex adjustments, and for them you must use the tips shown in Fig. 4. The **hex blade** works on many slugs,

Specialized tools

You'll find a **diddle stick** very useful—it's a solid piece of plastic about 16″ long by 1/8″ in diameter with flat blades at both ends, and is used to adjust TV tuner oscillator slugs from the front of the cabinet. When the tips become dulled you can file them down flat again. If a slug is frozen, use a long, skinny metal screwdriver to loosen it (be careful), then adjust the slug for best picture and sound with the diddle stick.

Somewhat similar is Erikson's **Tippy Stick** which is a flexible Tenite rod with a nonmagnetic metal tip at one end and a plastic tip at the other. You break the slug loose with the metal end and adjust it with the plastic tip.

Sometimes you lose a TV tuner oscillator slug by adjusting it too far in. Before you pull the chassis, try GC's **Slug Retriever.** You slip the shaft onto the slug slot and push the handle, expanding the split tip and grabbing the slug. Then you rethread the slug into its form.

Often it's useful to keep track of how many turns you've adjusted a slug or control. One way to do so is by using GC's **turn-counting tool.** Calibrated lines show how many turns—to the quarter of a turn—you have worked the adjustment.

Want to buy

If you're particular, you may want to select only the alignment tools you need, buying them one by one. But kits are available which include a number of popular tools in a plastic folder you can throw in your tool box or carry in your shirt pocket. You can buy kits for TV, CB, industrial, and other special fields.

If you do a lot of alignment, you best bet is probably to buy a couple of each type of tool. For one thing, it's nice to have a backup if you lose one. Also, sometimes it's necessary to work two similar adjustments simultaneously with both hands. Many alignment tools cost less than a dollar, so you won't have to spend a lot of money to obtain the insurance of extra tools.

There are, of course, other specialized alignment tools designed for special purpose adjustments. What has been covered here are the most useful tools. **R-E**

PROGRAMMED

STEREO MULTIPLEX FM IN 1970 CARS

by LARRY ALLEN, cet

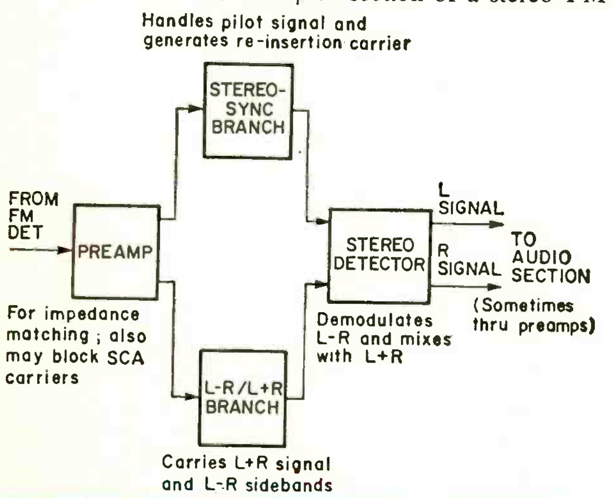
Just read each easily digested frame of information. Then test your grasp of it by answering a multiple-choice question. If you choose correctly, you're guided automatically to the next program capsule. If you miss, don't worry; extra programed information helps you to a correct answer.

Stereo (often called *multiplex*) broadcasting over FM stations began several years ago. Yet technicians hesitate to work on such receivers. This goes double for sets in automobiles. Which is too bad . . . for the 1970 cars now on the road and those to come have more of these receivers than in any year before.

In this short course, you'll discover there's no good reason to be afraid of stereo FM sets. Most of them are basically alike. Differences are minor. Learn one brand or model and you can handle them all.

How simple they really are can be seen in the function diagram. This diagram could easily belong to almost any brand or model. That's because any multiplex receiver must do certain things, no matter who designs or builds it. The differences, then, lie in the stages themselves, and even they are remarkably similar.

1 Here's how the multiplex section of a stereo–FM



set works. The composite multiplex signal comes directly from the FM discriminator or ratio detector. There's no de-emphasis network, because it would foul up the L—R sidebands. A preamplifier matches the high impedance of the discriminator to the lower impedance of the stages in the multiplex section. The preamp is usually a combination stage that amplifies some of the signal and merely matches impedance for the rest.

The L—R sidebands and the L+R signals are separated from the 19-kHz synchronizing signal at the preamp. In preamps of some models, traps and filters eliminate SCA (67-kHz, etc.) signals, so they can't interfere. In others, the SCA traps may be in the L—R/L+R branch. The composite L—R/L+R stereo signal, minus the 19-kHz pilot carrier, is fed to the stereo detector.

The pilot signal is amplified in some models. A carrier generator in the stereo-sync branch produces a 38-kHz reinsertion carrier for the stereo detector. Without the carrier, the detector can't extract the L—R audio signal from the L—R sidebands. The pilot signal synchronizes the phase of the carrier-generator signal, so the demodulated stereo is exactly like the original modulation.

The stereo detector combines the 38-kHz reinsertion carrier, the L—R sidebands, and the L+R signals in a way that recovers separate left and right audio signals. The two-channel audio output goes to a stereo amplifier.

Question: Name the two branches of a multiplex section.

- ☐ Left and right. **Move on to Frame 14.** (page 81)
- ☐ Pilot and L—R/L+R. **Check frame 20.** (page 90)
- ☐ Discriminator and i.f. **Read Frame 5.**

2 You're on the right track, but not correct. The synchronized oscillator is common in Delco models, but a frequency doubler system is what's used in most others. The doubler is sometimes preceded by an amplifier, sometimes followed by one, and in one brand it's alone. You might want to **reread Frame 20,** but it's okay if you just **go on to Frame 12.** (page 68)

3 **You're not right.** This was a nonsense answer. If you picked it, you're only guessing, and should begin at **Frame 1** again. However, if you think you know the right answer now, go back to **Frame 20** (page 90) and have another try.

4 **You're on the wrong track.** This might sound complicated enough to be an answer, but it isn't. You need to give the whole idea a little more thought. However, the answer is plainly stated in **Frame 13** (page 80). Perhaps you'll get it quicker if you'll read that frame over again and then try answering the question.

5 **Come on . . . you knew that wasn't the answer.** You skipped to this frame just to see what it says, right? Fact is, you probably knew the right answer all along. So **go back to Frame 1** and pick it out.

(continued on page 66)

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

Could they be talking about you?

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

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

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

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

(continued from page 61)

6 **That's a preposterous answer!** You didn't really think that, did you? The foils of the capacitors have absolutely no bearing on the polarity of the outputs. **Read Frame 13 again** (page 80) twice, if you picked this answer seriously) and choose the right answer to the question.

7 **Right you are.** Their reversed polarity merely reverses the polarity of the L—R signal they develop. Then, combining that with the regular L+R signal gives a net audio signal that is opposite, too. Okay, you're doing great so far. Now **move on to Frame 11** (page 67) and learn about stereo indicators. They're simple.

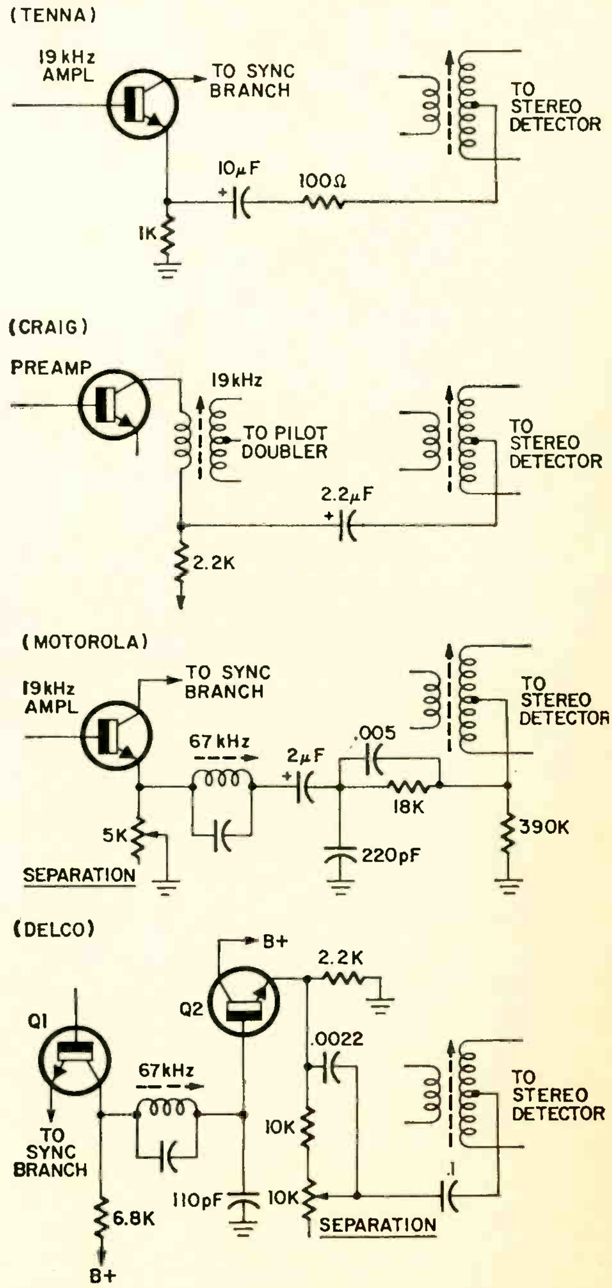
8 The L—R sidebands and L+R signals go from the preamp to the stereo detector by a separate branch. As usual, they differ from set to set. All the diagrams of L—R/L+R branches show the input preamp or the first 19-kHz amplifier as the stage that isolates L—R/L+R. The pilot signal goes to its own branch, which was already explained in **Frame 12** (page 68).

The simplest L—R/L+R branch is in the Craig stereo–FM receiver. It's nothing more than an electrolytic capacitor. The transformer primary in the collector circuit isn't decoupled at the bottom end, thus leaving the supply resistor as part of the output load. The transformer couples out the 19-kHz pilot signal, and the remaining signal—the L—R sidebands and the L+R—goes through the capacitor to the center tap of the stereo detector transformer.

The Tenna Corp. version isn't very much more complicated. The load feeding the L—R/L+R branch is the emitter resistor. In the branch, there's a larger-value electrolytic, and a 100-ohm resistor that improves frequency balance of the branch. Again, the multiplex signal (without pilot carrier) is fed to the center tap of the detector transformer.

In the Motorola L—R/L+R branch, a 67-kHz trap blocks SCA carrier, if any is present. Beyond the coupling electrolytic, a time-constant circuit consisting of two capacitors and two resistors feeds the raw stereo signal to the detector.

The Delco L—R/L+R branch is obviously the elaborate one. There's an SCA trap, then impedance-matching emitter follower Q2. A frequency-compensating network couples the signals from the emitter load of Q2 to the center tap of the stereo detector transformer. A SEPARATION control is part of the compensation network. The 0.1-μF capacitor also blocks dc from the transformer winding.



Question: Exactly what signals are handled by the branches shown in the figure above.

- ☐ L—R sidebands and L+R audio signals. **Go on to Frame 13** (page 80).
- ☐ Left and right audio signals. **Move to Frame 9.**
- ☐ Composite stereo signal and pilot carrier. **Check Frame 19** (page 90).

9 **You're only partly right.** The answer you chose is true under one condition: that the receiver is picking up a monophonic FM signal. A monophonic signal is equivalent to a simple L+R signal, which can go right on through the L—R/L+R branch of the multiplex section.

L+R is applied to both sides of the stereo detector equally, since it goes into the transformer center tap. There's also no 19-kHz pilot to activate the sync branch, so there's no 38-kHz reinsertion carrier in the detector. The L and R signals go unaffected to the detector output and finally to both speakers. That's monophonic reception.

However, the question in **Frame 8** refers to stereo reception. **So, go back,** read the question again and you'll pick out the right answer easily.

There are only three groups of adjustments in a stereo–FM multiplex section: (1) The SCA traps, (2) the stereo-sync coils and (3) the SEPARATION control. Before you start, make sure the BALANCE control is the stereo amplifier is properly set, and then proceed.

You can use a modulated 67-kHz (and 53-kHz, when that's included) signal for trap adjustments. Clip a scope or vtvm at the center tap of the stereo detector transformer. Or, you can use an unmodu-
10 lated 67-kHz (or whatever) signal and monitor your adjustment with a dc voltmeter clipped to the output anode of one of the stereo detector diodes (D2 or D3 in the diagram in **Frame 13** page 80.

Be sure to force enough signal through the traps to get a noticeable reading. Then tune the appropriate coil(s) for minimum indication on the voltmeter or scope.

Next, adjust the 19- and 38-kHz coils using an accurate source of unmodulated 19-kHz signal. These adjustments can be made with the signal from a stereo–FM station, although modulation may affect readings if you connect a voltmeter in the stereo detector. Tune all 19-kHz and 38-kHz coils and transformers for maximum indication.

To assure best separation, you must use a stereo–FM generator or a station that periodically broadcasts a one-channel-only signal. If one does, it's usually on the left channel. But be sure—call the station and ask.

With left channel modulated, connect an ac vtvm across the right-signal output of the multiplex section or across the right-side speaker output of the receiver. Turn the volume up and set the separation control for minimum right-channel reading while receiving a left-channel signal.

That's all there is to it. Simple . . . right? You've done so well, getting this far, that you get off without a final exam. **You've just graduated!** **RE**

So the listener will know for sure when a stereo program is being received, many auto sets nowadays have a light that comes on during stereo programs. The light is turned on by the pilot carrier. Some of the ways this is done are shown.

Three models—the Tenna, Craig and Motorola—depend on dc voltages that are a byproduct of actions in other stages. In two of them—the Tenna and Craig—the dc triggering voltages are a result of using full-wave diode doublers to raise the 19-kHz signal to a 38-kHz carrier. A small positive voltage develops at the cathodes of the diodes whenever a 19-kHz sync signal is present.

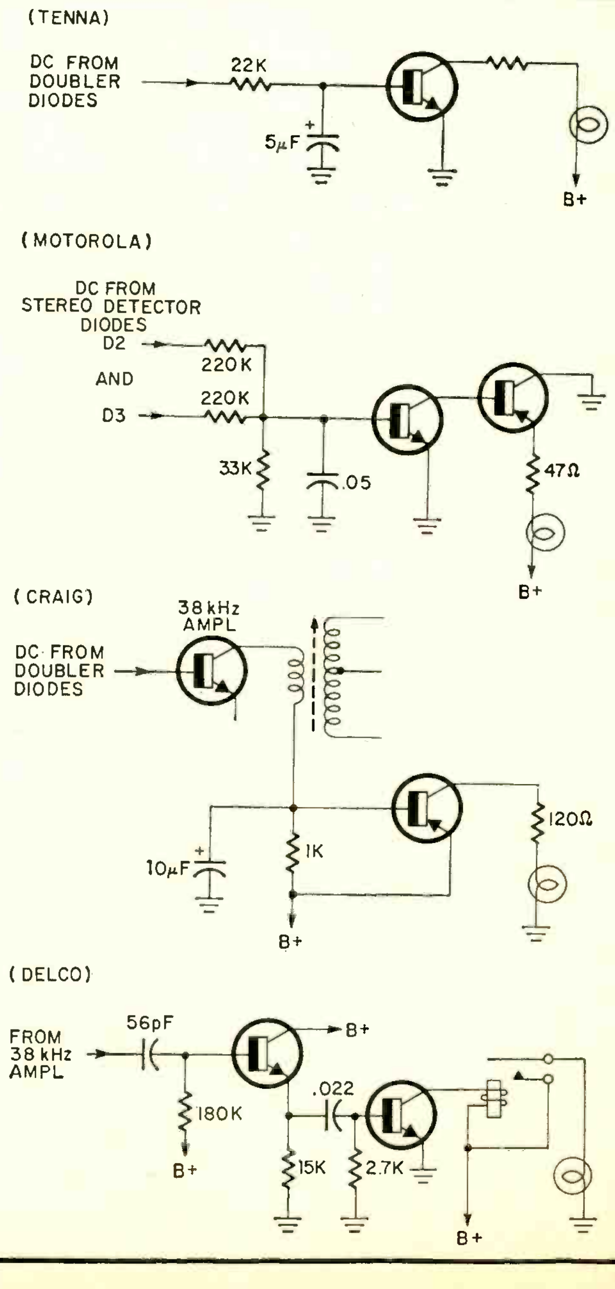
In the Tenna unit, that dc merely biases a transistor that has a lamp in its collector circuit. The Craig circuit takes advantage of the effect of the voltage on average conduction in the collector of the 38-kHz amplifier transistor. A supply resistor in the collector circuit develops a voltage change that biases the lamp-control transistor. In this case, B-plus is fed to the emitter, and the collector-load lamp goes to ground.

If you look back at the stereo detector in **(Frame**
11 **13,** page 80), you'll notice that a positive voltage can easily be picked off at the cathodes of D2 and D3. This is what is used to activate the Motorola stereo indicator. A pair of 220,000-ohm resistors prevents any interaction with normal operation of the stereo detector. The voltage thus obtained biases a dc amplifier which turns a switching transistor on or off. The lamp is between emitter and B-plus; collector is grounded.

Delco uses a relay. Some of the 38-kHz signal developed when a pilot signal is present is fed to an amplifier. The amplified signal goes to a control transistor whose bias changes according to how much signal is applied. When the signal is there, the relay closes, lighting the lamp.

Question: What part of the total stereo signal is used to trigger stereo indicator lights?

☐ The pilot carrier. **See Frame 18** (page 81).
☐ The L–R sidebands. **Move along to Frame 17** (page 81).
☐ All of it. **Check Frame 22** (page 90).



Yes, a frequency doubler is the most common way to get a synchronized 38-kHz carrier from the 19-kHz stereo sync signal. As you remember from the diagram in **Frame 1** (page 61), the 19-kHz sync signal is separate from the stereo composite signal at the input preamp stage.

Since the stereo-sync branch is the one most likely to differ in various multiplex sections, it's a good one to understand well. All three major types are shown in below, with circuit details. The middle one is the most popular.

At the top, the Motorola is the simplest of the bunch. The preamp is also a pilot amplifier; a 19-kHz tuned circuit is the collector load. The 53-kHz tuned circuit is a trap to prevent audible interference between an SCA carrier and the upper end of the L/R sidebands (they go up to 53 kHz). The takeoff for the L−R/L+R branch gets its signals from the emitter—across R2, the SEPARATION control. There's another SCA trap in that branch, but it's not shown.

The diode clips off the negative half of each cycle, which makes it easy for the transistor to amplify the second harmonic of 10 kHz. The tuned transformer rounds out the amplified 38-kHz cycles, and applies the carrier to the stereo detector.

The middle schematic has a passive doubler. A tapped transformer applies the 19-kHz signal to a full-wave rectifier circuit. The output, which is twice the input frequency, is coupled to a 38-kHz amplifier. Then a transformer couples it to the stereo detector.

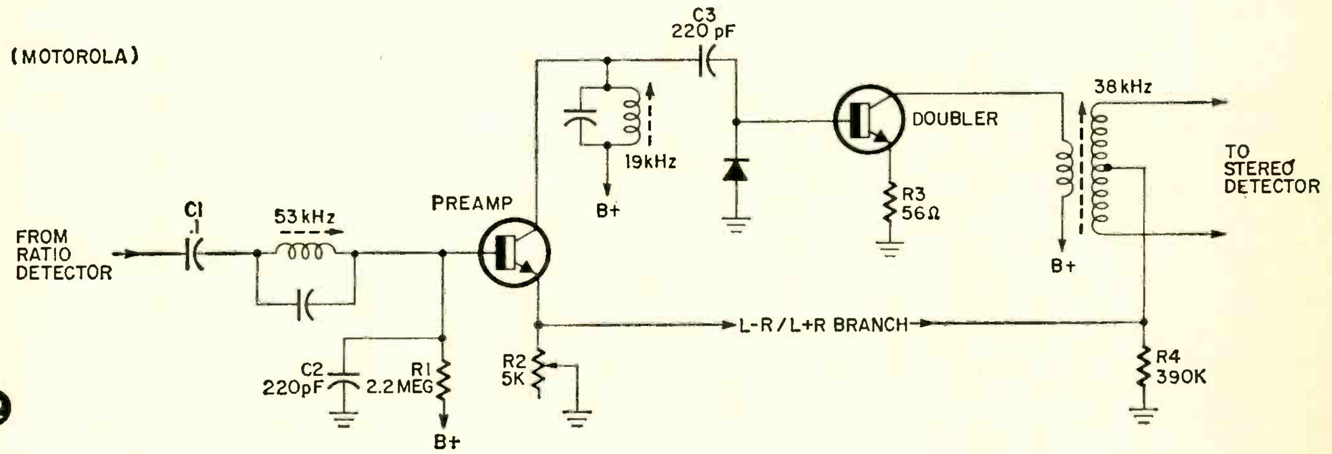
The bottom version of these sync branches is the Delco, with the locked oscillator. The oscillator is a Hartley. It is synchronized by 19-kHz signals fed to the base of the oscillator transistor. The 38-kHz oscillator is transformer-coupled to the stereo detector.

Question: Can you figure out one factor common only to doubler-type pilot channels?

☐ A diode is responsible for the doubling. **Move to Frame 15** (page 81).

☐ The transistors are all npn types. **Go to Frame 16** (page 81).

☐ The 19-kHz signal is always transformer-coupled. **Look at Frame 21** (page 90).



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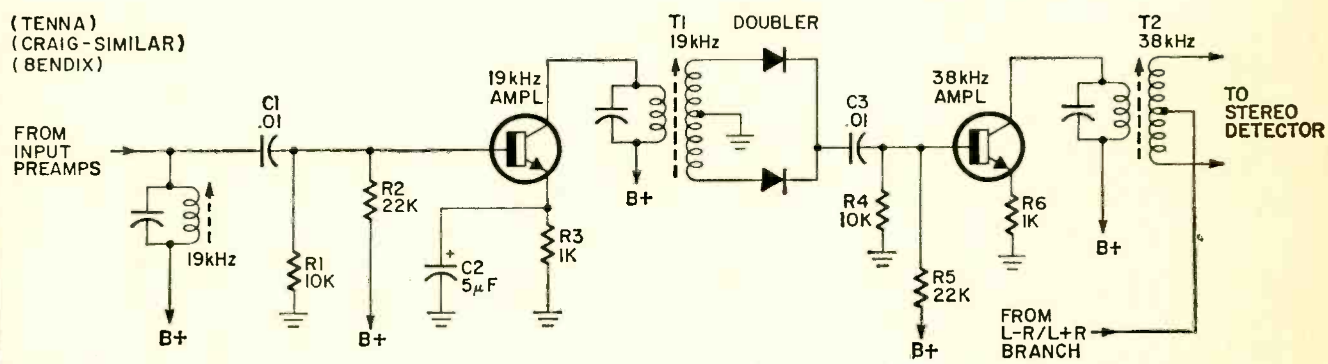
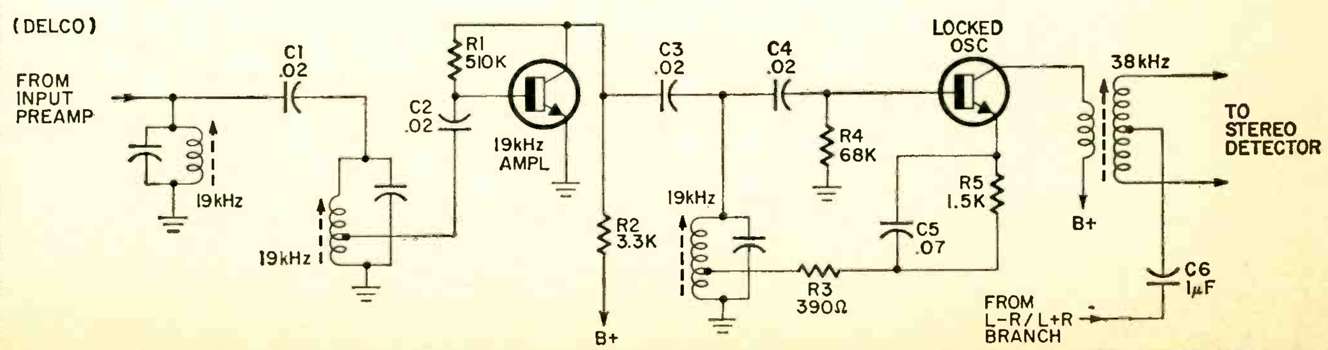
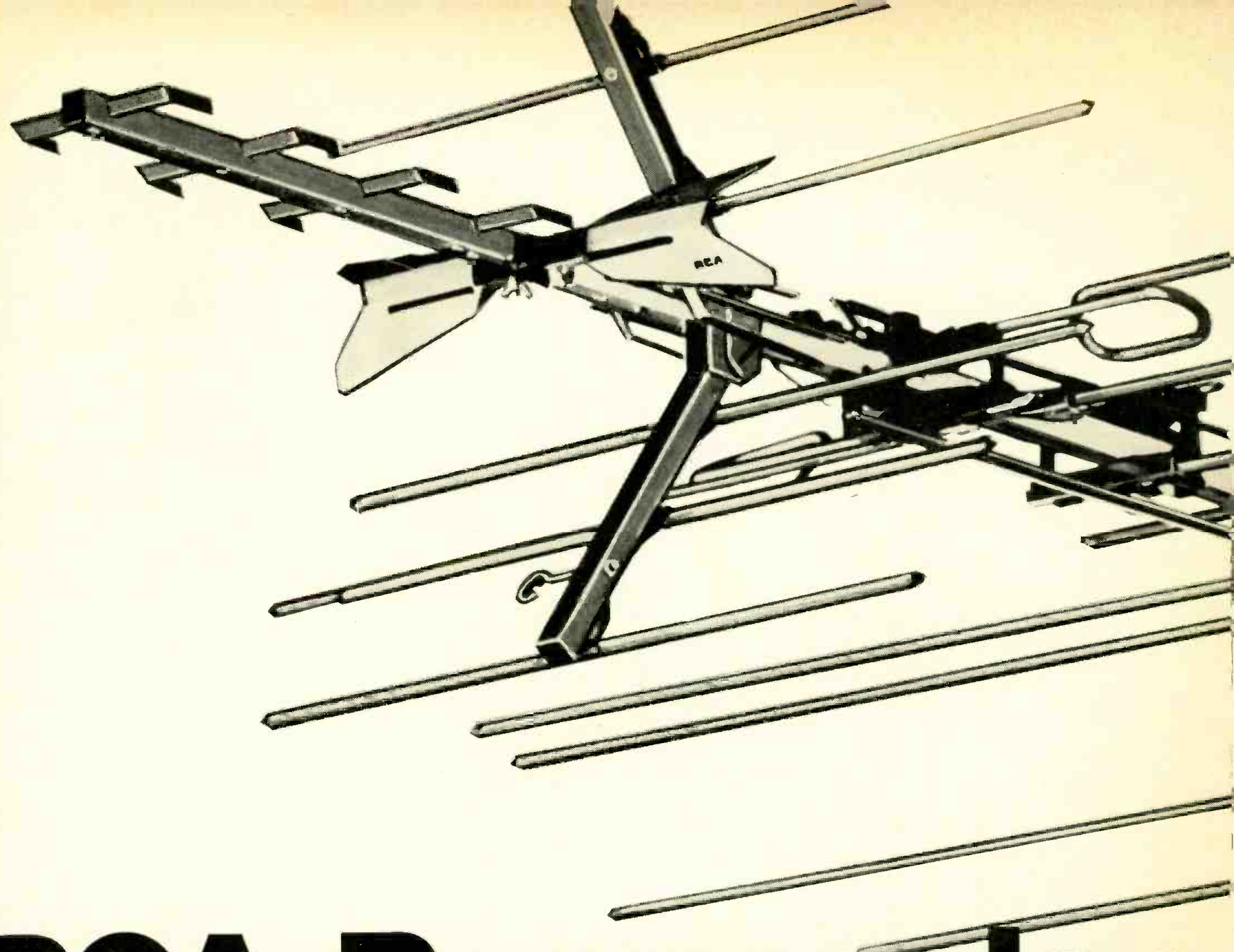




(continued on page 80)

When RCA engineers put their minds to antennas, outstanding things happen:

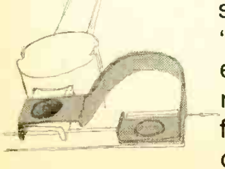


RCA Permacolor

Permacolor is not just an improved antenna, it's a completely new antenna. New in looks. New in design. Very easy to set up and install.

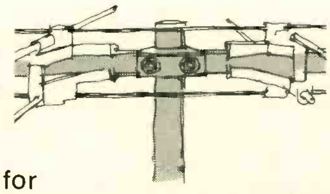
And Permacolor is manufactured exclusively by RCA. Here are a few of its many unique features:

Permanent Connections.
Any antenna is as permanent as its electrical connections. Particularly between the elements and the feed line. If a connection fails, ghosts, streaks, "noise," even total reception failure may occur.



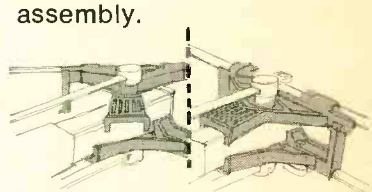
On a Permacolor an aluminum strap solidly connects every active element to the feed line. Connection failure is virtually eliminated.

Tuned Circuits.
Permacolor elements are integral parts of tuned circuits and many perform more than one function. Circuits stay "perma-tuned" because elements are permanently connected. Feed lines are unbroken aluminum strips perfectly balanced for optimum impedance match and minimum ghost pick-up.



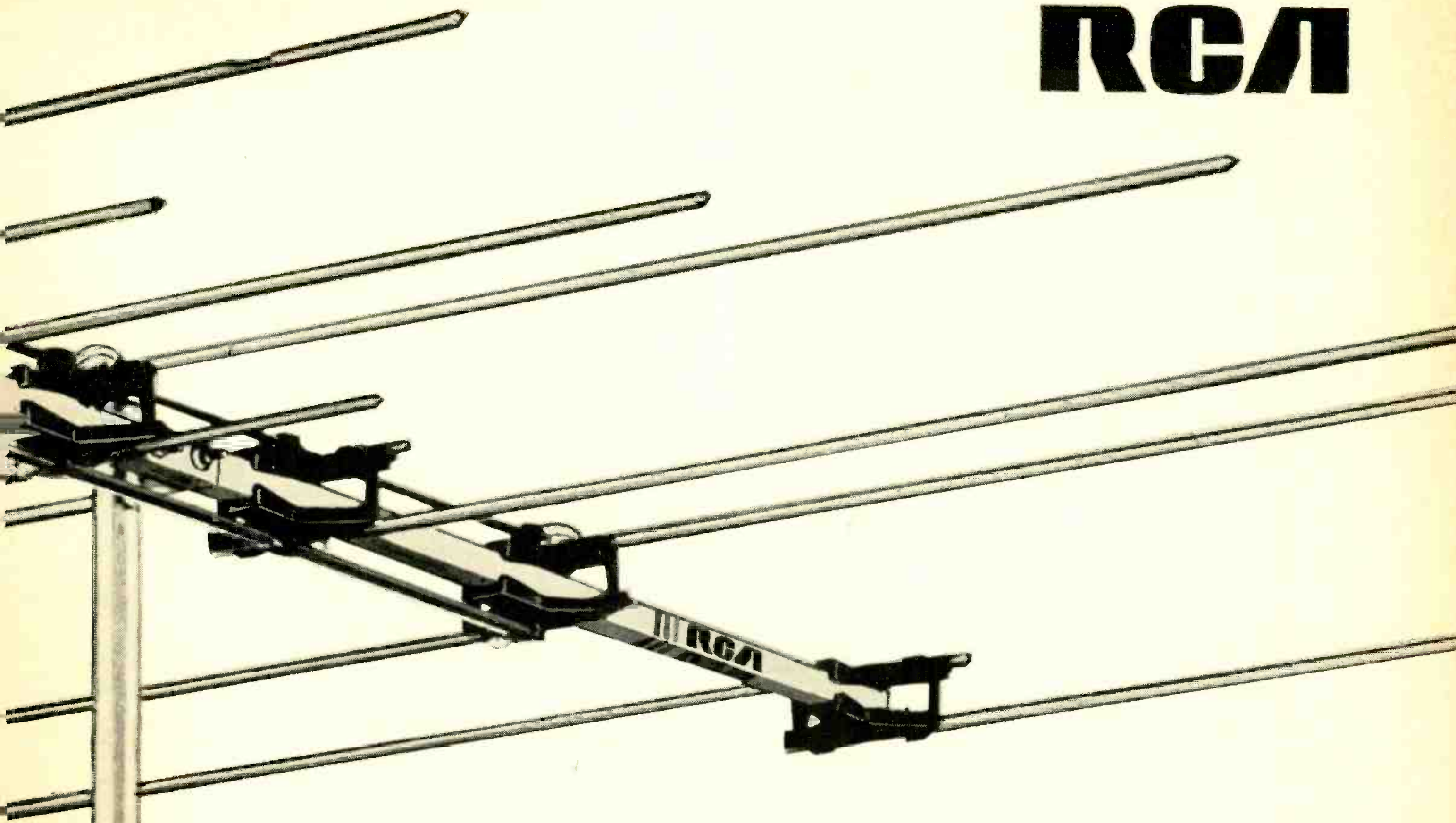
Revolutionary Insulators.
Permacolor insulators are polypropylene, a tough, flexible, waterproof plastic with superior electrical properties. Their unique design includes many ribs and barriers to make leakage paths longer.

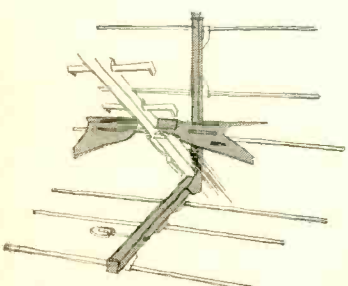
On a Permacolor, elements do not pivot. Instead, the elements are assembled right into the insulators. Each insulator, gripping 5½ inches of element, pivots as a unit. When the Permacolor unfolds, insulators snap in place and permanently lock to form a rigid truss. There's no point of high stress along the entire assembly.



Superior Combinations.
UHF and VHF get bigger boosts on Permacolor combinations. On the corner reflector, the angle is increased to 110° for optimum efficiency. And for the first time, a bow tie is included. This best type of UHF dipole is integrated into a single downlead, made possible by a newly designed three-tuned-circuit coupling/isolating network.

RCA



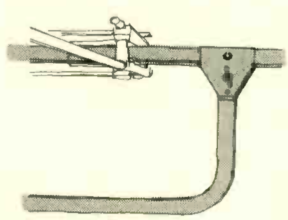


Permacolor combinations are uncompromising all-channel antennas.

Square Boom.
A square boom supports the Permacolor. And it isn't a feed line—it's at ground potential. Detuning effects that often occur when a grounded mast is coupled to a signal carrying boom are eliminated.

The mast clamp is heavy plated steel and locks around the boom without rivets. A double set of serrated teeth take a vise-like bite on the mast to prevent slipping or twisting.

Goes Up Easier.
A Permacolor goes up in one piece. On the roof. Not on the ground. There's no bag of parts. There's nothing to take apart. An installer's job has never been easier or faster.



And installation is just as easy on larger models. A double boom gives added strength, yet takes up only 10 inches on the mast. This allows Permacolor to be placed closer to a rotator, thus minimizing stress on the rotator as well as the mast.

Tough Finish.
Permacolor has a tough blue and gold vinyl finish on all aluminum parts—even the hidden areas. It's similar to the long-lasting coating on aluminum siding for homes.

There's not another antenna like the new, trim, clean RCA Permacolor.

See the complete line of Permacolor antennas today. Your RCA Parts and Accessories Distributor has them now.

Parts and Accessories
Deptford, N.J.

NEW SEMICONDUCTORS

AGC I.F. AMPLIFIER IC

The μA757C is a new high-gain agc i.f. amplifier designed for AM and FM communications receivers, where it provides high-gain amplification without detuning the external circuits. It consists of two gain-controlled sections that can be operated independently or in cascade.

The design of the Fairchild IC features excellent dynamic signal range and improved signal-to-noise characteristics; a linear relationship between agc voltage and the logarithm of gain which simplifies the design of agc loops and S-meter circuits. Useful up to 25 MHz, the μA757C provides constant input/output impedances at changing agc levels and gain is constant despite temperature and supply-voltage variations.

Agc sensitivity is 50 dB per volt with a 70-dB agc range at 10.7 MHz. Voltage gain at this frequency is 70 dB, power gain is 78 dB. The IC operates within a temperature range of 0° to +70°C and comes in a 14-pin dual-in-line package. Price is $7.50 for 1-24; lower in larger quantities. **R-E**

COMING NEXT MONTH

JULY 1970

- **10 Steps To Best Mike Use**
  Proper mike use is the key to first rate PA systems and tape recordings. Learn the right way, first.
- **FET Dual-Trace Scope Switch**
  A must for experimenting with digital circuits; simplifies audio troubleshooting. Handles signals out to 1 MHz.
- **Use PA Systems Effectively**
  A few simple rules and precautions make it easy to get the best out of your PA setup.
- **Kwik-Fix™: Color Demodulators**
  Solid-state demodulator sections can be tough to repair unless you know what to look for. Included are screen symptoms, dc voltages and waveforms.

NEW PRODUCTS

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

PORTABLE FISH SPOTTER, *Heathkit MI-29,* all solid-state, features wide-dispersion-angle transducer that allows fisherman to survey greater areas underwater in shorter time, down to 200 ft, with 5% depth accuracy. Describes underwater terrain and vegetation; spots not only schools but individual fish. Gives navigational depth sounding as secondary

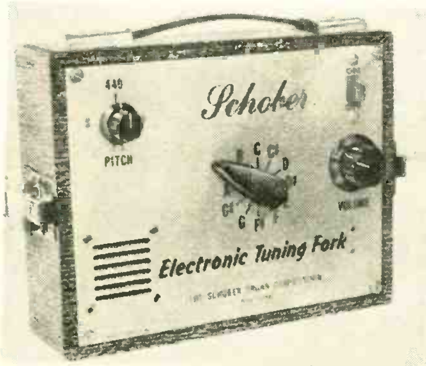
function. Operates from internal batteries in completely waterproof, floating case. Heath noise rejection control allows unit to be close to engine without ignition noise showing up on calibrated dial. Adjustable sensitivity control eliminates echoes from bottom in shallow waters. Waterproof transducer mounts with 2 large suction cups to transom or side of boat and comes with 15-ft. cable. $84.95. **Heath Co.,** Benton Harbor, Mich. 49022.

Circle 46 on reader service card

INTEGRATED STEREO AMPLIFIER, *TA-1144,* consists of preamp and power amplifier, uses all silicon transistors giving 70-watt dynamic power (IHF) into an 8-ohm load without distortion. Uses quasi-complementary-symmetry circuit, assures low distortion and high damping factor at low frequencies. Features 2 pairs of phonograph input connectors for 2 turntable systems, binaural auxiliary input connector on front panel for duplicating tape or temporary use, pre-power amplifier selector for multichannel system, easy-to-read tone and balance controls. $219.50. **SONY Corp. of America,** 47-47 Van Dam St., New York, N. Y. 11101.

Circle 47 on reader service card

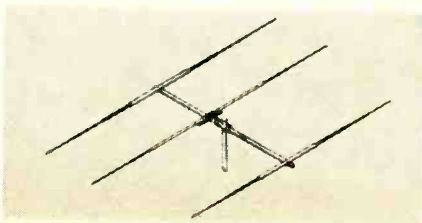
ELECTRONIC TUNING FORK has 12 steady tones, middle C through the B above it. Pitch accuracy is within 5 cents (5% of semitone). Special knob sets scale at A-440 but permits resetting anywhere between about 435 and 445. Tones have harmonics, making zero-beat tuning technique easier and permitting unit to be used directly to tune instruments in higher and lower octaves. Has



strong wood case (5½ x 7 x 3 in.) covered with tough, attractive fabric; front cover and carrying handle. Operates on 2 flat 9-volt transistor batteries. Has own built-in loudspeaker. Solid-state circuitry with no moving parts and no warm-up time. Voltage regulator maintains pitch accuracy during entire life of batteries (about 18 hr of continuous operation and several times that in normal use). $49.95, with quantity discounts. **The Schober Organ Corp.,** 43 W. 61 St., New York, N. Y. 10023.

Circle 48 on reader service card

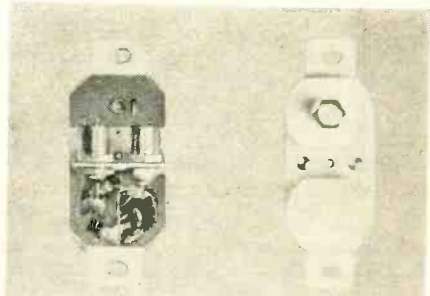
SINGLE-BAND BEAM ANTENNAS, *Classic 10* and *15* feature new feed system plus optimum spacing, maximum gain, increased bandwidth, more efficiency through balanced capacitive matching. Have rugged, lightweight con-



struction with high-impact insulators and clamping blocks, aluminum element support and tubing, stainless-steel hardware. *Model CL-10* for 10 meters, 1 kW; *model CL-15* for 15 meters, 1 kW. Forward gain: 8 dB compared to reference dipole; 10.1 over isotopic source. Front-to back ratio: 20 to 25 dB. SWR: 1.5/1 or better. Feed-point impedance: 52 ohms. Recommended transmission line: RG-8/U. *Model CL-10,* 10 meters, 1 kW, $57.64. *Model CL-15,* 15 meters, 1 kW, $66.50. **Mosley Electronics,** 4610 N. Lindbergh Blvd., Bridgeton, Mo. 63042.

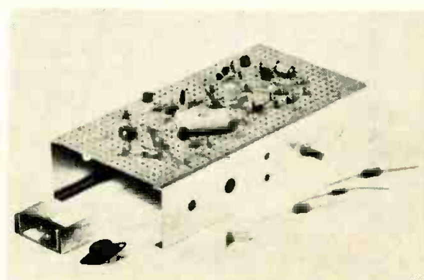
Circle 49 on reader service card

MATV TAPOFFS AND LINE EXTENDER AMPLIFIERS, *models SL-6302* and *SL-6312.* Latter gives 12.5 dB at uhf (channels 14 through 83) and passes vhf at unity gain. The former model gives 13.5 dB gain at vhf (channels 2 thru 13) and unity gain at uhf. Both units give an 82-channel "F" output tapoff. Can be cable-powered from any 17-Vdc, 24-mA source. Are designed



primarily for use with JFD *Smoothline* cable-powered systems. Ideal for extending MATV trunk lines to accommodate extra TV outlets or when wing is added to building. Fit any standard electrical box; can be installed anywhere on MATV trunkline. Can amplify signals enough to eliminate snow at end of old lines. $47.50 each. **JFD Electronics Co.,** Systems Division, 15th Ave. at 62 St., Brooklyn, N. Y. 11219.

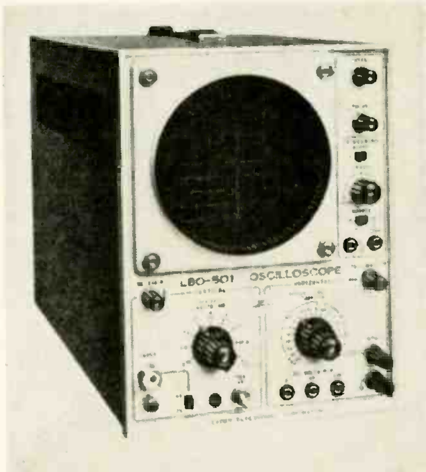
Circle 50 on reader service card



SOLDER-TYPE BREADBOARDING KIT consists of phenolic breadboarding deck, metal base, solder-type feed-through terminals, switch and potentiometer brackets, universal "Z" brackets, right-angle brackets, smaller pieces of phenolic board and assembly hardware. Deck, 5" x 10". Base has ¼", ⅜" and ½" holes. Feed-through terminals accommodate 6 or more wires on top and 4 or more on underside of breadboard deck. Terminal insertion tool provided. Universal "Z" and right-angle brackets will mount IC sockets. **Houle Mfg. Co.,** P.O. Box 276, Santa Susana, Calif. 93063.

Circle 51 on reader service card

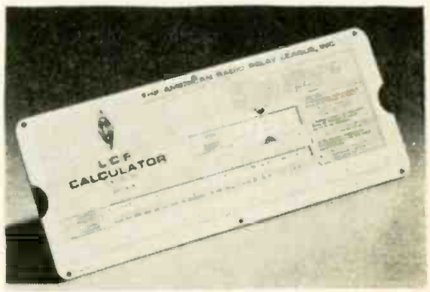
SOLID STATE OSCILLOSCOPE, *LBO-501*, 5" scope with bandwidth of dc to 10 MHz, triggered sweep range from 0.2 μsec/cm to over 0.2 sec/cm, calibrated vertical input,



sharp-rise-time calibration square waves, calibrated time base, special sweep positions for viewing horizontal and vertical TV sweep patterns, vertical sensitivity of 20 mV p–p/cm. Tilt stand for easier viewing. Uses semiconductors, high voltage power supply and dc coupling. $339.50. **Leader Instruments,** Long Island City, N.Y.

Circle 52 on reader service card

L/C/F CALCULATOR, *Type A*, gives frequency corresponding to given wavelength or vice versa, inductance and capacitance which will resonate at given frequency or wavelength, and vice versa. Inductance given in microhenrys



and capacitance in picofarads; wavelengths in meters and frequency in kilo- and megahertz. Carries table of equivalents and 23 cm/9 in. ruler. $2.00. **American Radio Relay League, Inc.,** Newington, Conn.

Circle 53 on reader service card

7-IN-1 DC BIAS SUPPLY, *Model BE156*, for color TV alignment, provides 3 separate 25-V supplies that can be switched positively or negatively. Seventh range of negative 0 to 75V is provided to meet specifications of manufacturers using 67.5V to bias chroma amplifiers during alignment. Can be used

with any sweep and marker generator. Supplies well-filtered at 1/10 of 1% ripple with little or no interaction between them. $24.95. **Sencore,** Addison, Ill.

Circle 54 on reader service card

CLEANING AND LUBRICATING TOOL, *Gozinta*, designed for use from front panel, manufactured from aluminum alloy with female threads machined on one end to adapt to bushing of control after knob is removed. Has plastic valve extension on other end which will pressure-fit contact cleaner aerosol cans. When pressure is applied will force-

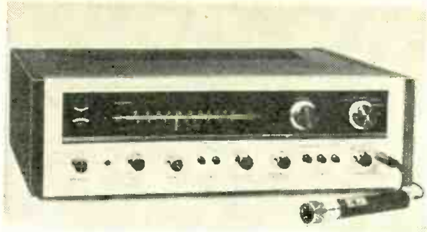
clean control. Adapter supplied for car radios. Gozinta and car radio adapter comes with 3 oz. aerosol can of *Lubrite*. $2.67. **Workman Electronic Products, Inc.**, Sarasota, Fla.

Circle 55 on reader service card

COMPACT CARDIOID CONDENSER MIKE, *Sony Model ECM-22,* designed for home recordist and semi-professional. Uses permanently polarized electret capsule. Switch selects either flat frequency response or one that is rolled-off below 200 Hz. Comes with swivel-mounted adapter, wind screen and vinyl case, 20′ cadmium-bronze 2-conductor shielded cable, $99.50. **Superscope,** Sun Valley, Calif.

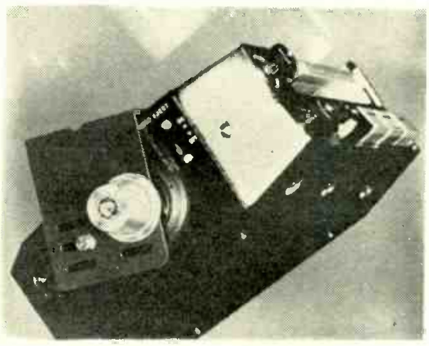
Circle 56 on reader service card

AM/FM STEREO MULTIPLEX RECEIVER, *SX-1500TD,* featuring microphone mixing circuit with separate volume control permitting voice or instrument mixing with tuner, phono,



tape recorder or PA. FET front end. 4 IC's in i.f. section and monolithic IC in multiplex section for improved separation. Silicon transistors. Output power of 180 watts (IHF). Free from SCA beat. Muting circuit eliminates hiss or noise between stations. 5-speaker position selector. Silver and black contrast and polished rosewood end-pieces, $399.95. **Pioneer Electronics U.S.A. Corp.,** Farmingdale, N.Y.

Circle 57 on reader service card



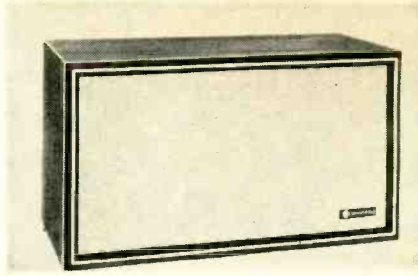
CAR ACCESSORY SECURITY LOCK, *Bolen 200,* 7-pin tumbler cylinder lock secures electronic equipment to desk, table, car or panel and cannot be removed without owner's key. Free spinning and wrench resistant. Owner has one of 25,000 key combinations. $10.95. **Bolen Industries, Inc.,** Hackensack, N.J.

Circle 58 on reader service card

CASSETTE RECORDING TAPE, *Duratape,* fits all types of recorders and comes in reels with 30, 60, 90 and 120-minute playing time. Non-jamming and packed in plastic box. Non-abrasive cleaner for cassette recording heads available. **Mallory Battery Co.,** Tarrytown, N.Y.

Circle 59 on reader service card

3-WAY BOOKSHELF SPEAKER SYSTEM, the *Criterion 100B*, incorporating 10" woofer with 5½ lb. magnet structure



and 2" dia. voice coil, 3½" midrange speaker and 1½" direct-radiator super tweeter. 12 dB/octave L-C crossover network operates at 3,500 and 10,000 Hz. Enclosure is bass reflex type with sonic tube. Overall frequency response: 30-1,000 Hz. Power handling capacity: 40 watts. Impedance: 8 ohms. Walnut veneer. 21½" x 11¾ x 9¾". $44.95. *Stock no. 99-02115WX.* **Lafayette Radio Electronics,** Syosset, N.Y.

Circle 60 on reader 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 75 and circle the numbers of the items you want. Then detach and mail the card. No postage required!

TEST EQUIPMENT CATALOG, *form No. 517,* features Sencore's complete line of electronic test equipment for 1970. Contains specs on *Mighty Mite VI*—FET-operated tube tester with extra socket for testing new tubes, tube-caddy-size color generator, FET tester—*model FT155*—and new *BE156* bias supply. Also carries field-effect meters, sweep and marker generator, sweep-circuit analyzer, combination oscilloscope/vector scope, combination transistor/FET testers, CRT tester, and other special-purpose instruments. **Sencore, Inc.,** Addison, Ill.

Circle 61 on reader service card

GRANTHAM'S ASSOCIATE DEGREE PROGRAM BULLETIN covers enrollment requirements, curriculum in engineering technology, cancellation and refund policy, tuition, G.I. Bill training information, and enrollment by correspondence application. Prerequisites for enrollment: high school diploma or equivalent and one year's full-time experience as technician. **Grantham School of Engineering,** 1505 N. Western Ave., Hollywood, Calif. 90027.

Circle 62 on reader service card

FCC LICENSE CORRESPONDENCE COURSE BULLETIN covers information on various licenses offered by FCC, G.I. Bill eligibility, money-back warranty, certificate awarded, school's benefits, and application for enrollment. **Pathfinder School of Electronics,** 1505 N. Western Ave., Hollywood, Calif. 90027.

Circle 63 on reader service card

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

ELECTRONIC SERVICING CHEMICAL CATALOG, *No. 6970,* covers tuner sprays, contact and control cleaners, insulating sprays, lubricants, circuit coolers, etc. Eight-page catalog features *Tun-O-Foam,* foaming tuner lubricant/cleaner; *Tape Head Cleaner,* aerosol spray designed for cassette tape recorders; improved *Mask-N-Glas,* cleaner/polisher; *Tun-O-Wash,* tuner degreaser; and *Super Frost Aid,* to locate thermal intermittents fast. Free to distributors and TV technicians. **Chemtronics, Inc.,** B'klyn, N. Y. R-E

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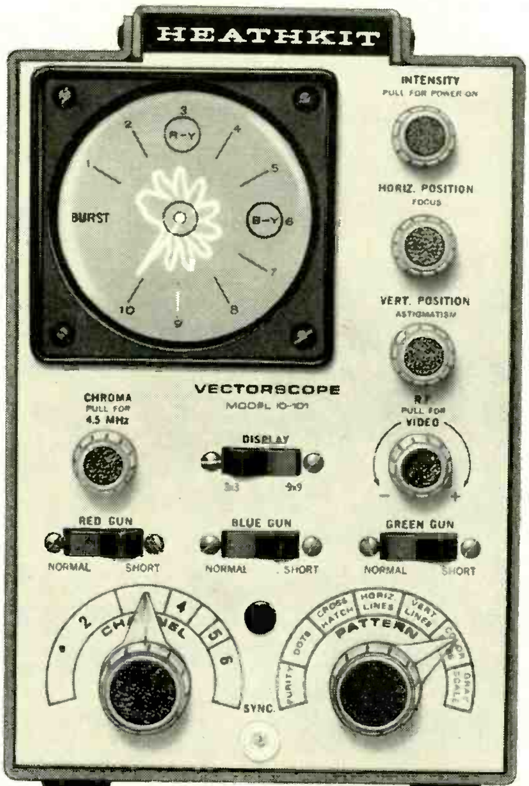

Accurately Performs All Of These Adjustments:

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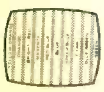
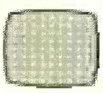
Kit IO-101, 12 lbs. **$124.95***

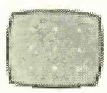
Fast switch selection of standard 9 x 9 display . . . or exclusive Heath "3 x 3" display


Color Bars

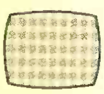

Dot Pattern


Horizontal Bars


3x3 Color Bars


3x3 Dot


3x3 Horizontal

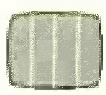

Shading Bars


Cross Hatch


Vertical Bars


3x3 Shading


3x3 Cross Hatch


3x3 Vertical

IO-101 SPECIFICATIONS — PATTERNS — Purity: Produces a snow-free raster for purity adjustments. **Dots*:** 9 x 9 produces a display of 110 small dots. 3 x 3 produces a display of nine dots for convergence adjustments. **Crosshatch*:** 9 x 9 produces a display of 11 vertical and 10 horizontal lines. 3 x 3 produces a display of three vertical and three horizontal lines for convergence and linearity adjustments. **Horizontal Lines*:** 9 x 9 produces a display of 10 horizontal lines. 3 x 3 produces a display of three horizontal lines for vertical linearity and pin-cushion adjustments. **Vertical Lines*:** 9 x 9 produces 11 vertical lines. 3 x 3 produces a display of 3 vertical lines for horizontal linearity and convergence adjustments. **Color Bars*:** 9 x 9 produces a display of ten standard color bars. 3 x 3 produces a display of three standard color bars. A visual fingerprint (voltage pattern) of all ten color bars in the form of a petal pattern is displayed for color circuit servicing. **Gray Scale:** Provides a wide bar crosshatch pattern with six shades of brightness for color gun level adjustments. **OUTPUT SIGNALS — Video:** Greater than ±1 volt peak-to-peak composite signal for composite signal injection beyond the video detector. **RF:** Variable to approximately 25,000 uV output, channels 2 through 6, for composite signal injection into the TV receiver antenna input terminals. **Sync:** Greater than 3.5 volts peak-to-peak signal for servicing sync circuits without video, or sets having separate video and sync demodulator phase adjustments. **GENERAL — Power Requirements:** 105-125 or 210-250 VAC, 50/60 Hz, 20 Watts. **Cabinet Dimensions:** 6¾" W x 9¼" H x 14½" D. **Net Weight:** 9½ lbs.

*The number of dots, lines, and bars indicated for a 9 x 9 display is the number displayed if the receiver under test has no overscan.

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TE-222R

Circle 112 on reader service card

PROGRAMMED CAR MULTIPLEX
(continued from page 68)

That's it! The signals handled by the paths in **Frame 8** page 66 are: the L+R, which is the equivalent of a monophonic signal, and the L−R sidebands, which are the result (at the transmitter) of amplitude-modulating the L—R audio signal on a 38-kHz carrier and then removing the carrier.

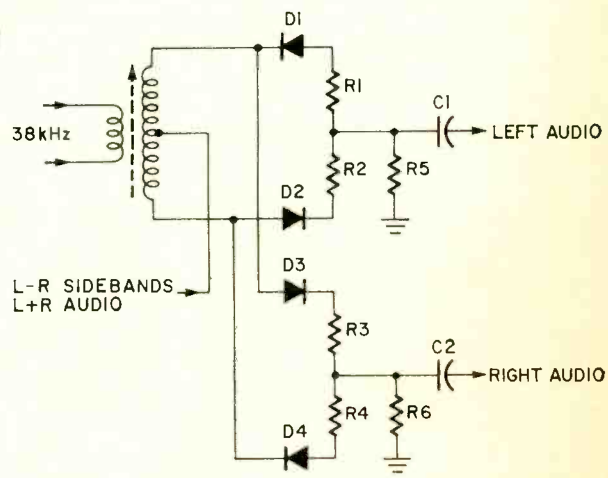
A receiver picking up a nonstereo signal doesn't get any L—R sidebands or any pilot carrier. The L+R is fed equally to both sides of the stereo detector, because of the center-tap connection to the transformer. This mono signal therefore goes right on through to the left and right audio amplifiers.

A stereo signal is what really puts the multiplex section to work. The pilot carrier precisely synchronizes a 38-kHz signal for the stereo detector. The SCA traps block out potential interference of that type. The L—R sidebands and L+R signals are fed to the center tap of the stereo detector transformer. And then what?

Fig. 4 shows essentially the stereo detector used in all stereo–FM receivers. You may see it drawn different ways schematically, but the circuit is virtually the same. One way to look at this stereo detector is as a pair of phase detectors. Here's how they work.

Take the one consisting of D1–D2–R1–R2. The 38-kHz signal is applied to both diodes in series. When a half-cycle has the top end of the secondary negative, both diodes conduct. On the next half-cycle, they can't. Thus they are switched "on and off" at a 38-kHz rate. Meanwhile, the L—R sidebands are being applied equally to both diodes, through the center tap of the transformer. The result is a re-creation of the L—R signals that originally formed the sidebands.

13



At the same time, L+R signals are being applied to the same diodes in the same way at the L—R sidebands. At the junction of R1 and R2, the recovered L—R and the transmitted L+R combine in additive phase. The result is cancellation of the right (R) signal and reinforcement of the left (L).

Notice the direction of the other diodes, D3 and D4. They are wired exactly the opposite of D1 and D2. They, too, are switched on and off by the 38-kHz signal, but in exactly opposite phase to D1 and D2. The signal that is recovered is a negative L—R, shown algebraically: −(L−R). Combining this with the L+R signal at the junction of R3 and R4 is therefore subtractive. The result is cancellation of the L signal and reinforcement of the R.

The audio outputs thus developed across R5 and R6 are coupled through C1 and C2 to the left and right amplifier channels.

Question: What is it about the lower pair of diodes (D3 and D4) in the stereo detector that causes them to recover an L−R signal that is opposite in phase from the L−R signal developed by the upper diode pair (D1 and D2)?

☐ The diodes don't do this. It is the connection across opposite ends of the transformer that gives the output the opposite phase. **Read Frame 4 next** (page 61).

☐ The outer foil of one of the output capacitors should be turned the other way for this to happen. **Go to Frame 6** (page 66).

☐ The lower diodes are connected in opposite polarity across the transformer, so their outputs are opposite in phase. **Go to Frame 7** (page 66)

14 **Wrong**—and so soon, too. You haven't read the first frame and studied its function diagram carefully enough. Either that or you're just guessing. **Go back to Frame 1** (page 61) and reread it. Then pick the right answer.

15 **Yes, both do use diodes.** The top one, the Motorola, uses the diode merely as a harmonic generator. Clipping off the negative half-cycle makes one side of the waveform flat like a square wave. As you probably know, a square wave is full of harmonics. The transistor would amplify all those harmonics except that its collector load is tuned to 38 kHz. That does away with all except the 38-kHz second harmonic, and that's what is passed along to the stereo detector.

The two-diode doubler acts a lot like a full-wave power supply without filters. The waveform is a series of sawtooth-like humps, at a frequency double that of the input. So again the stereo detector gets 38 kHz. This time it's amplified first.

It looks as if you have the idea of the stereo-sync branch pretty well. **Move now to Frame 8** (page 66) and find out about the L−R/L+R branches in various sets.

16 **Yes, they are.** But that's not the right answer. The best way to figure out this one is by careful study of the three diagrams in **Frame 12.** Then look at the three answers **at the end of Frame 12** (page 68) again and pick another one.

17 **Not so.** They're not always present, even when a stereo signal is. When there's no voice or music, there is no L−R or L+R. So neither one is very dependable to keep a stereo lamp burning. **Go back to Frame 11** (page 67), study it again quickly, and have another go at the answers.

18 **Yes,** the pilot carrier. It's present all the time a stereo signal is being received, even during periods of no modulation. So it's dependable for turning on a stereo lamp and holding it on during stereo programs.

By now you have a pretty comprehensive idea how the multiplex section of a stereo–FM receiver works. To wrap it up, **turn to Frame 10** (page 67) and read how to be sure all adjustments are okay. They're something that throws many technicians, yet there's nothing much about them that's complicated.

(continued on page 90)

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.

Little tube blows big one

A color set came in with the flyback well smoked up, the 6DQ5 blown, and so on. The only cause I could find was a bad 3A3 high-voltage rectifier. How can such a little tube blow such a big one?—M. V., Chicago, Ill.

No trouble at all! The 3A3 is a part of the "load" circuit on the flyback, and this load circuit is *tuned!* Just like a radio transmitter: the secondary circuit is usually tuned to the third harmonic of the sweep. If you upset this tuning, your output tube will draw a very heavy current, and things will start to smoke.

Sylvania made some tests a while back on this point. They showed that only *30 seconds* of a "massive overload" on a horizontal output tube took away the equivalent of 1,000 hours of life! It doesn't take long.

Width sleeve "shorts" yoke

The horizontal yoke on a Zenith 1922 checked bad. However, I noticed the metal width sleeve was still in it. When I took this out, the yoke checked good. What happened?—W. F., Baltimore, Md.

Standard flyback-yoke checkers work on resonance: they have a tube and circuits that will oscillate if any inductance (flyback, yoke, etc.) is connected across the test terminals. However, if the inductance has a shorted turn, the circuit will not oscillate.

You can verify this by hooking up a good flyback and then wrapping a "shorting turn," made from a loop of solder, etc., around the core. The needle will drop into the bad sector on a yoke tester. Your width sleeve was acting as a shorted turn inside the yoke.

Mysterious short

I've an Admiral G-13 color chassis on the bench kicking the circuit breaker. I get a reading of only 4 ohms to ground from B+! However, all filter capacitors, etc. are okay! What can this be?—P. J., Tulsa, Okla.

That *is* just a little too low resistance, isn't it? It could be a wiring short, of course, but check the vertical positioning control. This is in the high B+ circuit. I've seen one with the same resistance and symptoms. The slider of the vertical position control was accidentally shorted to ground.

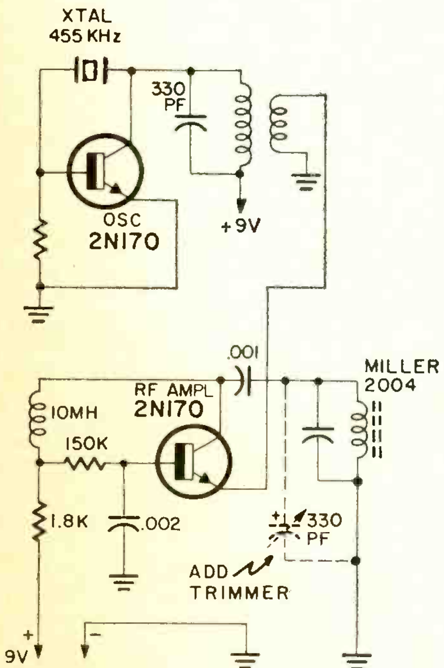
In any case like this, start in by isolating: *disconnect* all the branches of the B+ supply circuits, and look for the one with low resistance.

Low-Frequency Remote-Control Problem

I'm using a 455-kHz fixed-frequency receiver to operate a latching relay, for remote control operations. Now, I'm trying to build a hand-held transistor transmitter that will actuate it satisfactorily, and I'm having trouble getting enough rf power output.

I can make it work, but I don't have enough range. Can you suggest a better antenna circuit for the transmitter?—W.S., College Park, Md.

You can attack this kind of a problem from either end; get more output from the transmitter, or increase the signal pickup of the receiver. It might be easier to add a long-wire loop all around the room, for the receiver. This is the method used in If communication and paging systems in commercial units. In most cases, it can be easily added.



You'll get more out of your transmitter by peaking that antenna coil, I think. This is a ferrite-core loop designed for BC receivers, and covers a range of 550–1600 kHz., if a 365-pF tuning capacitor is used. You show a 330-pF fixed capacitor, and this may be peaking your antenna a bit too high. Try shunting the 330-pF unit with a variable capacitor that will add up to about 400–425 pF at maximum.

Peak the transmitter by using the receiver as an output indicator. In most receivers like this, the developed voltage at the grid of the relay control tube is almost directly proportional to input signal strength.

No vertical lines on bar-dot generator

In a lot of sets, I have trouble getting plain vertical lines with my new bar-dot generator. Horizontal lines are okay, but sometimes the vertical lines are so faint I can hardly see them. If this happened on all sets, I'd send the generator back! It doesn't, though, only on a few. Why?—A. V. P., Charleston, W. Va.

Save the postage! Your new bar-dot's probably okay. This happens on some sets which have video peaking controls. If you have this control set at "soft," or counterclockwise, it can cause a slight smear effect, and this makes the vertical bars faint.

Check the setting of this control; it should be at "crisp," or fully clockwise. The basic cause is a loss of low-frequency response. Also, be sure your fine-tuning control is properly adjusted. Between the two, they can kill vertical bars almost entirely.

Calibrating with WWV

I've just finished building a signal generator, and I want to calibrate it using harmonics with WWV. I get too many "beeps." How can you tell which one is correct?—R. G., Burlington, Iowa

The best way is to count up from the fundamental. For example, if you want to check the generator at 10 MHz, connect a good antenna to a receiver and tune in WWV at 10 MHz. Leaving the antenna connected, couple the signal generator rf output loosely to the antenna lead-in.

You can get a direct check by zero-beating the generator against the 10-MHz signal. Switch the modulation on and off to identify the generator's signal. Then tune the signal generator back to 5 MHz. You should hear its second harmonic beat against the 10-MHz WWV signal. You can go back to 2.5 MHz, and even back to 1 MHz (10th harmonic) and still hear a good usable beat.

Remember the harmonic of the generator signal will be higher in frequency and lower in amplitude each time you go up one harmonic. The second harmonic is double the frequency and half the amplitude. If the receiver has an S-meter, this will provide a rough check. Or use an output meter across the voice coil.

Broadcast radio stations are very accurate (±5Hz) and can also be used. Use harmonics to check lower generator bands. For instance, the 450-kHz second harmonic is 900 kHz. There's usually a BC radio station near 900 KHz for calibration.

Remote-control intermittent

I've got an intermittent in the "Channel Lower" control of a Zenith Space Command. Works for several days then acts up.—M. H., Brooklyn, N. Y.

If all other functions are working, this one must be something nice and simple, like a slightly dirty relay contact. Open the control chassis so that you can see the relays, then push the button for the intermittent function. You can then see which relay moves. Check its contacts, and "paper" them. Slip a piece of stiff paper such as a postcard between the contacts and hold them closed. Then, pull the paper out. This is a very good home-made contact burnisher.

Converting CATV line amplifiers

I'd like to know a good way to convert a transistor CATV line ampli-

fier from its present 40–110-MHz coverage to 40–220 MHz.—T. G., Canton, Pa.

So would a lot of people! However, this would involve replacing all the transistors with higher-frequency cutoff types, changing all coils and capacitors, and so on. In other words, you could (and would) be building a completely new amplifier. This has been verified by some of my CATV friends who have tried it.

This is "theoretically possible and technically impractical."

Horizontal coil 'rings wrong'

I've got an Admiral 15D1B portable, and the horizontal oscillator won't work. I checked everything I could think of, even the 3900-pF (.0039 µF) capacitor across the ringing coil. There's only −18 volts on the horizontal output tube grid. Should be −35 volts. What's going on?—L. B., Elmhurst, N. Y.

I see something that might be wrong! While most of these chassis did use a 3900-pF capacitor across the ringing coil, some runs used a coil which needed only 680 pF. You may have one of them. Try a 680-pF capacitor to see if it won't bring the oscillator back on frequency.

Design scope preamp?

Can you design a transistorized scope preamplifier for a dc scope for me?—T. B., New Berlin, Wis.

Nope. I'm not smart enough. Besides, this department tries to stay out of "design" as much as possible. That's not my forte.

However, I can give you an idea: look up a transistor TV schematic, and steal the video output stage. This will go from a pretty low frequency to at least 4.5 MHz, and it does work. Lots of good ideas in such books as the G-E *Transistor Manual*, Motorola's *Semiconductor Data Book* and RCA's *Transistor Manual*.

Test CRT as CRT checker

If I use a 8YP4 test CRT and get a good bright picture when the original CRT shows only a very dim picture, does this mean the original tube is bad? Or is it because the smaller tube naturally makes a brighter picture?—S. W., Flin Flon, Man., Canada

That usually means the original CRT is weak. To confirm your test results, measure the HV and the dc voltages on the CRT base, screen grid, etc. If these are okay, but the original tube's raster is dim, the tube is weak. A 50-volt p-p video signal on the cathode, is further confirmation. This much signal should make a good "contrasty" picture. **R-E**

NEW BOOKS

MOST-OFTEN-NEEDED 1969 COLOR TELEVISION SERVICING INFORMATION (Vol. C-69). Compiled by M. N. Beitman, Supreme Publications, 1760 Balsam Road, Highland Park, Ill. 60035. 8½ x 10¾", 192 pp. Paper, $4.

In our review of Vol. TV-28 covering 1969 b-w TV receivers, we mentioned that we thought the publisher should either include color TV service data in the TV series or come out with a new series devoted entirely to color. Evidently, he was thinking along the same lines. This manual—the first in the new color TV series—contains reprints of original manufacturers' schematics and detailed servicing data covering about 400 models and chassis from 14 manufacturers. Possibly, due to an oversight or last-minute editorial or production problems, the Magnavox service data covers the T917 solid-state b-w chassis rather than a color set. This new manual is a must for all active TV service technicians.

HANDBOOK OF PRACTICAL ELECTRONIC TESTS AND MEASUREMENTS, by John D. Lenk. Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632. 302 pp., 6¼ x 9¼". Hardcover, $15.

Details operations that can be performed with basic test equipment by the technician. Covers voltage, current, resistance, capacitance, inductance, impedance, decibel, time, frequency and phase, solid-state, microwave, antenna and component measurements. A brief explanation of the theory behind each measurement is included. Generally, a simple and laboratory test are described.

101 TV TROUBLES FROM SYMPTOM TO REPAIR by Art Margolis. Tab Books, Blue Ridge Summit, Pa. 17214. 5½ x 8¾ in. 224 pages. Hardbound, $7.95; paperbound, $4.95.

A cause and cure guide to problem solving virtually any TV trouble—color or black & white. Troubles are broken down into 5 basic categories: brightness, contrast, sweep, color, and sound. Each category lists specific troubles relating to that symptom. With the categorized trouble list and index, the reader can find the exact symptom and the trouble cure for many TV circuit defects.

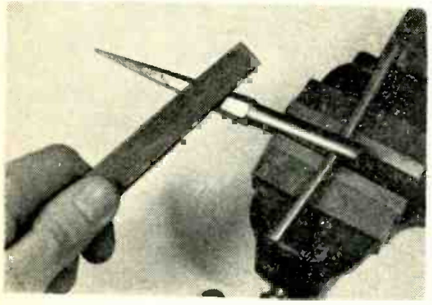
MOST-OFTEN-NEEDED 1967-1969 RADIO DIAGRAMS AND SERVICING INFORMATION (Vol. R-27). Compiled by M. N. Beitman, Supreme Publications, 1760 Balsam Road, Highland Park, Ill. 60035. 8½ x 10¾", 192 pp. Paper, $4.

Volume R-27 is the latest in the almost perennial line of service manuals reprinting original manufacturers' schematics and service data covering AM, FM, AM-FM radios and phonographs. Contains such essential data as dial-stringing diagrams, alignment charts, component layouts, PC board patterns, and tube and transistor terminal voltages. **R-E**

TRY THIS ONE

SALVAGING A HAND REAMER

Don't throw away your hand reamer that is ineffective because of nicks and rounded edges. Instead, use a flat file to restore each surface of the



reamer to like-new condition. For best results, clamp the reamer in the vise, and make an equal number of long even strokes on every flat surface.—*Robert E. Kelland*

RADIO CONTROL MONITOR

With the large increase in the use of 72–76 Mhz radio-control devices to operate overhead cranes, this tip may prove quite helpful to other service personnel as it has to our own plant electronics crew.

When a radio-controlled crane is reported out of service, it helps if the repairman can determine, on the spot, if either the portable transmitter is at fault or the crane. Since cranes can be anywhere from 30–100 ft off the floor, that climb to the crane bridge can be laborious and time consuming—especially since cranes generally break down someplace other than where a crane ladder is located.

We have found that the popular FM pocket portable, currently available for under $20 and covering the vhf police bands (150 Mhz–172 Mhz), can pick up extremely strong second-harmonic signals over 50 ft away. Command tones are clearly discernable on this unit. Our men carry one in their pocket and quickly determine if the transmitter is at fault (it generally is), or whether the trouble is up on the crane bridge where the electronics and electrics are located.

The vhf set also proved to be a useful tool in the shop for monitoring transmitters under repair. It does not replace the scope or other instruments, but for minor repairs such as weak batteries, broken cables, and intermittents, it is a time-saver that our men have come to appreciate.—*Domenic R. Ripani* **R-E**

VECTOR-SCOPE ON THE QUASAR

by STAN PRENTISS

AMERICA'S ALL SOLID STATE, LARGE screen, color set chassis, Motorola's TS-915/919. has now been on the market two years. Except for a solid-state high-voltage rectifier and certain ac regulation in top-of-the-line models, the basic receiver has changed little.

Appearances can often be deceiving, however. Tuners are always undergoing modifications (or outright substitution); resistance-capacitance-inductance values may be altered for additional noise suppression, agc action, horizontal sweep improvements, or to render a better picture.

The TS 915 is certainly no exception. Motorola engineers devoted major attention to the color circuits, and have removed shielding from color panel S and simplified a number of signal paths with favorable results that can be seen in vector display patterns.

Vectorscopery

Right now let's take a look at a random selection of vector waveforms that could well identify the difference between a good set and a host of later troubles. If you're worried about the proper vector scope setup, reverse polarity of the normal vertical and horizontal plates (since color and luminance are both fed to the receiver's cathodes) and connect a standard, calibrated color bar generator to the receiver terminals. Then connect the vertical plate of the oscilloscope through an RC network to the red cathode of the CRT and the horizontal plate to the blue cathode. Adjust the receiver's *Hue* control so that the No. 1 color bar is yellow-orange and the third bar is red (the receiver will respond exactly).

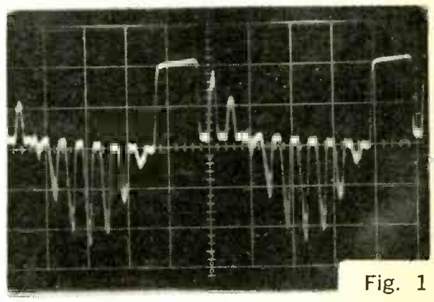


Fig. 1

Then, if you're still dubious, connect an oscilloscope through a low-capacitance probe to the blue cathode and set the *Hue* control so that the third and ninth color reference bars are as near zero (center horizontal graticule line) as possible (Fig. 1). Note several things in this receiver. The brightness control must be considerably retarded. The horizontal blanking pulse is some 10-μsec plus wide. And the tenth color bar is blanked, presumably to relieve stress on the dc regulated collectors of the horizontal output transistors. (We're using a calibrated triggered sweep oscilloscope.)

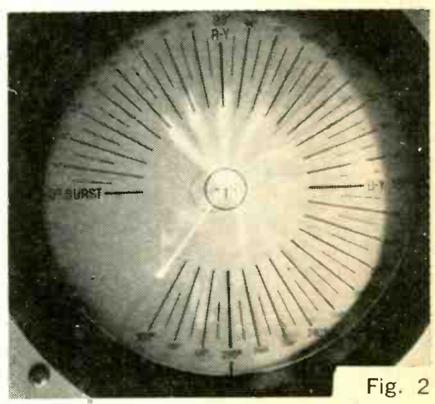


Fig. 2

The first pattern shown is the true vector scope pattern (Fig. 2) with the receiver properly adjusted showing the third red bar at a true 90° and sixth blue bar at approximately 180°. Immediately you know that the receiver is operating correctly and is demodulating near quardature (90°), one of the optimum angles for satisfactory flesh tones. The slight fuzziness in the display is due to the cycling of several air conditioners in the distributor's building.

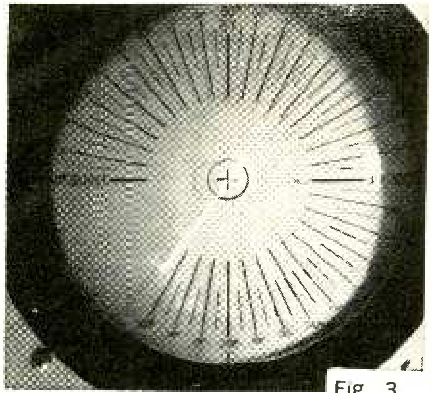


Fig. 3

As the scope reveals, the 10th color bar is completely blanked. Note the sharp rise and fall times of the vertical red bar; this is highly indicative of good color detail.

Breakdowns

The first "breakdown" we'll exhibit (Fig. 3) is a common base-to-emitter short of the 1st color i.f. amplifier. (This really simulates an open, since collector voltage merely rises to that of the supply.) If the 3.58 MHz oscillator quits or,

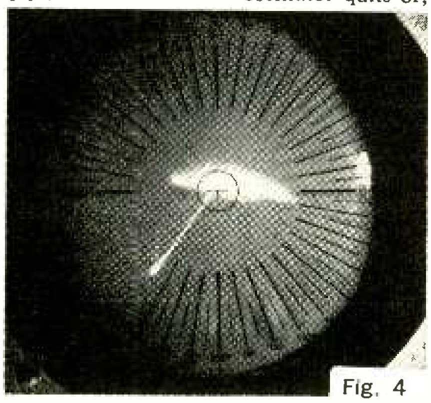


Fig. 4

for that matter, if there is any complete break in the color chain, the vector scope will produce only this single diagonal line.

At times like this, the vector scope is basically useless, except to tell you that the trouble is in the receiver and not in the cathode ray tube. No color and a full vector display would directly implicate the receiver's CRT.

The next fault is a shorted diode from the collector of the color oscillator output to ground. As seen in Fig. 4 and on the receiver's CRT, this upsets the frequency of the color oscillator output by disturbing the shunt and feedback net-

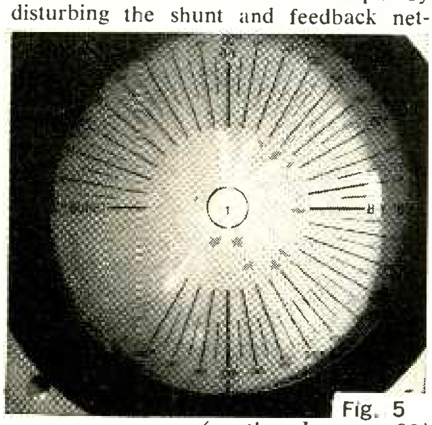


Fig. 5

(continued on page 92)

PROGRAMMED CAR MULTIPLEX
(continued from page 81)

19 **You missed!** Remember, the pilot carrier goes its own way. It goes down the sync branch, where it locks a 38-kHz oscillator or is doubled to form a 38-kHz carrier. So that keeps it out of the L−R/L+R channel. Go back and **reread all of Frame 8** (page 66) and then pick another answer.

20 **Yes, that's right.** You're on your way. The pilot, or stereo-sync, portion is always taken from the composite stereo signal and fed to the reinsertion carrier generator. The L−R sidebands and L+R signal follow their own path to the stereo detector. That's why the function diagram shows two branches—one for sync and one for L−R/L+R. These do not correspond to the two audio channels—left and right—that are the *output* of the stereo detector.

There are important differences among various models. For example, one brand doesn't use an amplifier stage in the L−R/L+R branch, though another needs that extra amplification. Or, SCA traps may be in the L−R/L+R branch instead of at the preamp.

Several models vary in how preamp outputs are split. In some, one signal is taken from the collector, which imparts some amplification. The signals for the other branch don't get amplified, being taken from the emitter. But of course it does isolate them from each other. Furthermore, they may get their boost from an amplifier in their own branch.

Probably the major difference in various models lies in how the 38-kHz carrier is developed. In Delco models, for example, a 38-kHz oscillator is used. An amplified 19-kHz pilot signal synchronizes it. Bendix sets, original equipment in some new cars, have a frequency doubler following a pilot amplifier. Motorola has a doubler, but it's stereo detector is sensitive enough that the pilot amplifier isn't needed. In Tenna Corp. receivers, a doubler comes first and the 38-kHz signal is then amplified.

In a few sets, an audio preamplifier for each side (left and right) follows the stereo detector. However, audio preamps are usually part of the audio section of the receiver.

Some models have a stereo indicator stage. No two brands have identical stereo indicator circuits. You'll learn a little more about them in a later frame.

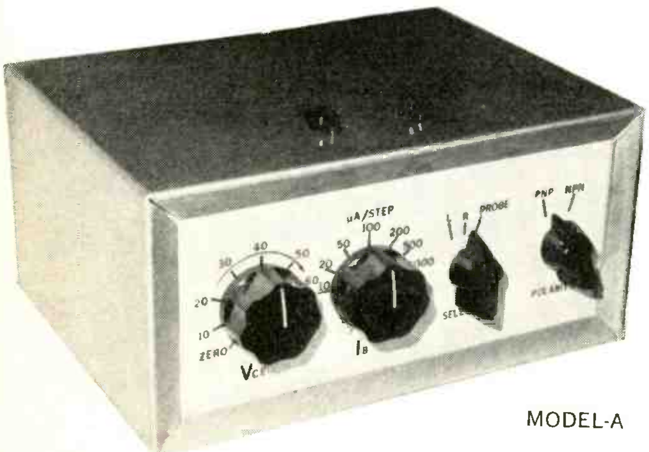
Question: What method is used most in auto stereo–FM receivers to develop the 38-kHz reinsertion carrier for the stereo detector?

☐ Multiplex channel pilot carrier. **Go to Frame 3** (page 61).
☐ Frequency doubler. **See Frame 12** (page 68).
☐ Synchronized oscillator. **Turn to Frame 2** (page 61).

21 **Oh, no it isn't.** Look again at the top diagram in **Frame 12.** That's a capacitor (C3) coupling the 19-kHz signal from the preamp to the diode in the base circuit of the doubler. Here's a clue: the similarity referred to by the question is in the doublers. **Now pick another answer in Frame 12** (page 68).

22 **No, that's not right.** Only one portion of it is there all the time when a stereo station is on the air. Stop and think about it a minute and you'll have the answer. If you can't get it, **go back to Frame 11** (page 67) and it'll come to you during a quick reading.

THE FIRST IN-CIRCUIT TEST TO TELL A GOOD TRANSISTOR FROM A BAD ONE. WITH NO IFS, ANDS OR BUTS.



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You get the message on an oscilloscope. If the transistor is good you see a family of curves; if it's kerflooey, a single vertical or drooping line appears; and if the transistor is open, the scope will show you a single horizontal line.

Another thing.

Transistor manufacturers make lots of essentially identical transistors. But each manufacturer uses different numbers, so you don't know the transistors are identical.

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It's all so simple, we don't know why somebody didn't think of it before. All we know is, nobody did.

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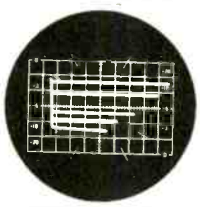
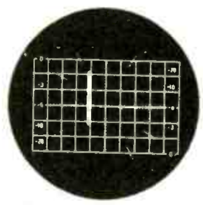

Good transistor.


Shorted transistor.


Open transistor.

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Circle 128 on reader service card

VECTOR SCOPE ON THE QUASAR
(continued from page 89)

work and produces a "fan" of high frequency oscillations on the screen of the vector scope.

At this point, let's detune the coil in the color output circuit (Fig. 5) so the color bars on the set's CRT are moved to the left and the vector pattern is shifted to the right, the first bar now appearing at 85°. The third bar should be at 90°—remember? Detuning the luminance and chroma coupling transformer

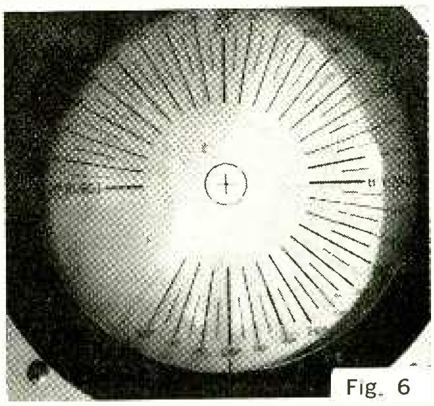


Fig. 6

will do the same thing if the top coil is detuned, and the inverse if the bottom coil is out of tune. It might be disastrous to attempt to align both of these transformers at the same time.

Should the capacitor in the collector of the color oscillator phase splitter short, the vector display would collapse to a diagonal line and the receiver's CRT would only show purple bars with green shading.

Demodulators and traps

An excellent use for the vector scope is finding troubles in the demodulators, color outputs, and 3.58 MHz traps. On video driver panel "L", for instance, if the red demodulator shorted the red vector portion of the display would collapse, leaving a fuzzy thickened line of blue information. The opposite would be true if the blue demodulator diode shorted (or opened). Should something happen to the green demodulator, however, the vector pattern would only shift 5° and the set's CRT would show all 9 color bars but with greenish background.

The "spectacular" vector exhibits are produced when detuning the LC subcarrier oscillator traps that now directly precede the red, blue, and green video drivers. Their effect is readily viewed on the vector scope and characterized by a fine line pattern on the receiver's screen.

In vector scope examinations, many useless patterns are produced if the bar generator has a sloppy output. Test your's first on a good receiver with vector scope attached before attempting to troubleshoot a defective one. You must also have a vector scope that will reverse both vertical and horizontal polarities for these cathode-fed color receivers. Otherwise, the patterns will be displayed upside down. **R-E**

TECHNOTES

INTERMITTENT SOUND—G-E S-2, P-1 AND P-2 CHASSIS

The small, green 0.047-μF capacitors used in the audio circuits of the S-2, P-1 and P-2 chassis receivers may be responsible for complaints of intermittent audio.

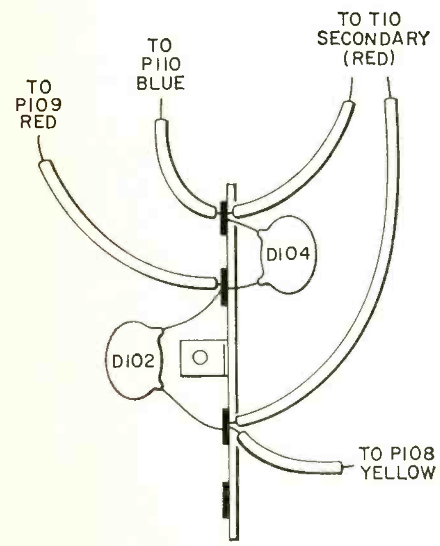
If C309 (S-2 chassis) or C310 (P-1, P-2 chassis) opens, audio is lost, sync buzz becomes pronounced and off-channel white noise is normal. There is very little effect on the audio quality when these capacitors are shorted.

In the P-1 and P-2 chassis, an open C304 causes reduced audio, sync buzz and no white noise when the tuner is switched to an unused channel. A shorted C304 upsets the bias on Q301 and causes loss of audio. There is usually no damage to Q301 when this happens.—*G-E Portafax*

WESTINGHOUSE RTF 3030A RADIO

To prolong the life and to better protect the stereo indicator lamp (LA-1), add a 47-ohm, ¼-watt resistor in series with the lamp.

Open the radio back cover to expose the PC board. Disconnect the wire located at the point marked P11 on the board. Solder one end of the resistor to the wire and the other end of the resistor to point P11. Tape the exposed connection.



To eliminate hum reported in some of these models, add a 0.01-μF, 500-volt ceramic capacitor across D104 and another one across D102 on the terminal board (see diagram) adjacent to the power transformer.—*Westinghouse Tech-Lit News*

ADMIRAL K10 COLOR AMPLIFIER TUBE

Before removing or installing an 8AC10 or 12AC10 color amplifier tube in hybrid 12-, 14-, or 16-inch color chassis, pull the ac line cord. If you don't, you are likely to damage color demodulator transistors Q20 or Q21. Surges, arcs and transients developed when making or breaking a live circuit can instantly ruin transistors.

Make it a habit to disconnect power before making or breaking connections on transistorized equipment.—*Admiral Service News Letter*

AC LINE FILTER CAPACITORS

Underwriters Laboratories requires only specific types of capacitors be used for line filters which are connected directly to the power line in G-E TV chassis. If failure occurs due to lightning or power-line surges, these special Mylar capacitors have a failure characteristic which does not create any hazard.

For C130 in CB, KC and KD chassis and C155 in the KE chassis, use G-E part EU25X4 (0.047-μF).

For C403 in the DD and D1 chassis and D404 in the A1 special-markets chassis, use part ET25X78 (0.022-μF).

For C403 and C414 in the DD and D1 special-markets chassis, use ET25X79 (0.01-μF).—*G-E Service Talk* R-E

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Circle 133 on reader service card

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20 TRIAC CIRCUITS
(continued from page 53)

cell, and presents a high resistance under dark conditions and a low resistance under bright conditions. Thus, under bright conditions, negligible drive is applied to Q2's base (due to the potential divider action of R4–LDR), so Q2 is off.

The base drive for Q3 is obtained from Q2 collector, so Q3 is also off under this condition, and negligible current flows between Q3's collector and the 12-volt positive line (Q3's collector is virtually shorted to the zero-volt line under bright conditions).

Suppose, on the other hand, that light levels are just low enough to raise the resistance of the LDR so a small base drive is applied to Q2. This base drive is amplified by Q2 and applied to Q3's base via R6. Transistor Q3 further amplifies the drive and feeds it back to Q2's base via R7–R8, thus completing a positive feedback loop. The circuit regenerates, Q3 switches sharply to saturation, and a heavy current flows between Q3's collector and the 12-volt positive line. (The collector of Q3 is virtually shorted to the +12-volt line.)

The values of feedback resistors R7–R8 give the minimum amount of positive feedback necessary for stable regeneration; therefore only a very small change in light level is needed to make Q3 change from OFF to ON, and the circuit gives very little "backlash."

In Fig. 10 the gate drive of the triac is obtained from Q3's collector via R2. Under bright conditions (Q3 off) the Q3 end of R2 is effectively clamped to the zero-volt line, so zero drive is fed to the triacs gate, and the triac is OFF.

Under dark conditions (Q3 on), the Q3 end of R2 is virtually shorted to the 12-volt positive line, and about 40 mA of gate current flows and the triac is ON. The trigger light level of the circuit can be preset with R4. The LDR can be any cadmium sulphide photocell offering a resistance of roughly 2,000 to 20,000 ohms at 2 foot-candles. RE

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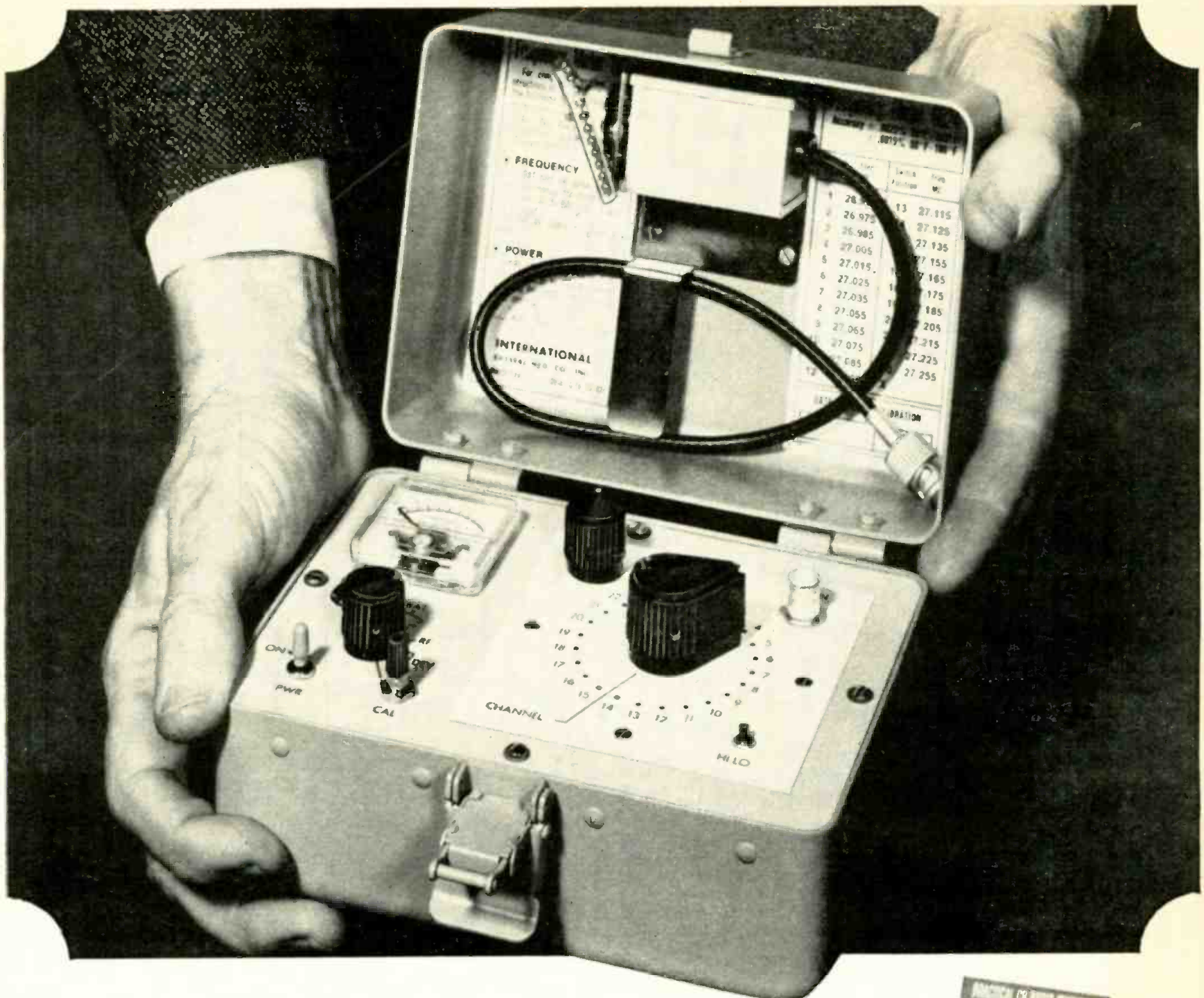

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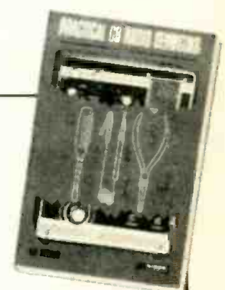

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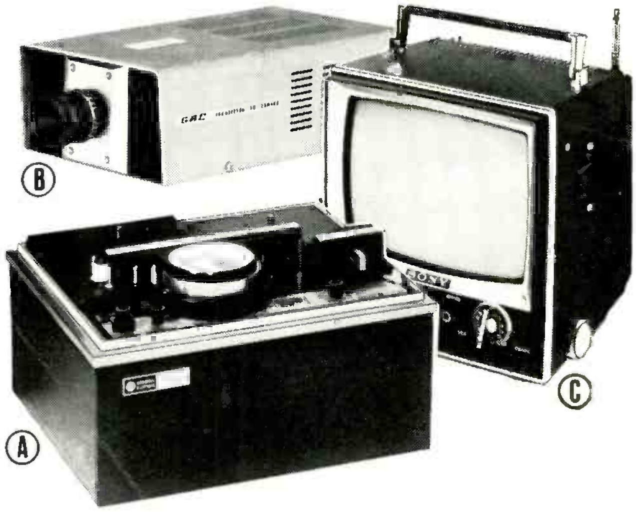

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