New 1969 color killer circuits

60c ■ FEB. 1969

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RETAILER: SEE PAGE 100 FOR SPECIAL DISPLAY ALLOWANCE

It's a color bar generator, too.

You're looking at the only tube tester that can check out almost every receiving tube and throw an alignment signal into the picture tube.

It's a combination tube tester and color bar generator.

So now all you need is a single instrument to do two of your most important servicing jobs: Make sure the tubes in a set are good. And make the adjustments you need to get a good, sharp picture on color and black-and-white TV sets.

We built it like a brick. (After you've carried it through a thousand doorways, you'll know why.)

And we've done everything to make it accurate and stable.

The new instrument starts off with a regulator-type transformer that doesn't give a hoot how the line voltage is acting up. (It doesn't even need a fuse.) There are 73 tube sockets that let you run all kinds of tests on all kinds of tubes. All you have to do is set 3 knobs. You can even check each section of a multi-section tube separately.

The color bar generator is all solid state. It puts out 6 crystal-controlled, rock-stable test patterns: 10 color bars, a clear raster, 10 vertical lines, 13 horizontal lines, 130 dots and a 10 x 13 crosshatch. All operating and calibration controls are right in front of you on the panel.

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It leaves your other hand free to carry something else.

For more information, see your Sylvania distributor or write to: Sylvania, CADD, 1100 Main Street, Buffalo, N.Y. 14209.

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Circle 8 on reader service card

NEW & TIMELY

Volume 40 Number 2 RADIO-ELECTRONICS February 1969

One-Tube Color-TV Camera From RCA

Washington, D.C. — A new low-cost, one-tube color TV camera was recently unveiled by RCA at a National Association of Educational Broadcasters convention.

The new cameras will be priced from $6500 to $10,000 —about half the cost of three-tube closed-circuit cameras now on the market. Lowered cost will expand use of color systems in education, industry and cable TV.

Color-encoding filters, experimentally studied for several years, are used in the camera. Light from the scene passes through striped red and blue color filters positioned 45° to one another. These filters detect the red and blue component, leaving the green (luminance) component when subtracted from the whole image. The vidicon scans the red-blue-green image, and resulting signal is converted into standard NTSC.

The new cameras will be available late this year.

NEW POWER FOR HEARTS

Philadelphia, Pa.—Help for users of electronic cardiac pacers is on the way in the form of new pacers that can be recharged through the skin. Current models either must be removed surgically to replace worn batteries, or recharged through permanently attached wires that can irritate skin and cause infection.

The pacer above was developed at ESB Incorporated, a Philadelphia battery company, and contains an induction coil that works in conjunction with a nickel-cadmium battery. A charging unit can be installed in a vest and used to recharge the pacer while the patient moves about, or the charger may be plugged into a wall socket. Recharging, required once a month, takes about 8 hours.

A similar technique has been developed by New York University scientists for transferring enough power through skin tissue to operate an artificial heart if one is installed in a human. Power is transmitted by induction between two ferrite-core disk transformers at frequencies between 3 and 30 kHz. Up to 30 watts of energy can be transmitted.

Both devices have been tested in animals, but have not been implanted in humans.

(turn page)

New Radiation Standards Set

Washington, D.C.—Standards for hazardous radiation from commercial electronic products are now under federal study. New legislation directs the Secretary of Health, Education and Welfare to set and control radiation standards for all kinds of electronic products.

The new law grew out of federal investigations that revealed dangerous radiation leakage and potential hazards in a number of products. In addition to excessive X-ray radiation from some color TV sets, studies showed that 24 of 30 microwave ovens at a U.S. medical center leaked potentially hazardous radiation, that about two-thirds of some 112,000 X-ray machines did not meet current standards, and that dangerous lasers are readily available to the general public.

IN THIS ISSUE

Want to experiment with IC's? Make sure you read Jim Ashe's article on using the PA-222. This little plastic-package IC audio amplifier is pure fun. The story's packed full of tips, techniques and circuits too.

LOOKING AHEAD

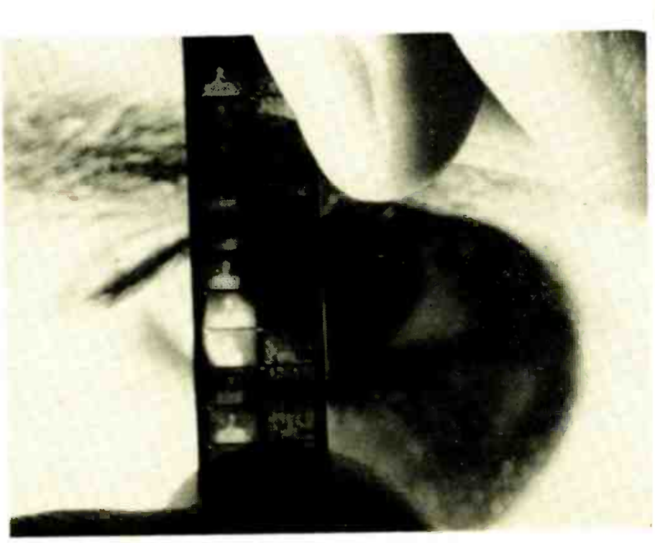
By **DAVID LACHENBRUCH**
CONTRIBUTING EDITOR

EVR—what it means

With fanfare befitting a television network, the Columbia Broadcasting System has officially launched its Electronic Video Recording (EVR) and duly forecast that its impact on education and home entertainment will be revolutionary.

The ingenious system, developed by a team under CBS Laboratories President Dr. Peter Goldmark, who 20 years ago gave the world the long-playing record, is described as the sight-and-sound equivalent of the LP disc. Using film in an unconventional manner, it's a playback—only medium which may give the proposed home

(continued on page 6)



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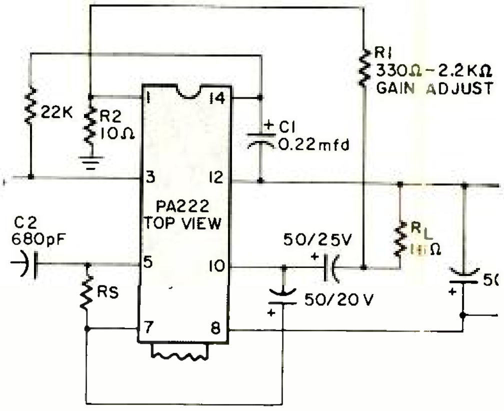
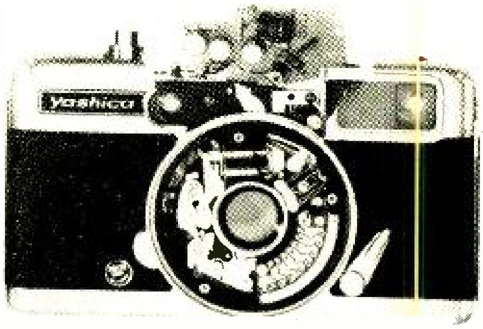
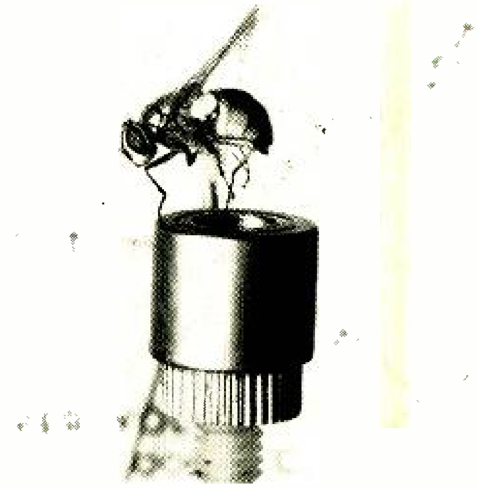


Experimenter's IC amplifiers are easy to make. Here's part of an IC circuit you can build. For the rest of it. . . . see page 54



Electronics in cameras? Just take a look above. For more details on the latest in camera electronics. . . . see page 39



Mike for flies was used in scientific tests. But its size puts it into the eavesdropper's kit. And he's got more. . . . see page 35

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STORING 3-D PIX

Two new techniques for storing holograms—3-D photos made with lensless laser photography—have sped up the storage process, and made it possible to store 1000 times more digital or pictorial data than with conventional holographic materials.

Using a sugar-cube size crystal of lithium niobate, Bell Labs scientists have discovered that 1000 different holograms can be stored in a single crystal.

To store a hologram, a laser beam is split into a reference beam, which shines directly on the crystal, and an object beam that first shines through a hologram transparency of the page or object. Interference patterns between the two beams create an internal electric field in the crystal that changes its refractive index. To record the next image, the crystal is rotated slightly.

To recover the stored images (see photo) a laser beam is directed through the crystal at the correct angle. Since the refractive index changes produced by the storing beams record intensity variations of the object, these shadings are recreated by the laser beam.

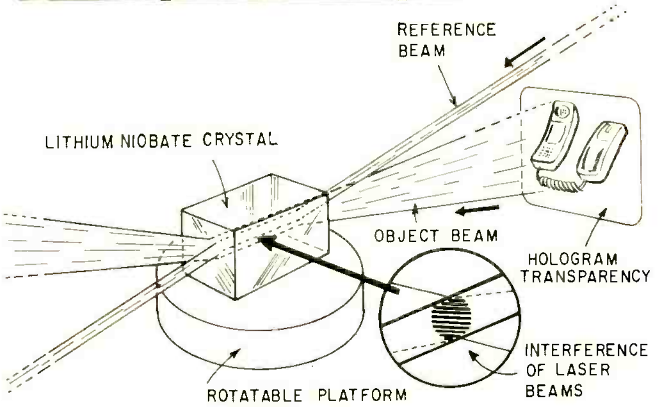
The optical memory crystal can be erased and reused by heating it to 170°C.

A magneto-optic method of hologram storage has been developed by IBM. It can produce holograms in 1 μsec.

The storage system uses a transparent europium oxide film that is kept at a cryogenic temperature of 20°K. A 1-megawatt giant-pulse laser generates a light pulse that passes through an optical system, the hologram, and strikes the film. The beam's intensity produces a magnetic pattern on the film that corresponds to the hologram image (Faraday effect).

When polarized light passes through the film, the hologram image can be viewed. A strong magnetic field will erase the film.

Because of the system's low efficiency (.01%), it is still impractical as a commercial system.



LASER BEAMS PROJECT BRILLIANT COLOR TV DISPLAY

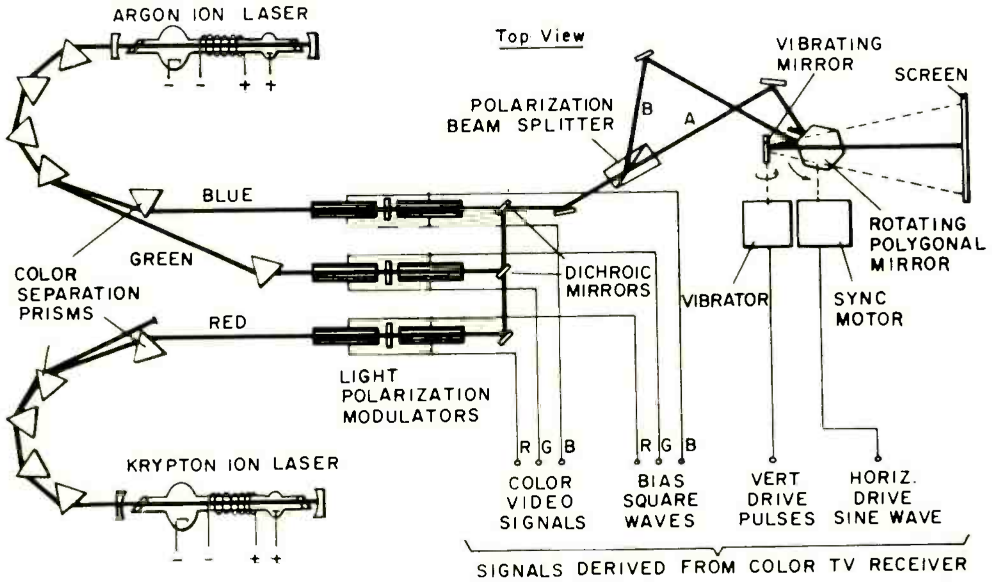
Bayside, N.Y.—A laser display system capable of projecting bright color TV pictures on large wall screens has been built at General Telephone & Electronics Labs.

The development could lead to a variety of indoor and outdoor displays for educational, entertainment and commercial use.

GT&E's laser TV uses an argon gas laser to produce blue and green light beams, and a krypton laser for the red beam. The polarization of each beam is then modulated with the corresponding blue, green and red video signal from a TV receiver. The beams are next combined by color-sensitive mirrors into a single multicolor laser beam.

A calcite-prism beam splitter then breaks the beam into a pair of similar full-color beams, which are reflected to a rotating 15-sided mirror to produce the horizontal scan lines. Before projecting on a screen, the beams are deflected to a vibrating mirror that produces vertical sawtooth scanning.

GT&E laser display system projects a 31 x 48-inch color image.



PICTUREPHONE EDITING

Murray Hill, N.J.—White dots on this video telephone photo represent the only significant picture changes in 1/60 sec.

Because so little change takes place (lip movement or eyelash flutter, for example)

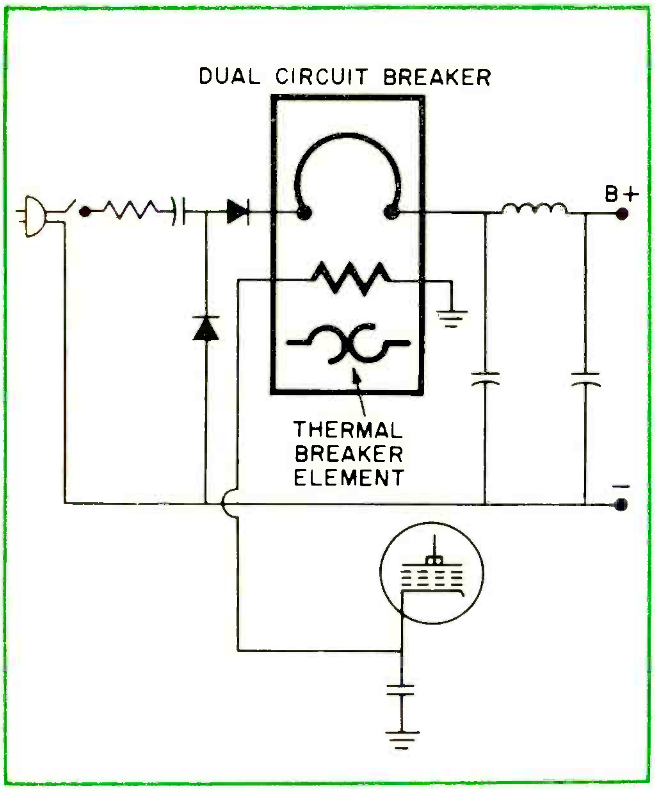
(turn page)

STOP THE SNOOPERS

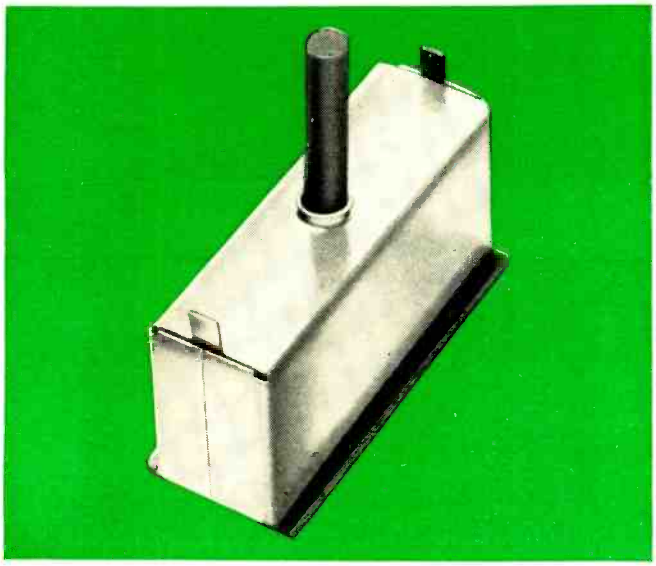
Keep those electronics ears out of your private conversations. It's easy once you know how to protect yourself. The full details start on page 35.

MALLORY Tips for Technicians

New circuit breakers for color TV



Typical hook-up for dual circuit breaker


Dual circuit breaker

Practically all the new color TV sets have a new kind of dual circuit breaker in them which you may not have run into before. Here's the story.

Remember back when black-and-white television used two fuses—one in the power supply input, and one in the horizontal output circuit? Next, in the interest of economy, the fuse in the horizontal output was eliminated. Then the designers switched to re-settable breakers, in the B+ line.

Along came color. Overload protection became necessary, because the horizontal circuits are more complicated, and more expensive components including the flyback transformer could be knocked out by a defect in the horizontal circuit.

The answer: a dual breaker which pops out from excess current in *either* the B+ or the horizontal output . . . in a single breaker case. It has two electrically isolated but thermally connected circuits, either of which can cause the B+ contacts to open.

The diagram shows a basic hook-up for the breaker. The thermal breaker element goes directly in the B+ line. A resistor inside the breaker, usually about 1.3 ohms, is connected between the cathode of the horizontal output stage and ground. This resistor is located so it will heat up the thermal breaker element.

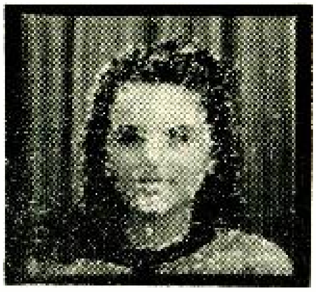
Along comes an overload in the B+. The thermal element pops the contacts open, in the usual manner. When there's excessive current in the horizontal output, the heating of the breaker's resistor has the same effect as a B+ overload, opening the contacts and removing voltage from the circuit.

Tip No. 1: breakers can fail because they get repeatedly reset into a fault. Check for gassy tubes and leaky capacitors before you replace the breaker, or you'll have the whole job to do over.

Tip No. 2: always replace with a Mallory breaker. We have three different dual breaker ratings in our line. They will replace the dual breakers in all existing color set applications. All are made to original equipment specifications. Your nearby Mallory distributor can supply you off the shelf. See him soon, or write to Mallory Distributor Products Company, a division of P. R. Mallory & Co. Inc., Indianapolis, Indiana 46206.

REMEMBER TO ASK—*"What else needs fixing?"*

Circle 10 on reader service card



in their Picturephone transmissions. Bell Telephone Labs have devised a technique for "editing" the video signals in order to transmit three video phone calls instead of one.

The technique is called "conditional replenishment," since it transmits (replenishes) only elements that change between 1/30-sec scans of the subject. Signals from the camera are converted into digital pulses representing the picture for pulse-code-modulation (PCM) transmission over telephone cables. These pulses are compared with pulses of a memory-stored reference picture.

When there's a significant difference between the new and reference pictures, the stored picture is updated and only the pulses required to update this reference picture is transmitted. The process takes only a fraction of a second, with no loss in picture quality.

The editing technique is being studied by Bell for application to Picturephone service planned for the 1970's.

Groovy Grooves?

New York, N.Y.—What happens to stereo records played with a monophonic cartridge? Not much, according a paper presented by Astatic to the Audio Engineering Society, provided it's a high-quality mono cartridge at low tracking force. But stereo grooves can be damaged in less than 10 playings with high mechanical impedance cartridges. Damaged groove distortion, however, is frequently masked by the inherent distortion in low-priced phonographs. **R-E**

LOOKING AHEAD

(continued from page 2)

video tape systems a run for their money.

EVR players for educational and industrial use will be produced first, to be made exclusively by Motorola Inc. in the U.S. and Canada until 1971, after which CBS hopes the home market will be ripe and other manufacturers will be licensed to make the players.

Judgment of EVR's impact on the home will have to wait until CBS drops the other shoe, for the system's most intriguing aspect—the generation of color pictures from a low-cost black-and-white film cartridge—is still in the lab and the consumer version isn't expected to be ready until 1971.

What has been demonstrated, and what Motorola will produce first, is a black-and-white player that combines the simplicity of motion picture film with the handling ease and flexibility of a tape cartridge system. The player feeds directly to the antenna terminals of any standard television set by means of a single cable. The film is contained in a completely enclosed circular cartridge 7 inches in diameter and less than 3/8-inch thick, with a large center hole, looking like a swollen 45-rpm disc.

The film itself is completely unorthodox. Measuring just 8 mm, it has no sprocket holes and contains two series of frames side by side, each with its own magnetic sound track, providing in effect, two "tracks" of visual material (photo). In the center, between the pictures, is a series of white indexing indicators, which trigger the player's electronic "shutter" while the film moves continuously at 6 ips. Each track will play up to 26 minutes for a total of 52 minutes, with 180,000 individual frames.

To play an EVR film, the cartridge is dropped on the spindle of what looks like a 45-rpm phonograph (an automatic tape-cartridge changer is within the realm of possibility). The play button is pressed and the film is automatically threaded onto a takeup reel. Like a tape recorder, the EVR player is capstan-driven and has fast-forward and reverse pushbuttons, a digital frame counter, plus additional pushbutton controls to stop the motion (providing a still picture) and for selecting track A or track B.

As viewed in CBS's demonstration, using Motorola 18-inch TV sets as monitors, the system provided extremely high-resolution pictures with excellent contrast—superior to all but the best off-the-air reception—particularly remarkable in view of the fact that each actual film frame is only 3-mm wide.

Although CBS has revealed few technical details, it's known that the player uses a flying-spot scanner as the pickup agent.

Motorola plans to introduce its first black-and-white

(continued on page 12)

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Before you put out money for a home study course in TV Servicing and Repair, take a look at what's new.

National Electronic Associations did. They checked out the new TV training package being offered by ICS. Inspected the six self-teaching texts. Followed the step-by-step diagrams and instructions. Evaluated the material's practicality, its fitness for learning modern troubleshooting (including UHF and Color).

Then they approved the new course for use in their own national apprenticeship program.

They went even further and endorsed this new training as an important step for anyone working toward recognition as a Certified Electronic Technician (CET).

This is the first time a self-taught training program has been approved by NEA.

The surprising thing is that this is not a course that costs hundreds of dollars and takes several years to complete. It includes no kits or gimmicks. Requires no experience, no elaborate shop setup.

All you need is normal intelligence and a willingness to learn. Plus an old TV set to work on and some tools and equipment (you'll find helpful what-to-buy and where-to-buy-it information in the texts).

Learning by doing, you should be able to complete your basic training in six months. You then take a final examination to win your ICS diploma and membership in the ICS TV Servicing Academy.

Actually, when you complete the first two texts, you'll be able to locate and repair 70% of common TV troubles. You can begin taking servicing jobs for money or start working in any of a number of electronic service businesses as a sought-after apprentice technician.

Which leads to the fact that this new course is far below the cost you would expect to pay for a complete training course. Comparable courses with their Color TV kits cost as much as six times more than the $99 you'll pay for this one.

But don't stop here. Compare its up-to-dateness and thoroughness. Find out about the bonus features —a dictionary of TV terms and a portfolio of 24 late-model schematics.

Get all the facts. Free. Fast. Mail the reply card or coupon below.

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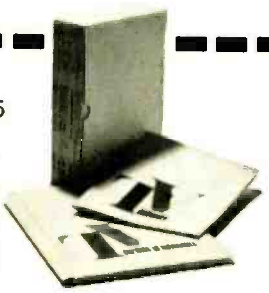

Yes, I'd like all the details about your new TV Servicing/Repair basic training package. I understand there's no obligation. (Canadian residents, send coupon to Scranton, Pa. Further service handled by ICS Canadian, Ltd.)

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Prices slightly higher outside U. S. and Canada.

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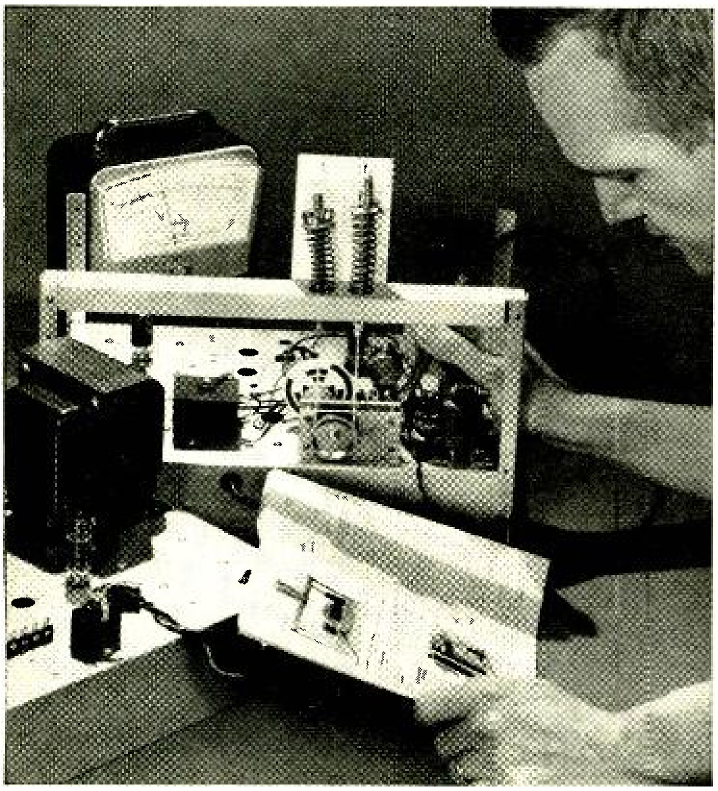

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Almost without realizing it, the NRI discovery method gives you the professional's most valuable tool—practical experience. You learn maintenance, installation, construction and trouble-shooting of Electronic circuits of any description. Whether your chosen field is Industrial Electronics, Communications or TV-Radio Servicing, NRI prepares you quickly to be employable in this booming field or to earn extra money in your spare time or have your own full-time business. And you start out with training equivalent to months—even years—of on-the-job training.

NRI Has Trained More Men for Electronics Than Any Other School

— By actual count, the number of individuals who have enrolled for Electronics with NRI could easily populate a city the size of New Orleans or Indianapolis. Over three-quarters of a million have enrolled with NRI since 1914. How well NRI training has proved its value is evident from the thousands of letters we receive from graduates. Letters like those excerpted below. Take the first step to a rewarding new career today. Mail the postage-free card. No obligation. No salesman will call. NATIONAL RADIO INSTITUTE, Electronics Division, Washington, D.C. 20016.

L. V. Lynch, Louisville, Ky., was a factory worker with American Tobacco Co., now he's an Electronics Technician with the same firm. "I don't see how the NRI way of teaching could be improved."

G. L. Roberts, Champaign, Ill., is Senior Technician at the U. of Illinois Coordinated Science Laboratory. In two years he received five pay raises. Says Roberts, "I attribute my present position to NRI training."

Don House, Lubbock, Tex., went into his own Servicing business six months after completing NRI training. This former clothes salesman just bought a new house and reports, "I look forward to making twice as much money as I would have in my former work."

Ronald L. Ritter of Eatontown, N.J., received a promotion before finishing the NRI Communication course, scoring one of the highest grades in Army proficiency tests. He works with the U.S. Army Electronics Lab, Ft. Monmouth, N.J. "Through NRI, I know I can handle a job of responsibility."

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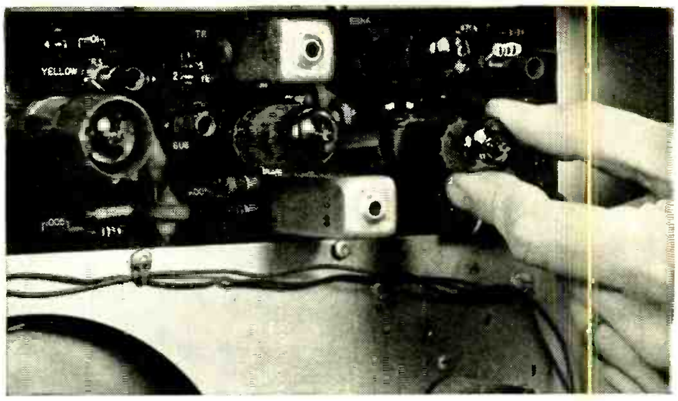

COLOR TV CIRCUITRY COMES ALIVE

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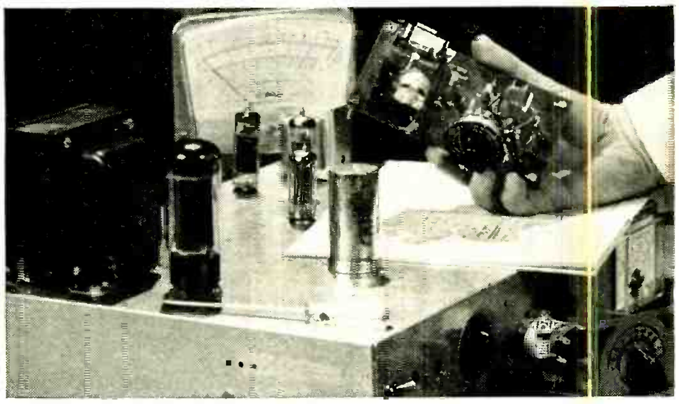
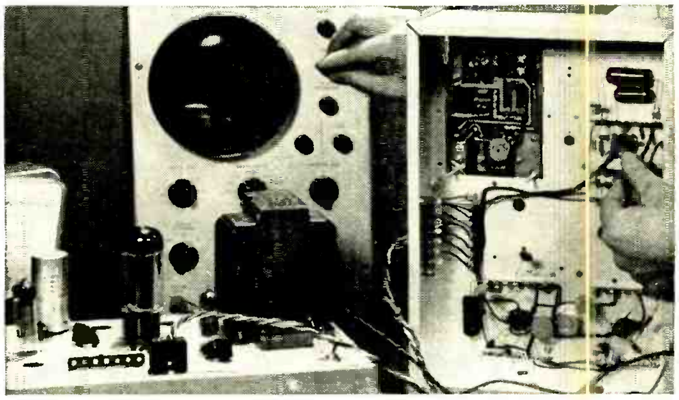


COMMUNICATIONS EXPERIENCE

comparable to many months on the job is yours as you build and use a VTVM with solid-state power supply, perform experiments on transmission line and antenna systems and build and work with an operating, phone-cw, 30-watt transmitter suitable for use on the 80-meter amateur band. Again, no other home-study school offers this equipment. You pass your FCC exams—or get your money back.



COMPETENT TECHNICAL ABILITY

can be instantly demonstrated by you on completing the NRI course in Industrial Electronics. As you learn, you actually build and use your own motor control circuits, telemetering devices and even digital computer circuits which you program to solve simple problems. All major NRI courses include use of transistors, solid-state devices, printed circuits.

LOOKING AHEAD

(continued from page 6)

EVR players early in 1970, designed for specialized non-home markets. These ruggedized units will be priced at "less than $800," but still considerably above the $280 estimated by CBS more than a year ago. The *New York Times* will be the first organization to produce films for EVR. These will be a series of 50 educational selections for use in schools, each running 15 to 20 minutes.

What's in it for CBS? The processing bonanza. The network company is now building a plant to make EVR cartridge films from standard 16 and 35 mm film and video tape. Cartridges, says CBS, can be duplicated at extremely high speed and relatively low cost. Informal estimates were $7–$8 for processing and "cartridging" the film, with a resulting price of $25–$35 per complete educational film package.

No significant in-home market is envisoned until the color version becomes available. The color EVR will use the same size cartridge, operating at the same speed, but giving only one-half the playing time—a maximum of 26 minutes, or about 30 minutes if thinner film is used. The space occupied by Track B on the current black-and-white film will be devoted to coded information which, electronically scanned, will "color" the optical image on Track A.

A demonstration of the principle of color EVR is expected soon (perhaps including a "sneak preview" on one of CBS's television stations), when CBS introduces a similar system, but in 16-mm size and without the cartridge, for use by television stations to produce color pictures electronically from specially processed black-and-white film. It's claimed to give resolution equal to that of 35-mm color film.

Whether EVR will ever be a significant consumer product will be known only after the introduction of the home color version in 1971, and when the prices of home players (or combination color sets and EVR) are established.

But it can't cook

What must be the world's most complicated home television receiver is now on sale in Belgium, which obviously is the most confusing place in the world for a TV viewer to live. In much of the country, broadcasts can be received on non-standard Belgian 625- and 819-line systems as well as from the Netherlands, Germany, France and Luxembourg in various other standards, in two color systems and on two broadcast bands.

More computer than TV receiver, the color set built by Philips has an automatic switching system which adjusts it to receive at programs in at least 11 different combinations of standards and frequency bands. In case you're interested, these are some of the combinations: European 625-line b-w and PAL color on vhf and uhf, Belgian 625-line b-w (whose picture and sound modulation differ from general European standard) in vhf and an eventual second channel in uhf, the same Belgian system with PAL color and with SECAM color (not yet on air), Belgian 819-line b-w on vhf, French 819-line b-w vhf broadcasts (with channel width and spacing different from the Belgian equivalent), French 625-line broadcasts in SECAM color on uhf. The price, for a table model: more than $1,000. **R-E**

Correspondence

ARTICLES I'D LIKE TO READ

I am a constant reader of your magazine and like it very much—especially the transistor circuits you suggest building. I build most of these circuits you publish, and would like to see more of them.

How about publishing some of the following articles in some of your future issues:

1. Low-voltage transistor capacitor tester (test of quality).
2. TV transistor camera (closed-circuit rf).
3. FET transistor quality tester.
4. Transistor audio oscillator.
5. Transistor signal generator.
6. Transistor multiband receiver.
7. Control rectifier quality tester.
8. Triac quality tester.

C. P. ARMENTROUT
Titusville, Fla.

TECHNICIAN CERTIFICATION

I would like to comment on an article that appeared on page 12, RADIO-ELECTRONICS, Sept. 1968, titled "Electronic Technician Certificates."

There is a problem presenting today's technician to the public. An ever increasing number of people seem to be under the impression that all a technician does is think about how much money his next job should bring and what to spend it on.

As unfortunate as it is, we brought it upon ourselves! Years back, and even today, we didn't stand up and demand that certain standards should be met by every service person. We didn't insist on competent technicians. We didn't (and don't) insist that the "technician" obtain a certain degree of education in theory and practical experience before turning him loose to repair anything from radio sets to extremely urgent medical devices!

The National Electronics Association appears to be approaching this problem by offering certificates to identify a competent electronic technician. However, I feel they're just scratching the surface.

I agree that licensing competent technicians is the first step. However, that license should expire within three years and re-examination should be required for renewal. This would insure that the individual has kept himself abreast of developments in the field. Also, the examination should be designed to conform with the particular area that the individual does his work in, i.e., radio-TV. communications, computers etc. The NEA or IEEE should establish a volunteer representative in as many areas as possible to administer the examination. A "mail order" license just doesn't turn me on. Neither does multiple choice questions. There should be drawings showing voltages then asking "what's wrong with this circuit?"

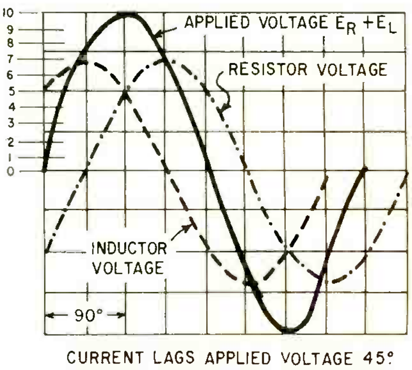
I could go on and on, but, you get the idea. Let's clean up the electronics field. In today's age there is no place for some of the incompetency that we have all seen "somewhere." (Usually somewhere else!) I think that any technician worth his soap would support such a program.

DAVID L. DOWNING
Detroit, Mich.

Dave, you learned to walk before you could run. Sure the NEA testing approach is not the cure all. But it is one of those first steady steps that can lead to making the service technician a respected professional.

KIRCHHOFF DOESN'T LIE

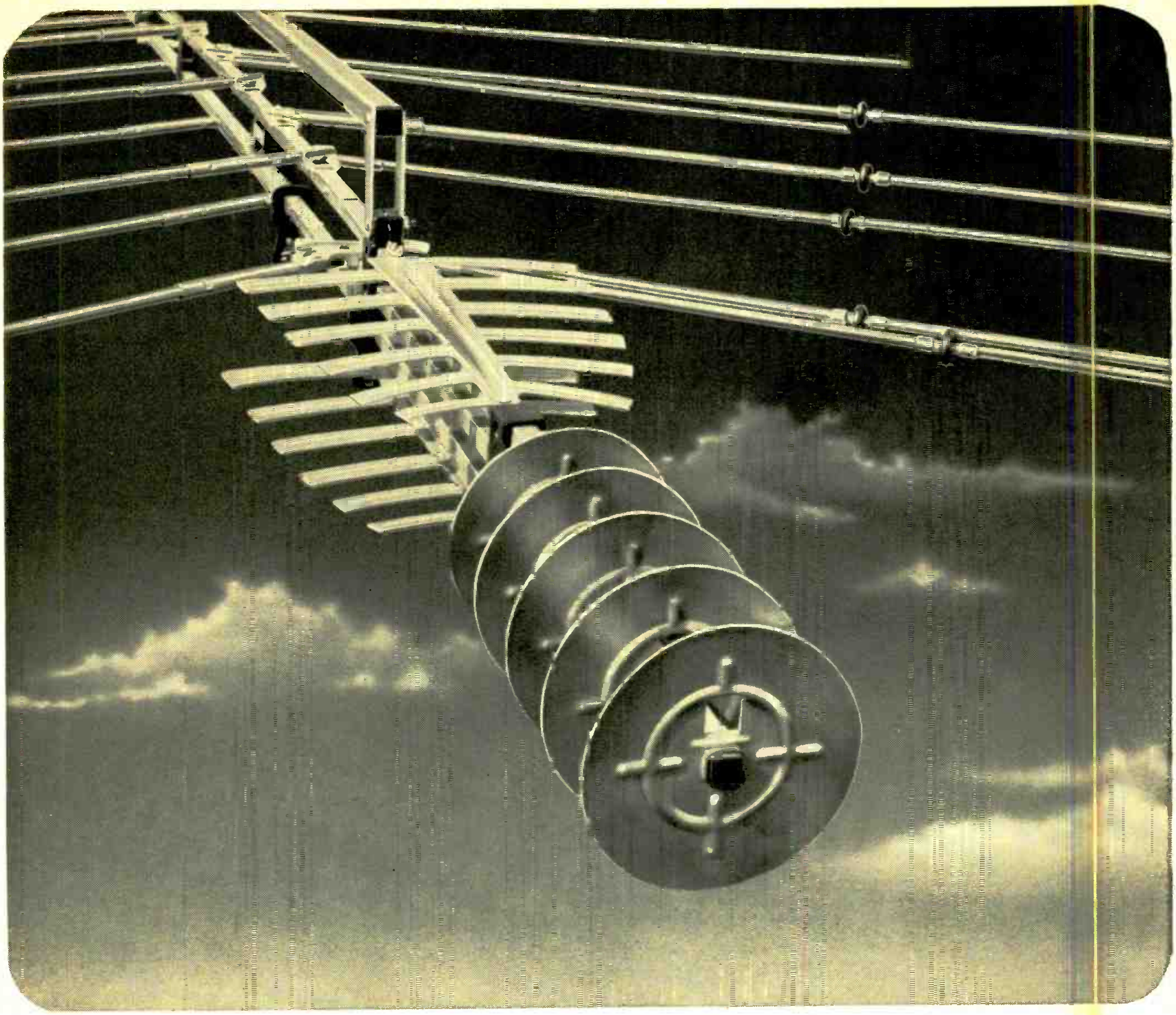
I was a bit disappointed that a letter panning a story of mine was published without a chance for me to get in my two cents worth. Mr. Rich-



CURRENT LAGS APPLIED VOLTAGE 45°
RESISTOR AND INDUCTOR VOLTAGE 90° OUT OF PHASE.

INDUCTOR VOLTAGE LEADS APPLIED VOLTAGE BY 45°
RESISTOR VOLTAGE LAGS APPLIED VOLTAGE BY 45°

ter (Correspondence, July 1968) is correct when he says that there is never a time when the voltage is 7.1 volts and 2.9 volts ("Horseflies, Tractors and Mr. Kirchhoff," March 1968). Instead, the voltage at the peak



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of the applied voltage is 5 volts across the inductor and 5 volts across the resistor. When the voltage across the inductor is 7.1 volts, the voltage across the resistor is zero, but Mr. Kirchhoff is not violated because at that same instant the applied voltage is 7.1 volts. The graph shows this clearly, but Mr. Richter should have plotted *three* sine waves instead of two. As the graph shows, the inductor voltage leads the applied voltage by 40° and the resistor voltage lags the applied voltage by 45° when $X_L = R$

Mr. Richter is incorrect when he intimates that the essential point of the story must be "unlearned". The point of the story is, as anyone who will read it can see, that Mr. Kirchhoff is as valid for ac as for dc and that the sum of the voltages at any instant is equal to the applied voltage at that instant. The purpose of my article was to point this out and I'm truly sorry that a numerical error occurred.

WAYNE LEMONS
Buffalo, Mo.

IT HAPPENED TO ME

I'd like to pass on an interesting phenomenon noted while doing some independent experimentation with tuned circuits. I found that most, but not all transistors react to the influence of a strong magnetic force. An example of this influence is the ability of the magnetic force to change the frequency of an oscillator. By placing an Alnico magnet close to the transistor being used as a local oscillator in a superhetrodyne receiver, it was possible to change the frequency of this oscillator to cover the entire broadcast band. The distance and position of the magnet determined the rate of change.

Later, an electromagnet was used and the voltage varied to the magnet coil. The same effect was noted—the oscillator changed frequency in step with the varied emf. The gain of an audio stage was reduced from full output to a point where it was no longer audible to the human ear, by the same methods described above. It is assumed that this phenomenon is an extension of the Hall effect.

DEAN D. CAMERON
Seattle, Wash.

Coming Next Month

Complete details for building a battery-operated stereo phonograph are in our next issue. Two IC's let you pack amplifiers for both channels in the pick-up arm. This project is one of five audio articles in the March RADIO-ELECTRONICS.

In the Shop . . . With Jack

By **JACK DARR**

SERVICE EDITOR

10 STEPS FOR FAST COLOR CRT CHANGES

CHANGING A COLOR CRT CAN BE A hard job or an easy one, depending on how you go at it. If you use the right tools and techniques, it can be a lot simpler and faster. Try this.

First, we'll assume that the set is otherwise o.k. This can be easily checked, since in most cases we'll have only one bad gun. So, this is a mechanical problem: getting the old tube out, and the new one in and readjusted in the least possible time.

Time yourself on the first job, then see if you can cut it down on the next one. We've run time-and-motion studies on quite a few sets, and found that this 10-step technique seems to be the quickest and easiest.

Step 1: Clear the bench and put a couple of pads on it. Discarded carpet samples about 2′ square are ideal. Get the new tube ready, but leave it in the box.

Step 2: Pull the chassis. Sometimes the tuner and controls can be left in if they won't interfere with getting the tube out. Set the chassis out of the way, and put all bolts, knobs, etc. in a box.

Step 3: Put a soft pad on the floor; a discarded sofa cushion is good. Take off the neck components: purity rings, blue lateral magnet, convergence yoke and deflection yoke. In late models, these may be all together, which simplifies things.

Lay these out on the bench in a line, just as they go back on the tube. It helps sometimes to make a rough sketch of the distance between each one.

Step 4: Take out the CRT mounting bolts and lift the old tube out. Set it on one of the bench pads. Now get out the new tube, and set it on another pad in the *same* position; high-voltage button toward you, away from you, etc.

Take off the mounting clamp or band and set it on the new tube. If the mounting "ears" (rectangular tubes only) are loose, *mark their positions* on the band *before* you loosen it. Or put a piece of tape over each ear to hold it where it ought to be. If the ears slip, they won't fit the bolt holes. This means taking the tube out of the cabinet again for readjustment, wasting a lot of time.

Set the whole works on the new tube, and make sure that the ears are correctly set, with the flanges under the faceplate, etc. Be *sure* that it is right side up. Tighten firmly, but not too firmly.

Step 5: Put the new tube in the cabinet and tighten the mounting bolts. Be sure that the tube is tightly fastened, and seated in the mask opening.

Step 6: Replace the deflection and convergence yokes, purity magnets, blue lateral, etc. Set them as close to where they were as you can, but don't tighten the clamps yet. Just enough to hold 'em firmly.

Step 7: Set the cabinet back up and slide the chassis in. Replace the knobs and hook up the high-voltage leads, yoke cables, tuner, etc. Turn the set on, set up the brightness controls, check the high voltage, etc. to make a good raster. Check centering of the raster at this time.

Step 8: Now we're ready to get into the time-saving part. Presumably, the set was fairly well converged before. What we've got to do is get that back in the least time. Do it the easy way. Replacing the tube shouldn't change any of the *dynamic* adjustments. Getting back to proper convergence should be just a matter of getting the neck components back to their right places.

Demagnetize the tube, just for

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.

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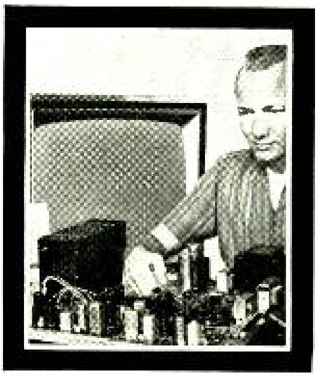

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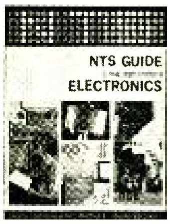

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luck. (If the purity looks good, don't bother.) Now set up the mirror and put a crosshatch pattern on the screen from your bar-dot generator.

Chances are it'll look pretty bad at first. If the purity is o.k., move the convergence yoke slightly back and forth, watching the screen to get the best overlap of the lines. In some cases—particularly if you get edge misconvergence—*turn* the convergence yoke just a tiny bit back and forth around the neck.

If you get problems, turn the blue screen off, and work with red and green to get a well-converged yellow pattern. If necessary, move both red and green with the static magnets until they are well overlapped. Now turn the blue back up, and work the blue lines over the yellow with the two blue magnets. If the blue lateral makes the lines move *diagonally*, check its setting on the tube neck, it isn't right. Probably needs turning around the neck. If the blue lateral doesn't have enough range (won't move the line far enough) it is probably off position fore and aft.

Step 9: Now run your regular setup adjustments: screen settings, CRT bias, video drives and check the tracking.

Step 10: Deliver and collect.

That's about all there is to it. The use of a known pattern on the screen will help you to get the neck components back in the right places in the least time. That's the most important part. Having the proper tools on hand and within reach can save you a lot more time—long nut drivers, stubbies and so on, all the special tools needed for this particular chassis.

In tests, we found that the average color picture tube could be changed and the set back in operation in about 25 minutes, with only one man on the job. **R-E**

"I keep bumping into things."

COVER STORY

EASY TO BUILD

High Power Electronic Photoflash

100-watt/second xenon photoflash with trigger circuit

by JAMES A. GUPTON, JR.

Faster than a moon-bound rocket and brighter than the noonday sun, the xenon flashtube is a miniature lightning bolt in a coil of glass tubing.

Its versatility makes xenon indispensable to photography. Flash duration can be varied from milliseconds to microseconds to stop action—even a bullet in flight. In addition, flash intensity can be varied to provide the exact amount of light needed for most situations.

The spectral distribution curve of xenon lamps reveals still another important characteristic. The high content of light output in the 350–450-millimicron region and low output in the 650–700-millimicron region raises the color temperature to almost 6500° Kelvin. So, color pictures taken with xenon lighting need no filters to correct for color balance.

Only three basic circuits are needed to operate the xenon flashtube: a dc power source, energy bank and trigger circuit. Several circuit variations are described here so you can select a unit that fits your construction budget.

A good starting point is the dc power source. Here you have a choice of batteries or a transformer-rectifier circuit. Circuits for either battery or transformer-rectifier power sources are in Fig. 1.

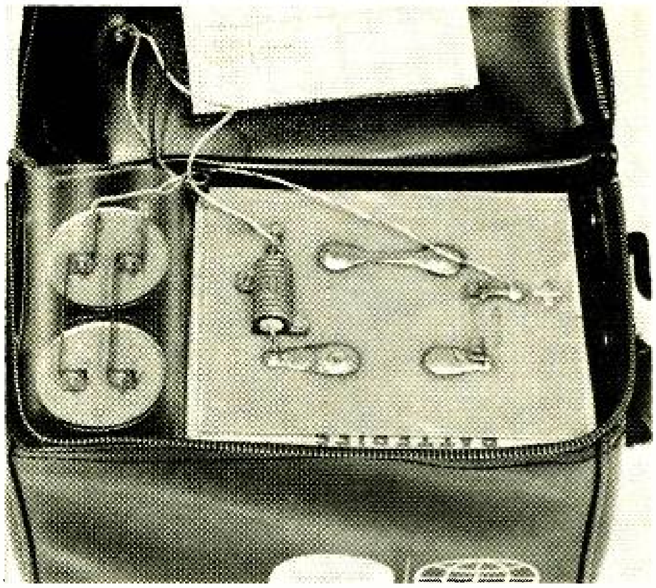
The convenience and rapid recycling of the battery source make it perhaps the most economical and easiest to construct.

The energy bank is the heart of the xenon circuit. Here the intensity and duration of the xenon light are controlled. Made up of a number of low-leakage, high value capacitance electrolytic capacitors in parallel. the energy bank accumulates an electrical charge and maintains that charge until an appropriate trigger circuit fires the xenon flashtube. This dumps the total charge through the flashlamp.

Capacitors in the energy bank do two jobs. They determine the total light output and control the duration of the flash. The greater the capacitance of the energy bank. the greater the light output and the longer the flash duration. For short flash duration, say in the microsecond range. capacitance is low, but the applied dc voltage is high.

Flash-power and how it works

The relationship between capacitance, voltage and power is illustrated by the formula: $J = CV^2/2$—where J = energy in watt/seconds; C = capacitance in microfarads; and V = applied dc voltage in kilovolts. For example: Suppose we have two 525-μF capacitors being charged by two 225-volt. series-connected batteries. What power will be available to the flashtube?



A photographic "gadget" bag makes a convenient carrying case for the battery pack. Bananna plugs beneath the circuit board connect 225-volt batteries. Place plastic over capacitors.

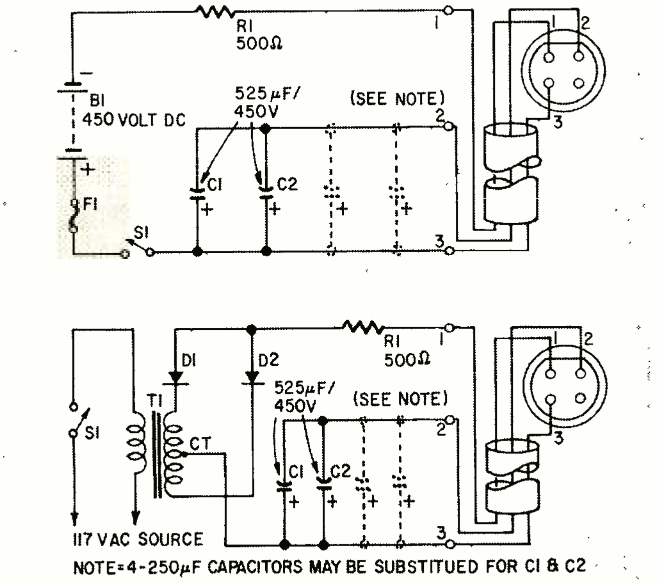


Fig. 1—Top drawing shows components for battery-source power supply. The transformer-rectifier circuit below permits ac operation. Battery operation provides the fastest recycling.

$$W/S = \frac{CV^2}{2} = \frac{(1050\,\mu F) \times (0.45\,kV^2}{2}$$
$$\frac{1050 \times 0.2025}{2} =$$

106.3 watt/second input energy

When used as a photographic light source. the flashtube's power is controlled by the total capacitance of the energy bank. When charged to 450 volts dc. a single 250-μF capacitor will produce approximately 25 watt/seconds. or almost 1000 lumen/seconds of light.

If several capacitors are connected in parallel to the dc power source by a shorting-wafer switch. the increased capacitance increases the total light energy. Reducing the capacitance of the energy bank speeds recycle time and reduces battery current drain.

The power of the energy bank can be extremely dangerous. Protective shielding for the capacitors is necessary to prevent accidental shock. A sheet of plastic can be heated in hot water or by the heat of a reflector spotlamp and formed around and over the capacitors to provide complete shielding. **Also be sure that you never exceed the power rating of the flashtube. Exceeding its power rating can result in the flashtube exploding, causing damage through flying glass.**

The trigger circuit and what it does

The trigger circuit provides a pulse of 5000 to 15.000 volts to the exterior of the flashtube. This high-voltage pulse ionizes the xenon gas in the tube to provide a discharge path through the tube for the accumulated energy-bank charge.

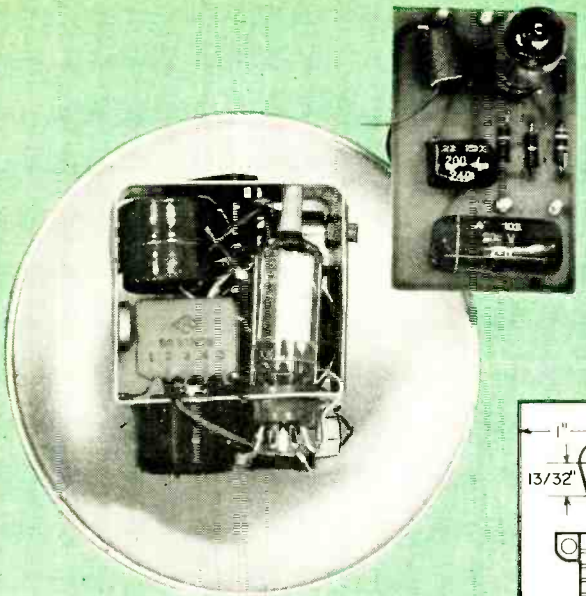
A typical class-I trigger circuit is in Fig. 2-a. This circuit is suitable for lower-power flash-tubes—50 watt/seconds or less. The main advantages are its simple circuitry and low cost. Applying dc voltage to terminals 1. 2 and 3 charges the 0.25-μF capacitor to about 180 volts. Closing the trip circuit discharges the capacitor through the trigger coil's primary circuit. This produces a high-voltage pulse to ionize the xenon gas in the flashtube.

A disadvantage of the class-I trigger circuit is the potential damage to delicate camera-sync contacts by the trigger current flowing through the trip circuit.

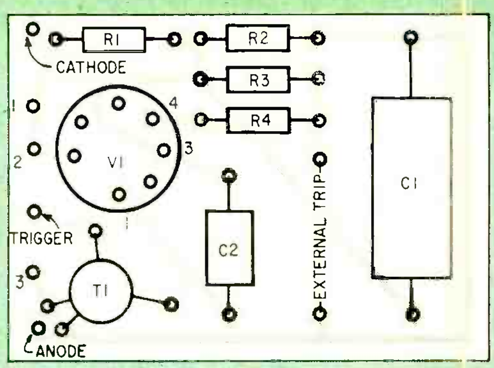
A class-II trigger circuit is shown in Fig. 2-b. This circuit provides trigger power for flashtubes up to 200-watt/second ratings. and offers complete protection for camera-sync contacts. Like the class-I trigger circuit. class-II circuit operation depends on charging a capacitor (0.5 μF. in this case). However. closing the trip circuit. does not discharge trigger current through the camera's shutter contacts. Instead, the charge fires the thyratron and passes through the trigger coil's primary circuit to induce the trigger ionization pulse.

The high-voltage pulse formed in the trigger circuit requires insulation and shielding to protect the user from electrical shock. The inner plastic-covered conductor of RG/58-U coaxial cable makes an ideal high-voltage conductor.

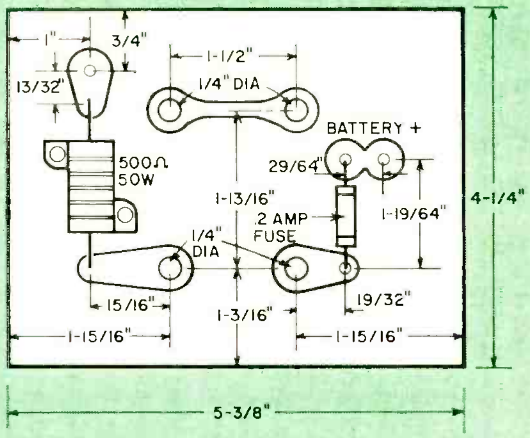
The simplicity of the circuit should eliminate the necessity for step-by-step kit-like instructions. However,



Printed circuit board used for class-II triggering (top right) is compared with similar mounted professional layout.

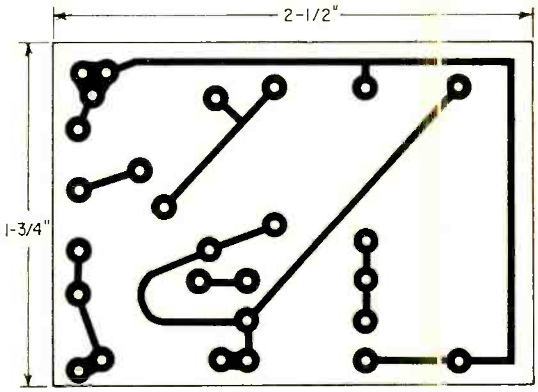


Location of parts on PC board (Class-II trigger) shown from component side. Terminals 1, 2, 3 supply C1's charging voltage.



Top view of battery-connector printboard with dimensions for terminals. Battery connector plugs soldered in the 0.250" holes connect the 225V batteries together.

Printed circuit board for Class-II trigger operation is shown here actual size. Trace, or use the drawing for photographic transfer.



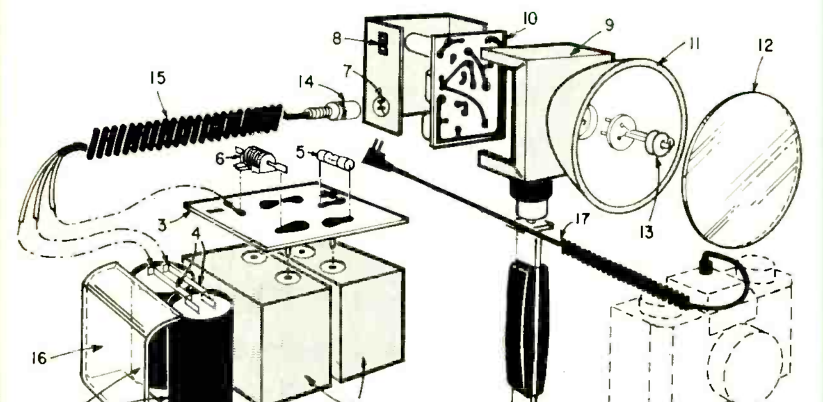
COMPOSITE PARTS LISTS

Class-I Trigger
R1—4.7-megohm, 1 watt, 5% resistor
R2—3.3-megohm, 1 watt, 5% resistor
C1—0.25-μF, 600-volt, capacitor
T1—trigger coil, Stancor P-2426 or UTC-PF7
Flashtube—FT-106 or FT-118 (see Misc.)

Class-II Trigger
R1—4.3-megohm, 1 watt, 5% resistor
R2—3.9-megohm, 1 watt, 5% resistor
R3—8.2-megohm, 1 watt, 5% resistor
R4—120,000-ohm, 1-watt, 5% resistor
C1—0.5-μF, 200-volt capacitor
C2—0.22-μF, 200-volt capacitor
V1—5823 tube (RCA)
T1—trigger coil, Stancor P-2426, Thordarson 22R115 or UTC PF7

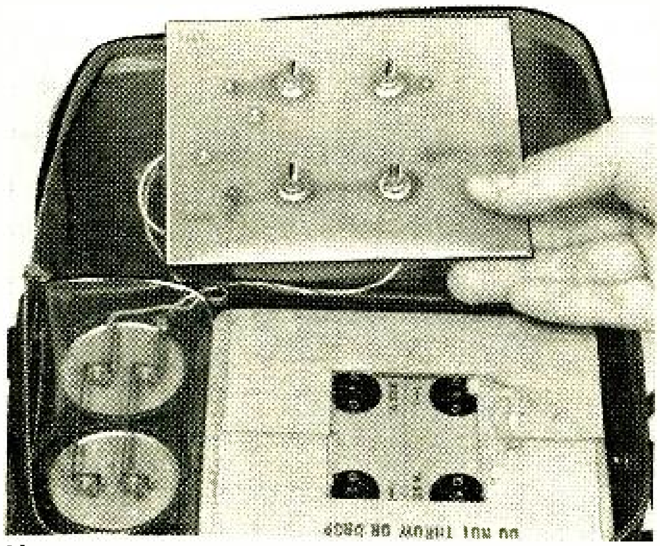
Battery Power Supply
R1—500 ohm, 50-watt resistor (Dale)
F1—0.25A, 3AG pigtail fuse
C1, C2—525-μF, 450-volt capacitor (Sprague No. D16442). (250-μF, 600-volt for substitute capacitors)
Type 100 battery connector plugs (4)

117V ac Power Supply
D1, D2—1A, 600-volt rectifier
F1—0.25A, 3AG pigtail fuse
T1—Power transformer, Stancor P-6425 or equal
S-1—spst switch
MISC—See assembly drawing parts list below. Flashtubes specified are available from Edmund Scientific Co., Barrington, N. J. 18007. The stainless-steel reflector bowl is available from Sears & Roebuck Co.



Assembly Drawing Parts List

1. 225V Burgess XX150 batteries (2)
2. 525-μF Sprague low-leakage photoflash capacitors
3. Battery-connector printed circuit
4. Copper buss bar for connecting capacitors
5. 0.25A 3AG pigtail fuse
6. 500-ohm, 50-watt resistor
7. 4-pin socket, Switchcraft No. 2504FP
8. 117V ac chassis-mount outlet
9. Mini-box housing for trigger circuit
10. Trigger pulse printed circuit
11. 5" dia. stainless steel mixing bowl
12. 5" dia. plastic flashtube shield
13. FT-118 flashtube
14. 4-socket plug, Switchcraft 2504M
15. Retractile cord, Belden 8602, 8603, 8604 or 8497



Plugs-eye-view of the circuit board that connects the batteries into the rest of the electronic system. Please note that these are high-voltage units; they pack a punch so be careful.

there are a few points to check if you have any trouble getting your flash unit to operate.

Trouble shooting casebook

If the lamp fails to operate, check the following:

1. Are batteries connected?
2. Are batteries connected in series? (Positive terminal of battery 1 should be connected to negative terminal of battery 2).
3. Does the negative power lead connect to shorted terminals 1 and 2 on the trigger circuit board?
4. Does the positive lead from the trigger circuit board to the flashtube anode? Negative lead to flashtube cathode?
5. Check capacitor terminals with a dc voltmeter for 450 volts dc. If no voltage, check the fuse.
6. Check voltage across the 0.5-μF capacitor for 180 volts dc.
7. Check flashtube for cracks in glass around glass-to-metal seals.
8. Check trigger coil circuit to flashtube, use high-voltage probe and measure trigger voltage (5 to 15 kV).

A construction suggestion: Most camera stores carry small plastic "gadget" bags which make an ideal carrying case for the battery power pack. **R-E**

GUIDE NUMBER RATINGS*

	FILM ASA RATING	GUIDE NUMBER
50 WATT—SECOND FLASH	40	55
	65	70
	125	95
	165	110
	400	170

	FILM ASA RATING	GUIDE NUMBER
100 WATT—SECOND FLASH	40	76
	65	95
	125	125
	165	145
	400	250

*Suggested ratings may vary with equipment and are given as a starting point for individual adjustments.

USING ELECTRONIC FLASH

Taking a picture with an electronic flash is similar to taking any other kind of flash picture. However, there are differences. First you use the daylight rating of the film and you use daylight film. The electronic flash duplicates the light spectrum of normal daylight.

Second, always use the X setting when using electronic flash. If you don't you may not get a picture.

Third, you can use just about any shutter speed you wish. The flash is so fast that it determines the speed of the exposure. However, it is desirable to avoid slow shutter speeds to reduce the effects of incident light. (For focal plane shutters do not use speeds faster than 1/60 second.)

To get the lens aperture use the guide number chart at the bottom left of this page. The proper guide number you should use can be found next to the ASA rating of your film.

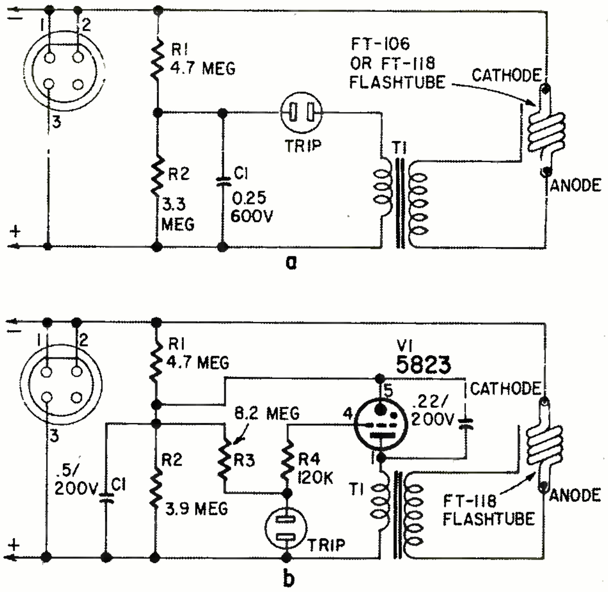


Fig. 2-a—Class-I trigger circuit for low-power flashtubes. Trigger current passes through camera-sync contacts. b—In Class-II circuit, a thyratron tube prevents contact overload.

JUST THE BEGINNING

If you liked this article you'll want to read the other electronics in photography features that appear in this issue.

On page 39 Associate Editor John Free's article "IC Electronics For Shutterbugs" appears. It's a broad-coverage article on today's electronics in modern photography.

And for the darkroom we've got a construction story on a digital darkroom timer on page 68. Flip the toggle switches to set the exposure timer for your enlarger. This all-electronic mechanism has no moving parts.

Circle 25 on reader service card

Join "THE TROUBLESHOOTERS"

They get paid top salaries for keeping today's electronic world running

Suddenly the whole world is going electronic! And behind the microwave towers, push-button phones, computers, mobile radio, television equipment, guided missiles, etc., stand THE TROUBLESHOOTERS —the men needed to inspect, install, and service these modern miracles. They enjoy their work, and get well paid for it. Here's how you can join their privileged ranks—without having to quit your job or go to college in order to get the necessary training.

JUST THINK how much in demand you would be if you could prevent a TV station from going off the air by repairing a transmitter...keep a whole assembly line moving by fixing automated production controls...prevent a bank, an airline, or your government from making serious mistakes by servicing a computer.

Today, whole industries depend on Electronics. When breakdowns or emergencies occur, someone has got to move in, take over, and keep things running. That calls for one of a new breed of technicians—The Troubleshooters.

Because they prevent expensive mistakes or delays, they get top pay—and a title to match. At Xerox and Philco, they're called Technical Representatives. At IBM they're Customer Engineers. In radio or TV, they're the Broadcast Engineers.

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Think With Your Head, Not Your Hands

As one of The Troubleshooters, you'll have to be ready to tackle a wide variety of electronic problems. You may not be able to dismantle what you're working on—you must be able to take it apart "in your head." You'll have to know enough Electronics to understand the engineering specs, read the wiring diagrams, and calculate how the circuits should test at any given point.

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For over 30 years, the Cleveland Institute of Electronics has specialized in teaching Electronics at home. We've developed special techniques that make learning easy, even if you've had trouble studying before. Our AUTO-PROGRAMMED® lessons build your knowledge as easily and solidly as you'd build a brick wall—one brick at a time. And our instruction is personal. Your teacher not only grades your work, he analyzes it to make sure you are thinking correctly. And he returns it the same day received, while everything is fresh in your mind.

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To keep up with the latest developments, our courses are constantly being revised. This year CIE students are getting new lessons in Laser Theory and Application, Microminiaturization, Single Sideband Techniques, Pulse Theory and Application, and Boolean Algebra.

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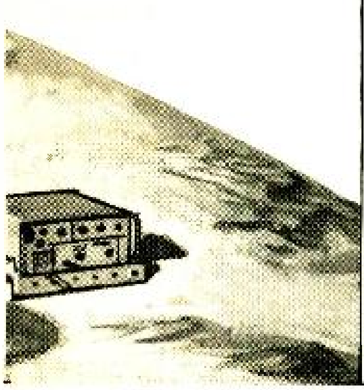

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Circle 26 on reader service card

Four-Channel Audio Mixer

Lets you blend four instruments or mikes into one amplifier input

by Jack Jacques*

THIS HANDY LITTLE AUDIO MIXER PERMITS combining up to four separate high-impedance devices into a single amplifier low impedance input stage. When used with the HEP Guitar Amplifier (RADIO-ELECTRONICS, November 1968), for example, up to four instruments and/or microphones can be fed into one input. There are separate level controls for each instrument.

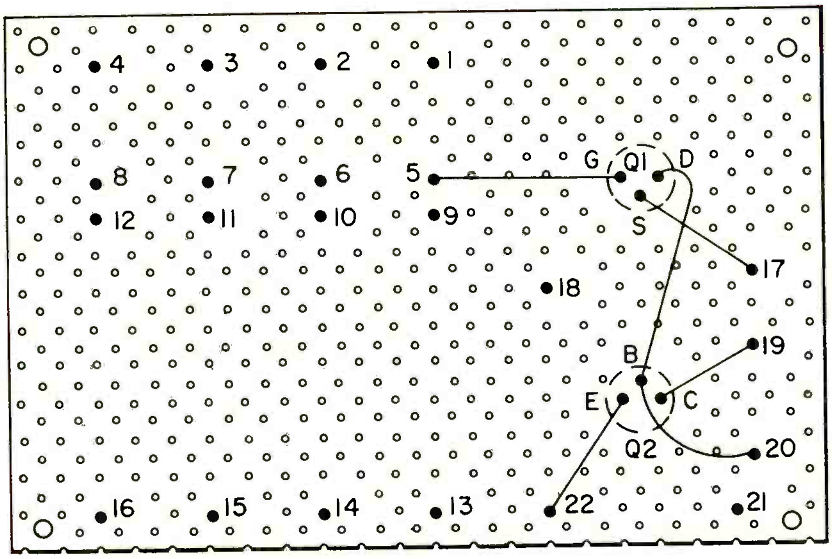
*HEP Technical Manager
Motorola Inc. Phoenix, Ariz.

You'll also find this mixer handy with the Vibrato, Reverberation, Fuzz Box and Electronic Bongos to be described in coming months.

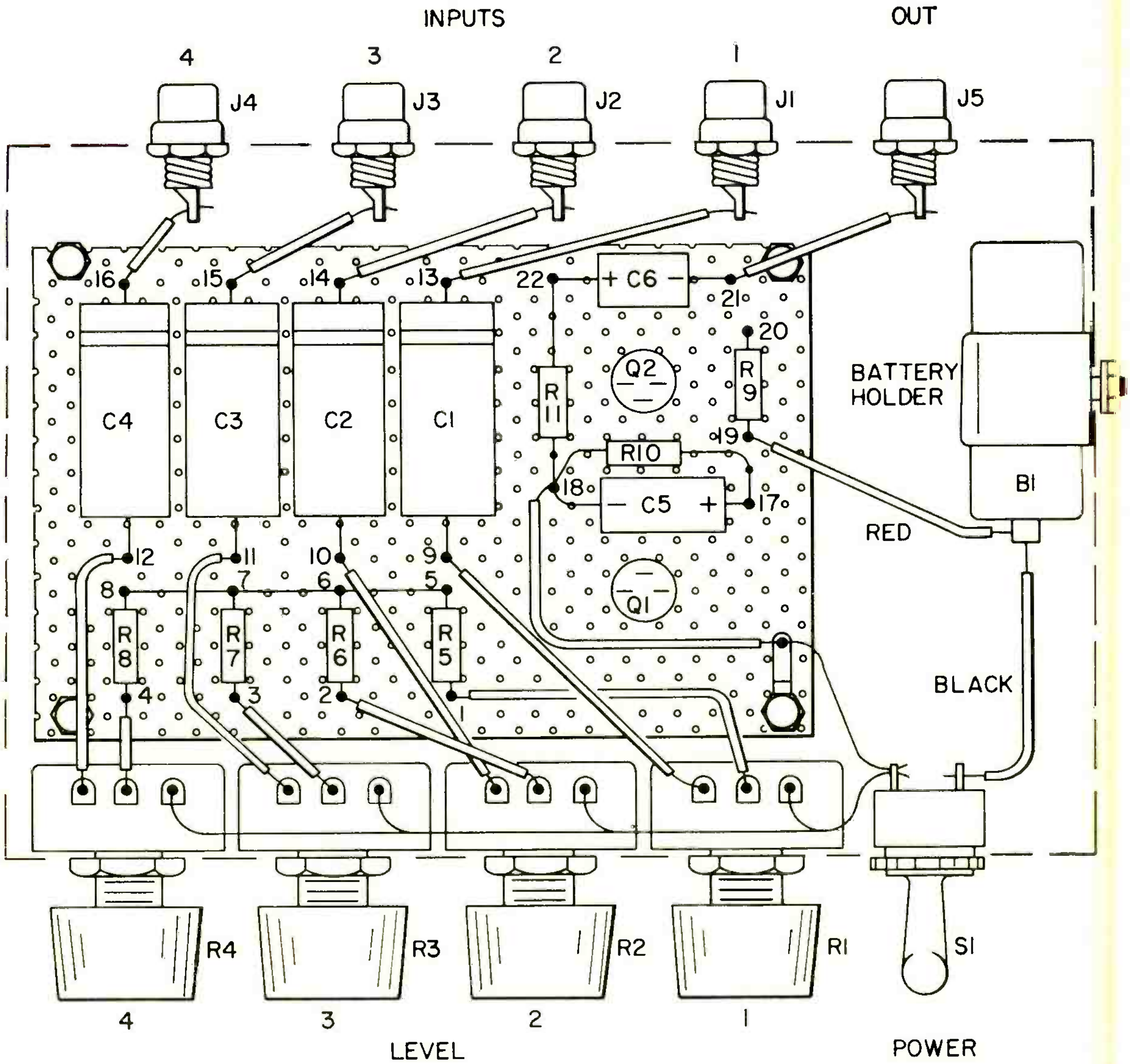
Frequency response of the mixer is about ±3 dB from 20 Hz to 100 kHz. Voltage gain runs between 5 and 10 dB, depending on the characteristics of the the FET and transistor you purchase. However, the maximum output level you can expect

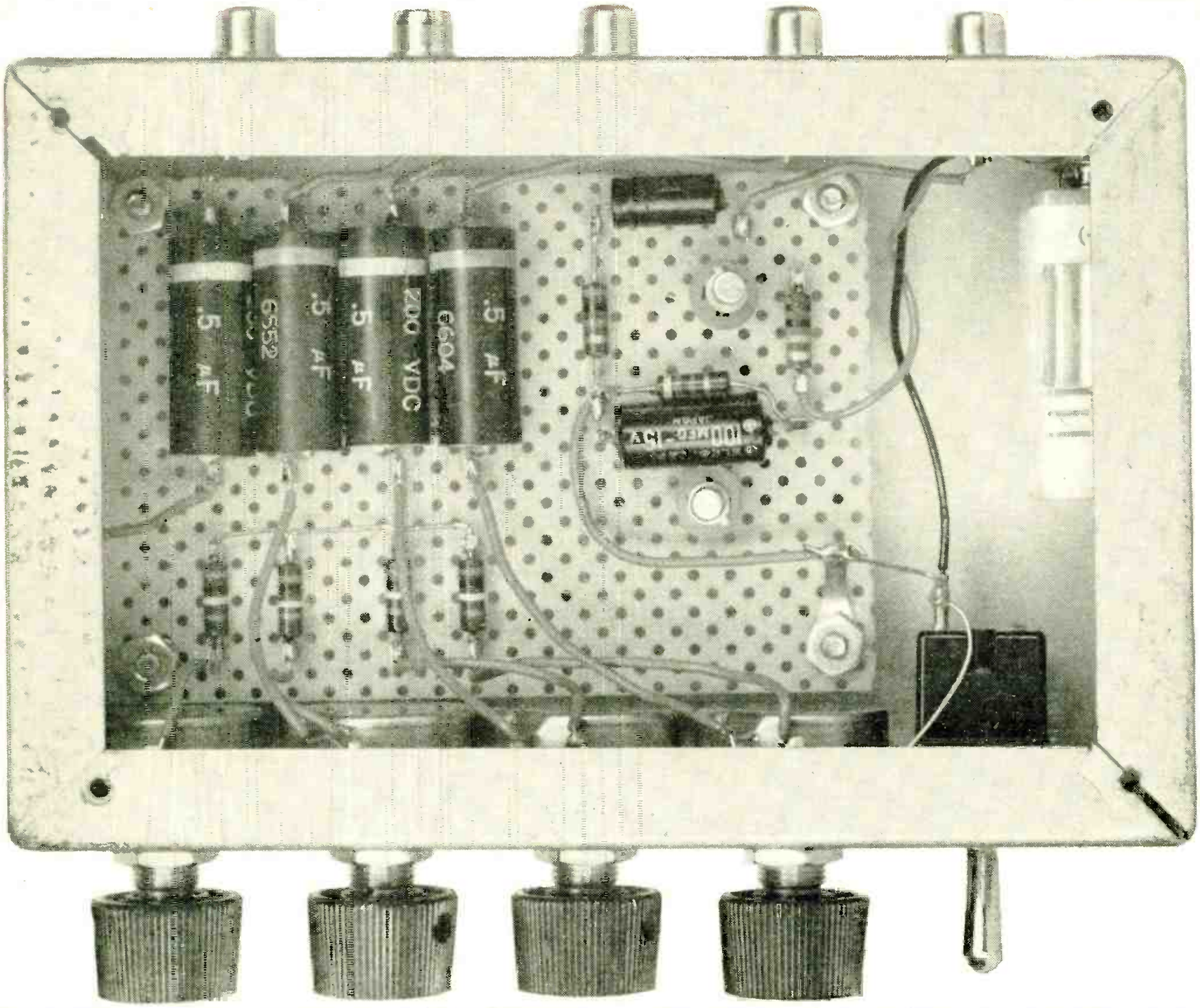
PARTS LIST

B1—9 volts, mercury (Mallory TR146X or equiv.)
C1–C4—0.5 μF, 100 V, Mylar
C5—200 μF, 10 V, electrolytic
C6—25 μF, 10 V, electrolytic
J1–J5—Phono jacks
Q1—N-Channel FET HEP801 (Motorola)
Q2—npn transistor HEP50 (Motorola)
R1–R4—potentiometer, 25,000 ohms (Mallory U29 or equivalent)
R5–R8—100,000 ohms
R9—10,000 ohms
R10—4700 ohms
R11—1000 ohms
S1—spst toggle switch
Misc: 5" x 7" x 2" chassis and cover. Battery clip, battery holder, transistor sockets (2), 2¾" x 4" terminal board (cut to size), push in terminals (22 Keystone 1499-FT or equiv.), terminal lug, 6-32 x ¾" machine screws, pan head (4); 6-32 nuts (12), 4-40 x 3/16" machine screws, pan head (2); 4-40 nuts (2), rubber feet (4).

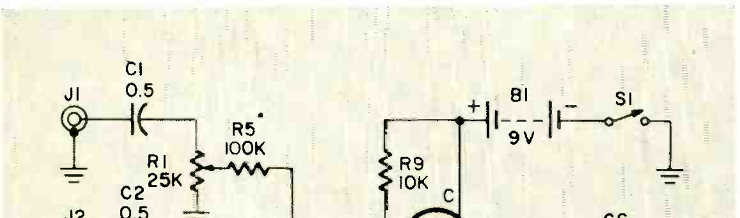


Component placement and wiring for the top and bottom of the board are shown in the pictorial. Numbers for the bottom view (left) correspond to those on the view below. Parts layout is not critical, but this arrangement will assure a satisfactory project.





Use insulator standoffs to mount the terminal board to the chassis. Bolt or rivet the battery holder to the side of the chassis.



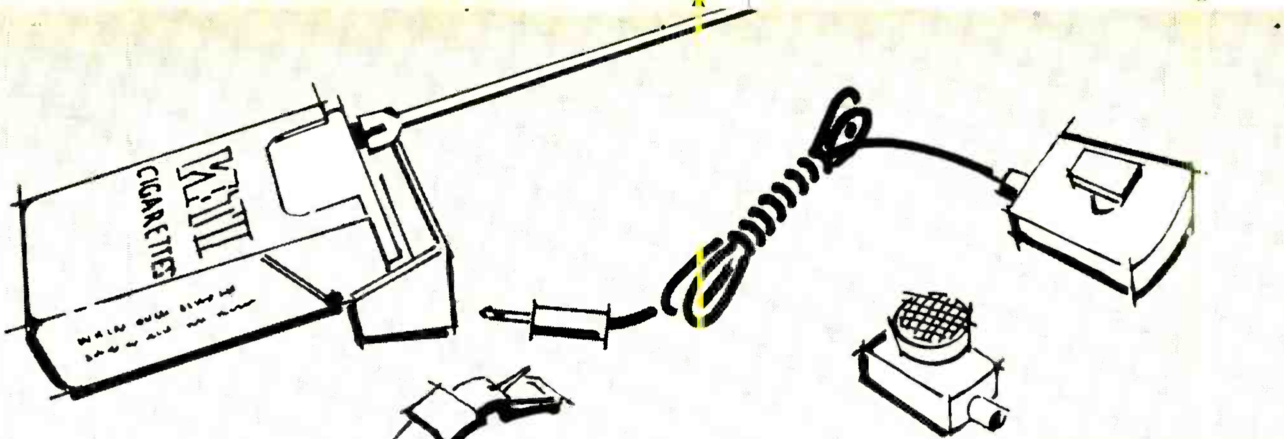
from this unit is 1 volt rms.

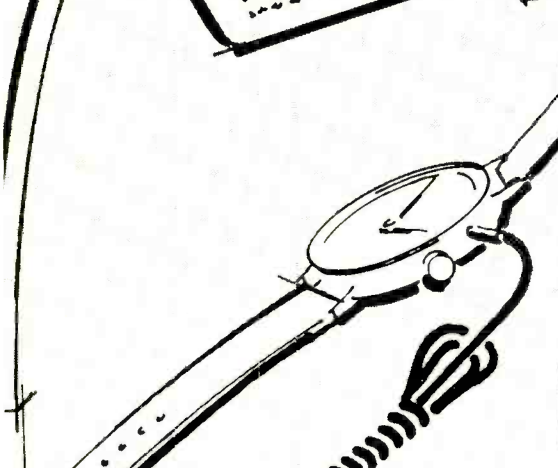
Construction is relatively easy. Just make sure you follow the detailed pictorial diagrams carefully. All wiring details and parts locations are illustrated.

At this point, you can now have a 10-watt guitar amplifier, an inverter to make it portable and a mixer. In the April R-E issue we will present details on the vibrato.

In the meantime how about some of you dropping R-E a line to tell us how far you've gotten. Include a snapshot or two if possible. **R-E**

Variable, high-impedance input stages accept four high-impedance instruments or mikes. Mixer acts as impedance matching device between inputs and your amplifier. Voltage gain is from 5 to 10 dB.

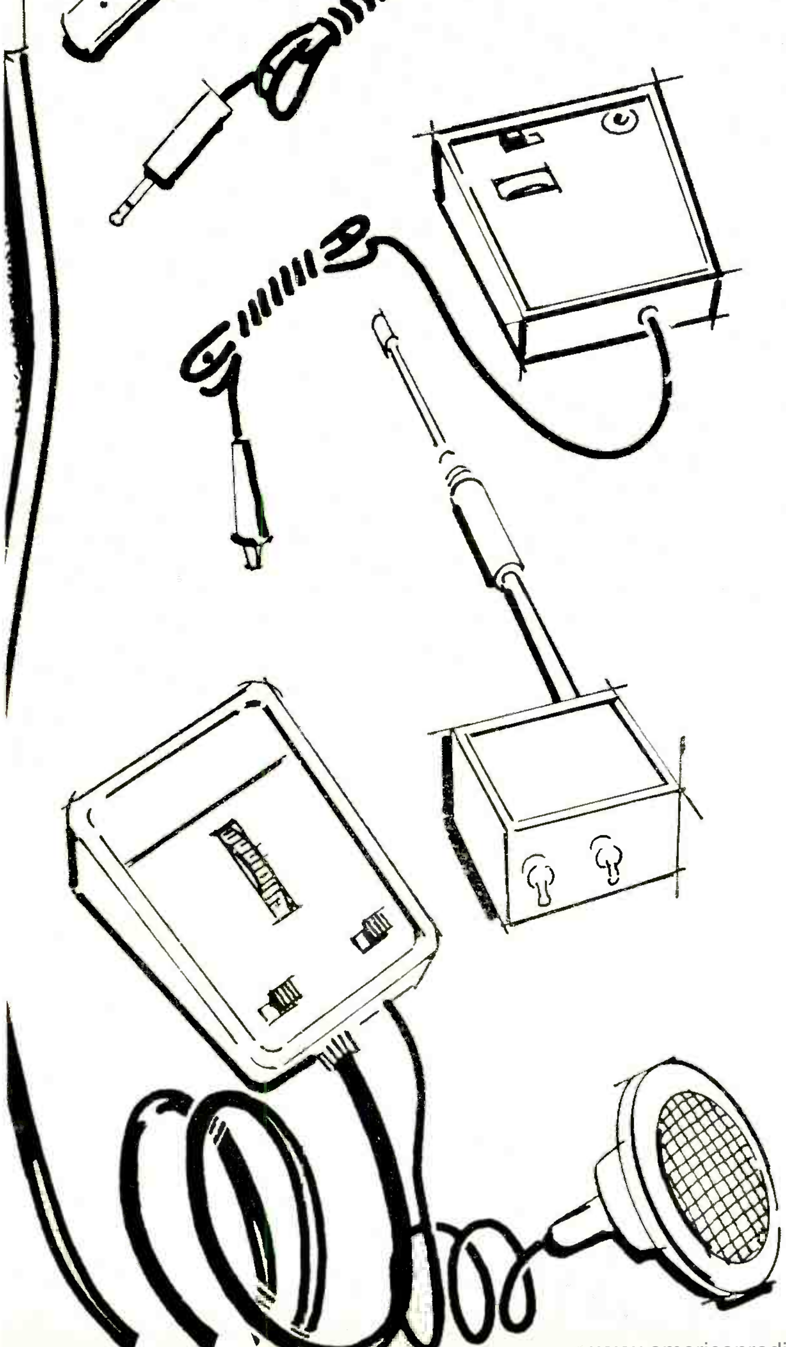




By BYRON G. WELS

Despite new laws against electronic surveillance, "bugging" is a booming business. Find out what you can do to protect yourself

Don't let them bug you!



CHANCES ARE SOMEBODY WOULD LIKE TO LISTEN IN ON your private conversations. And if they really want to, they can. However, there are steps you can take to foil the eavesdropper.

You'd be amazed who'd like to listen in. Business competitors would like to know more about your business affairs so they can conduct theirs accordingly. People in your own firm would like to learn more about you—possibly to learn how best to impress you. Or your peers might like to short-circuit your attempts at promotion.

In your own home? Well, I don't want to sow seeds of doubt, but do you have a suspicious wife? How about your neighbors? Then, too, could business relations be anxious to overhear what you have to say in the privacy of your home?

If there's one common thread among people who have found that they've bugged, it's their surprise at the extent and detail to which a "spy" will go to accomplish his end.

How bugs are planted

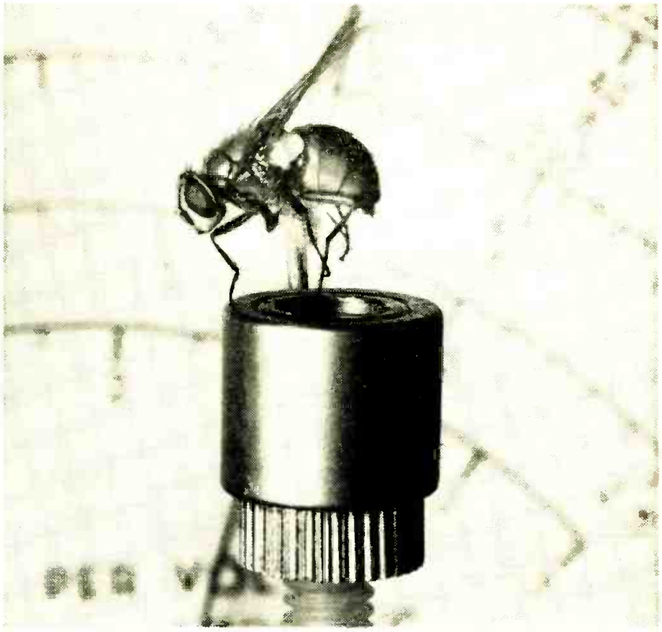
The easiest way to plant bugs is to have open access to the room. But this isn't really necessary. One recent case revealed that an office was being neatly tapped by a worker in the neighboring office who had rigged up a stethoscopic earphone to a small transistor amplifier. The pickup was a contact microphone of the type used on musical instruments, held firmly in contact with the separating wall between the offices—a wall that acted like a sounding board.

By far the most exotic applications are listening devices attached to telephones. You can purchase such units if you've got the price—$150 to $500. But they are easy enough to construct if you understand a bit about FM and telephones!

One such unit fits inside the telephone base. Once installed, the "spy" merely dials that number, and blows a small whistle into the mouthpiece of his phone. This signal keeps your phone from ringing, but from then until he hangs up his phone, the transmitter of your own phone will pick up room conversations and relay them to his telephone earpiece. Nice?

Another device is about the size of a silver dollar. It's a printed-circuit unit, using integrated circuits. To install

When telephone bugging is suspected, this "scrambler" assures private conversation. Voice is electronically coded and decoded at sender's and receiver's station.



Bug-size microphone, originally made for use in physics and biology labs, easily picks up sound of fly wings. Sensonics-built device contains a very high gain preamplifier.

it, simply remove the mouthpiece cover from any telephone (it easily unscrews), then drop the phone company's transmitter button into your hand. Place the waferbug in the phone, drop the transmitter back and screw the cover down.

This unit has an added feature. It draws its necessary 10 volts operating power from the telephone system each time you pick up the phone. The unit is a miniature FM transmitter, uses the telephone cord as an antenna and has a range of about 1000 feet, broadcasting to any nearby FM receiver tuned to the same frequency.

All bugs are not electronic. Another investigation recently revealed that a puzzling vital information leak was none other than an underpaid cleaning lady who came in at night to empty waste baskets and clean desks. Her careful cullings went to the competition, with a big fat bonus for her trouble.

Some electronic bugs are pretty elaborate in their simplicity. A 1" diameter blind hole can be quickly drilled on the underside of a wooden desk or table top. The mike button is placed in the hole and walnut wood filler is added to keep it in place. The wire leads are bonded to the wood with a dab of silver or copper conducting paint, which is then drawn along the underside, down a leg of the table, to a small hole in the carpeting. The silver conductive stripes are then covered with stain, and are totally invisible. Once under the carpeting, small wires can bring the signal to an amplifier and the "spy's" ears.

Lamps are another favorite location for eavesdroppers. The light bulb is removed and replaced with a soft plastic bulb which conceals a microphone. The lamp's line cord serves as conductor for the signal. The plastic light bulb? A mere 50¢ at any magic shop.

Bugging devices can be concealed just about any place in any room. Small FM transmitters designed for local broadcasting to a nearby tuner or receiver are easily hidden in a pack of cigarettes. Like a pack of cigarettes, they can be casually dropped behind a chair or hidden in a hollowed-out book.

How "safe" can you get?

For greatest protection against electronic eavesdroppers some organisations have resorted to building a room within a room. It's actually a small metal, wood and plastic box large enough to hold several people seated around a table. This windowless room sits on legs above the regular floor of the larger room and its roof falls somewhat short of the larger room's ceiling.

The walls of the secure room are designed so that they do not transmit sounds and they are electronically shielded. In addition, random noise generators operate in the larger outside room. The door to the secure room cannot be opened to admit a newcomer to a meeting until a red light first has flashed, and the occupants have stopped talking.

Why is such a drastic procedure necessary? Because even a newly built building can be "bugged". One of the simpler techniques of bugging a building under construction is to drop a protected microphone into wet concrete next to a steel reinforcing rod. The mike then cannot be located with a metal detector. Very thin wires are run from the mike, along steel girders and reinforcing rods and on water and sewer pipes to monitoring posts well away from the building.

This was the sort of system uncovered in 1964 in the U. S. embassy in Moscow and in a brand new U. S. embassy in Warsaw, Poland. So remember, cost is the important factor. If your conversations are worth listening to, there may be extra ears listening.

If you find one

If the "bugger" thinks you suspect him, chances are he'll plant a bug for you to find. He'll carelessly leave it in a vase of flowers or in a drawer. You find it, smash it and think you're safe. However, a smart surveillance man has several plants in any given room, so he can get good pickup wherever you move. If you find one, chances are there are others.

Look at it from the point of view of the guy planting the bugs. If he's a professional, he received a big fat fee for the job. The bugs themselves are expendable. He probably won't even attempt to recover the units, preferring to sacrifice them rather than run the additional risk of a second entry. If you find and smash a few of his units, he simply shrugs his shoulders and drives off.

Nor does he care a hoot about what you call him. He's in a dirty business, so don't think you'll discourage him by stomping around the room and swearing.

Once you find positive evidence that bugging is taking place, try to locate the devices themselves. Ask yourself where you would conceal them if you entered the room for the first time. If you find a unit, handle it with care and notify your company officers if the unit is found in your place of business, or the local police if it's in your home. Many commercial units have serial numbers that can lead authorities to the source, who might enable them to trace the buyer.

In one case inexpensive Citizens-band transceivers, locked in the transmit position, were found taped under an executive's desk. Their presence was not suspected, and they were revealed only when the tape let go and the unit dropped to the man's lap. Tracing the serial numbers and a bit of subsequent fingerprinting tied up the case.

Can you foil a bug?

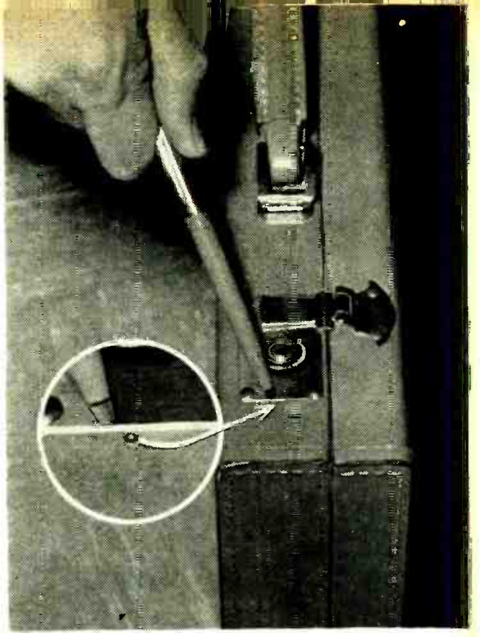
Sure you can—but it can be pretty expensive. There are firms that make a business of probing with electronic bug-detecting equipment. For a fee, they will electronically examine your home or office to check for the telltale signals that indicate a bug is operating.

There are easier ways. Remember that a bug cannot always be placed for optimum sound pickup. The listening agent must comprise and settle for what he can get. It isn't hi-fi by a long shot. Placing bugs where they can't be seen doesn't mean the best sound pickup at all times.

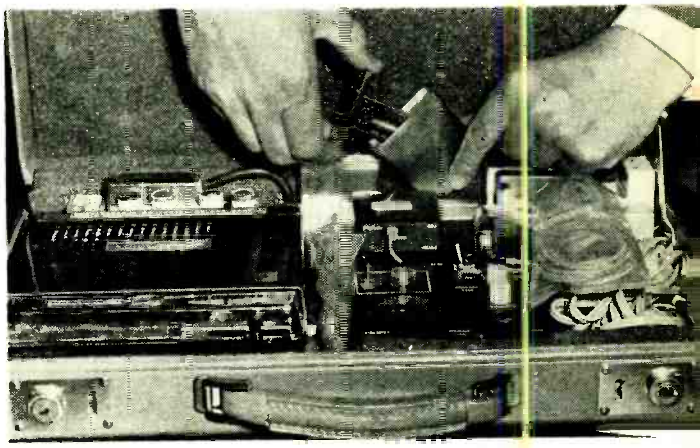
The best and least expensive way to foil the listener is to play a small transistor radio in the room where you're conversing. Pick a music station. The music blankets the full audio range, and any spoken words that the listener hears will be totally garbled by the music.

Another good foil is to arrange important conferences out of the office. A local luncheonette or bar, for example, usually provides a safe place to talk. But don't make appointments for such meetings over the telephone!

Modern industrial firms faced with similar problems have worked up new solutions. One major company hit on a novel answer. It created a conference room totally void of furniture and with a plain white tile floor, solid walls and ceilings. Only one door provides access to the room. The room is carefully examined before a conference, and the bare minimum of furniture is moved into the room just prior to the conference. People attending are also checked before admission, as are their clothing and other possessions. It's an *almost* foolproof system, but if a "bugger" wanted to, he'd probably find a way!



Familiar objects like this attache case are seldom suspected as "bugs." Tiny microphone hidden near brasswork works with recorder.



Voice-activated tape recorder (left foreground) saves battery power and tape. The crystal-controlled transmitter being held will transmit conversation to remote receiver.

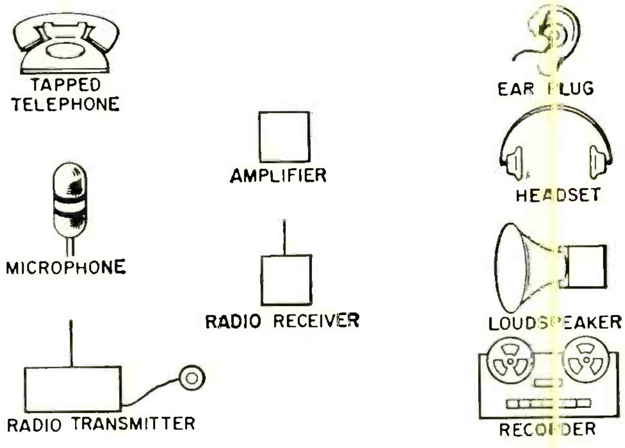
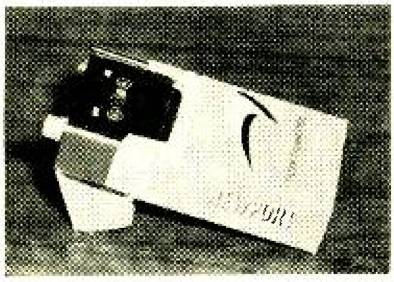
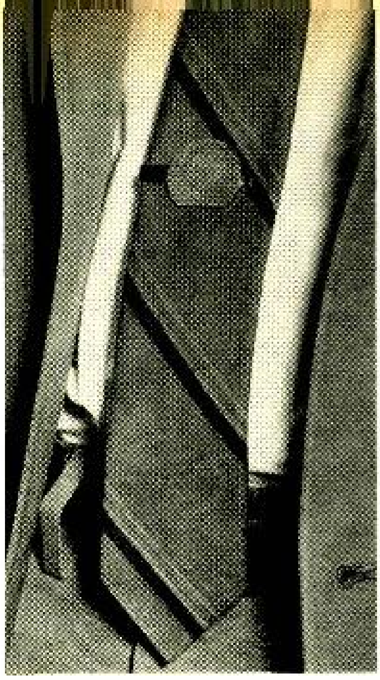


Diagram shows basic transmitting and receiving equipment for electronic surveillance. Under some conditions, all three transmission and four reception methods might be used at once.

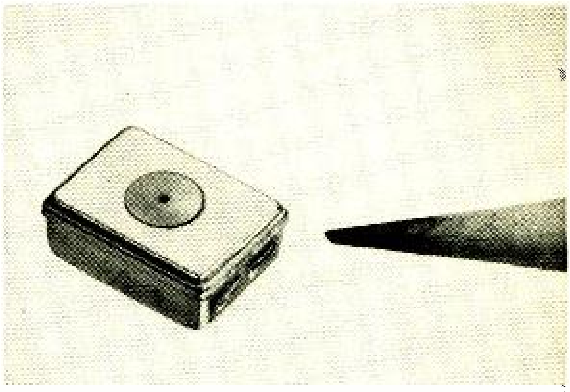
A cigarette package is another familiar enclosure for hiding a surveillance device. This miniature radio transmitter can transmit two city blocks with its built-in short-wire antenna.





Innocent looking tie clip is a sensitive microphone that can be connected to recorder or transmitter.

This subminiature microphone's dimensions are only .500" x .375" x .200", but it has a wide frequency response. Output is amplified for taping or transmission.



Recorders can be located

The heart of any bugging system is the recorder that monitors and records the overheard conversation. Reliability is the paramount consideration. As a result, the eavesdropper may pay as much as $1200 for a recorder.

Fortunately, it is possible to detect an operating recorder. As you know, when recording the magnetizing of the tape is not a simple linear function of the magnetic field acting on the tape. Actually, it is a non-linear process that can result in a distorted sound image. To overcome this, recorder manufacturers impose a high frequency bias of 20,000 to 100,000 Hz on the tape as it is recorded. This smooths out many of the irregularities and improves the recorded effect.

This high-frequency signal is easily detected by a counterintelligence "sweeper" when he approaches the vicinity of the recorder. Placing the recorder in a shielded box will reduce and sometimes can eliminate the spurious signals making the recorder extremely difficult to locate.

When a recorder is used to tap a phone line, some detectable amount of the high-frequency signal may leak back onto the tapped phone line, even though the coil is not in physical contact with the line. As a result it is sometimes possible to detect a tapped line.

Use a specialist

Good counter-intrusion specialists do not come cheap. One top West Coast firm, Police Systems Inc., Santa Ana, Calif., is an excellent example of why. The company's vice president, Robert Jefferies arrives at clients' plants and offices in a late-model Lincoln fitted out from bumper to bumper, from floorboards to roof, with sophisticated electronic gear, most of it custom made. One receiver designed to pick up weak signals from a miniature transmitter several blocks away costs $55,000 and another one was delivered for $30,000.

The Lincoln is not an ostentation. Jefferies needs a large, roomy car heavy enough to bear the weight of his equipment and reliable enough to meet all sorts of unplanned situations.

Another Californian, Harold K. Lipset, an ace San Francisco investigator, has described a schedule of fees that is fairly typical of those charged by reputable agencies. To sweep the average office for bugs, Lipset service generally receives about $250. The fee for insuring the security of a small conference room runs about $100. A large classified meeting of 100 persons where each person, all chairs, tables fixtures and walls, floor and ceiling must be guaranteed secure, can lead to a bill upwards of $1,000.

Can I be sure?

Let's face facts. If somebody is bugging you, chances are that, unless professionals are involved, he will be using commonly available devices. Certainly the telephone is worthy of careful examination and scrutiny. If you're really worried about the phone, you can get a scrambler and unscrambler, which electronically chops up your phone conversations so that the eavesdropper will be mystified by the garbled sounds he hears. The party to whom you are speaking must also be equipped with this device.

Bugs planted in a room, unless placed by a professional, are usually one of two types: wireless and wired. The latter need conductors to bring the information to the bugger, and the best way to locate them is to look for wires that don't belong in the room. Also examine ventilators and concealment areas—behind radiators or in lamp shades.

Wireless types are either FM or Citizens-band units. Both are easy to detect. Get a small FM receiver, and tune it across the band. Pay particular attention to frequencies between the regular broadcasting stations, and listen for a hiss. When you hear that, start talking. If you hear your own voice coming out of the FM receiver, you can bet that it's coming out of the bugger's receiver also!

To check for CB bugging, use a CB unit in the receive mode, and switch from channel to channel, whistling or speaking at each channel.

But don't worry for too long. In the course of preparing this article, we came across a case where a firm didn't plant bugs in the competition's offices—instead they planted rumors that they HAD planted bugs! The result? Weeks of confusion while the competition ran around and spent a small fortune trying to locate nonexistent bugs! **R-E**

IC ELECTRONICS FOR SHUTTERBUGS

Integrated circuits are gradually invading the photographic field. Here's a look at new—and future—solid-state applications

by JOHN R. FREE
ASSOCIATE EDITOR

THERE'S A SOLID-STATE REVOLUTION in modern photography. You name the device—IC, transistor, photoresistor—it's being used in a camera, photoflash or other piece of photographic gear.

Electronic shutters, which have inched gradually into the medium-price camera market in recent years, should become more prevalent as low-cost European models shown at Photokina (Cologne, Germany, photo show last October) reduce Japan's lead in the field. (See June 1967 RADIO-ELECTRONICS, p. 58.) Integrated circuits will cut shutter costs further when mass-production economies take hold.

Some manufacturers are phasing out the delicate, inertia-prone galvanometer from their cameras, replacing it with bulb-readout circuitry. And Zeiss Ikon Voigtlander now offers two models of their Ikophot, a meterless exposure "meter" that couples a transistorized bridge circuit with signal lamps. Photocell-regulated flash units, probably the most sophisticated photographic devices on the market, are this year sold by three companies. (A patent on one regulation technique has been held by Honeywell since 1965.) Pocket-size strobes to fit popular 35mm cameras are now common.

Whether you're a weekend shutterbug, an advanced amateur or a professional, the new electronic gadgetry can put greatly improved accuracy and reliability in your hands—at reasonable cost. This means film can be consistently exposed to recommended ASA ratings, leaving you free for creative photography instead of *f*-stop and shutter-speed worries.

Smaller still: Circuits for this photocell-regulated flash, Honeywell's Auto-Strobonar 660, have been packed into a smaller but similar automatic strobe, the 440, for shoe mounting (see page 42). New techniques simplify miniaturization.

IC shutter control

West Germany's Prontor shutter firm is switching its electronic shutter line to IC's, and their new 500S IC shutter is being used in Voigtlander AG's 500SE electronic camera.

But a radically new approach to electronic exposure control is a monolithic IC containing 37 transistors, 23 resistors and 3 diodes, developed at the Dutch research labs of Philips, Europe's largest electronics company. The IC, which requires sophisticated manufacturing techniques, is the logical next step for electronic cameras.

Philips' unusual IC has a light-sensitive, filter-compensated silicon diode (also integrated) mounted in the

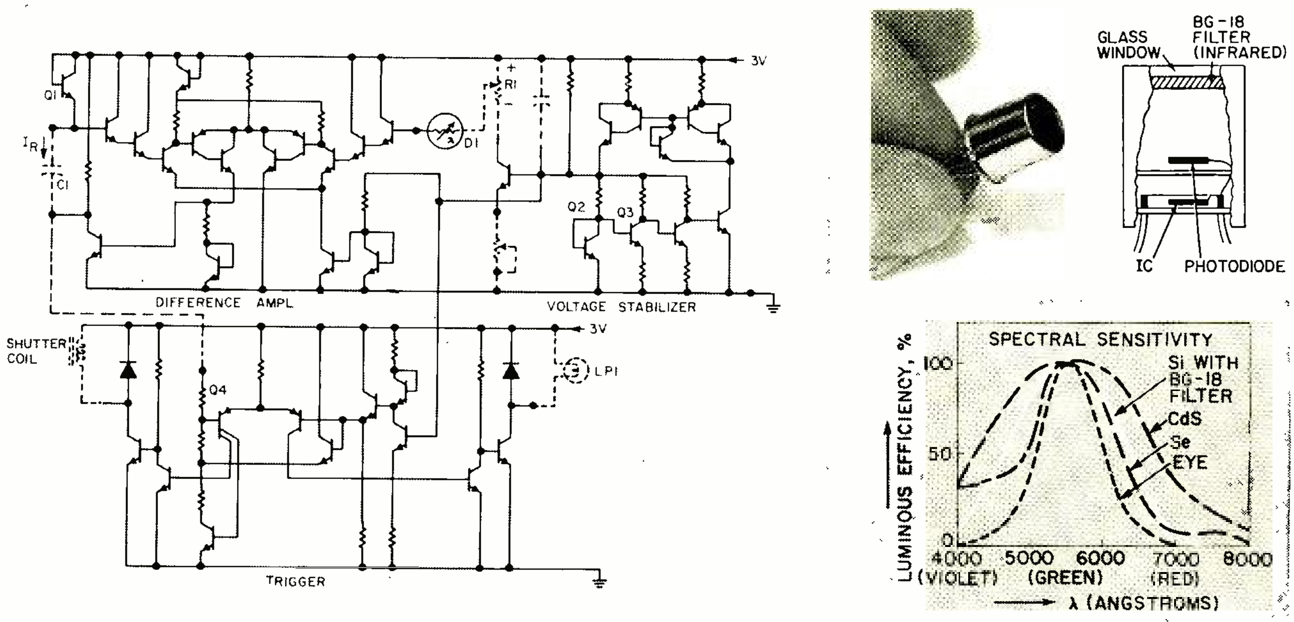


Fig. 1—New IC has nearly complete circuit for electronic shutter control on a few square millimeters, including a photodiode. Photo and drawing show size and structure of the IC. Graph indicates spectral sensitivity of filter-corrected photodiode.

IC case (see cutaway drawing). Thus the key component for electronic shutter control, a photosensitive cell, is an integral part of the circuit. Linear potentiometers for calibration, film sensitivity and diaphragm setting, a capacitor, 3-volt battery and electromagnetically operated shutter complete the system.

Silicon (Si), like most photovoltaic material, responds to infrared as well as visible light. To make the silicon diode "see" the wavelengths a human eye sees, Philips shifts its spectral response with a BG-18 infrared filter beneath the IC's "window." The filter's effect is shown in Fig. 1 (graph). Instead of normally peaking at the high end of the spectrum (near infrared), the diode's spectral sensitivity is shifted to the center, closely matching that of the eye, which is most sensitive to green light at 5550 angstroms. Response curves of cadmium sulphide (CdS) and selenium (Se), two other common photocell materials, are also shown.

The IC circuit (Fig. 1) consists of a voltage stabilizer, a difference amplifier, trigger circuit and a silicon photodiode.

An exposure begins when the shutter is opened and light striking photodiode D1 generates a voltage proportional to illumination intensity. To this voltage (V_{ph}) an adjusting voltage ($V_f + V_s$) for filmspeed and diaphragm setting is added. The sum voltage is fed to one branch of a three-stage Darlington circuit. The other branch, containing a reference diode (Q1 used as a diode), is used for feedback.

The output current of the amplifier (I_R) is fed through Q1 and integrated by capacitor C1 until the amount of light has reached the precise level called for by the setting of R1. The integration time can be any fractional interval from 1/1000 sec to 20 seconds. This superaccuracy is the major advantage of electronically controlled shutters over those with fixed shutter speeds.

With measuring capacitor C1 charged to the proper level, dual collector Q4 in the trigger circuit conducts, the shutter coil is energized and the shutter closes. Feedback from Q4's second collector is used to insure rapid response of the trigger circuit.

The film-speed and diaphragm-setting voltage ($V_f + V_s$) must be linearly dependent on temperature. Therefore, a unique voltage stabilizer is incorporated. It has two matched-pair transistors, Q2–Q3, and a stabilized voltage difference between their pn junctions is obtained by maintaining the junctions of these two transistors at different current levels with a fixed current ratio.

If a resistor instead of charging capacitor C1 is switched into the circuit, the current I_R can be used to check battery voltage, indicate possible under- or overexposure, the need for a tripod (with lamp LP1), or to automatically adjust a diaphragm with a servo motor. Film speeds from 25 to 2800 ASA and lens aperatures from $f/2$ to $f/16$ are possible with this arrangement developed by Prontor.

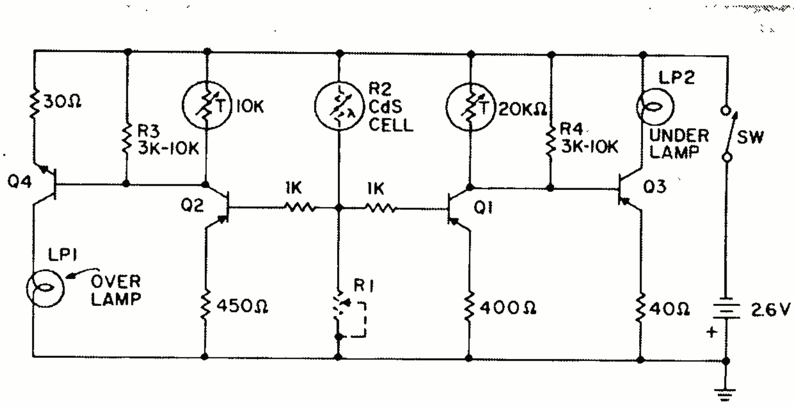


Fig. 2—Circuit used by Yashica in the IC Lynx 5000E camera. When aperture ring R1 is adjusted properly, over-under lamps LP1 and LP2 are out. Resistance ratio of R1 and CdS cell R2 determines correct exposure. Photos (right) show back and front views of thick-chip hybrid IC. Circuit replaced meter and moving parts in the standard Lynx.

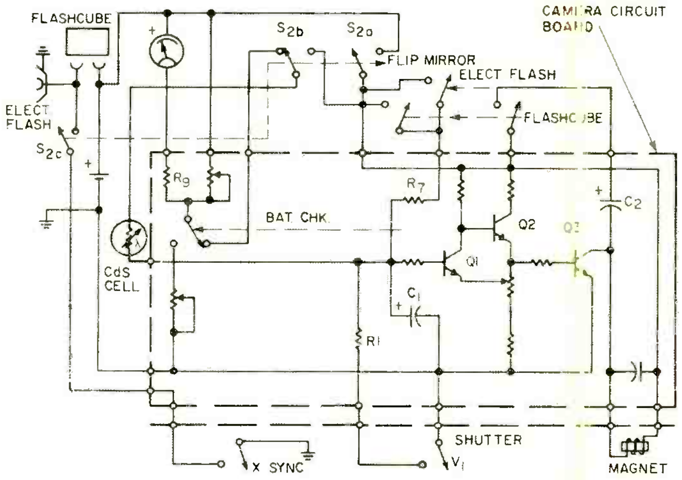


Fig. 3—Partially depressing release button on the new Kodak Instamatic Reflex gives a meter preview of shutter speed (photo left). Integrating capacitor C1 triggers Q1 when the CdS cell conducts, and the shutter blades close.

Yashica Co., one of Japan's major camera manufacturers, recently added an integrated circuit to its Lynx 5000E 35mm camera to replace the meter and other moving parts of their standard Lynx model. The four-transistor IC is a thick-chip hybrid, with most of resistors deposited on the base (see photos below).

"Over" and "under" lamps LP1 and LP2 (Fig. 2) are used to indicate when aperture ring R1 is adjusted properly for prevailing light (both lamps out).

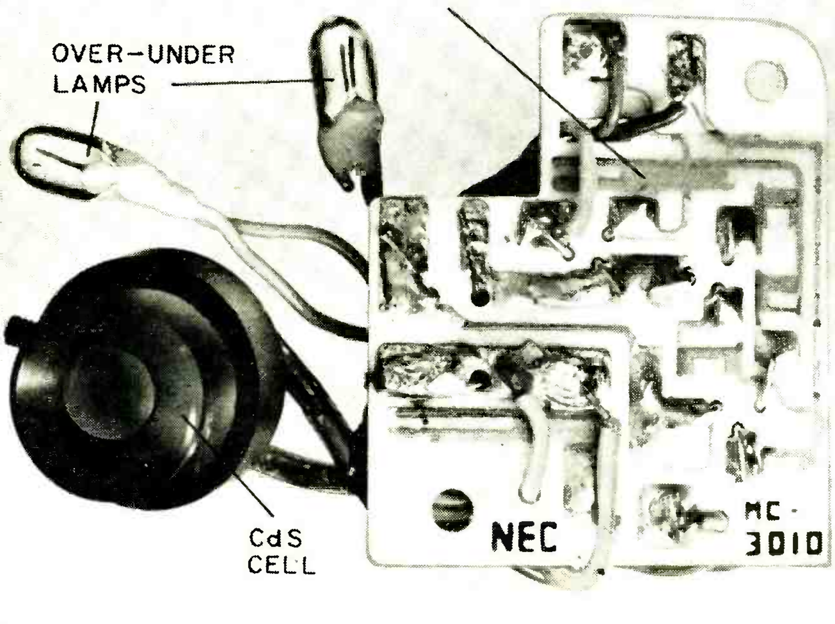
The lamps are controlled by the resistance ratio between CdS photoresistor R2 and aperture ring R1. The resistance of R2 decreases as it receives more light. When there's too little light for the settings (a dark subject) and R2's value is higher than aperture ring R1, transistors Q1 and Q2 are off. With Q1 off, Q3's base is biased negative and it conducts to light the "under" lamp.

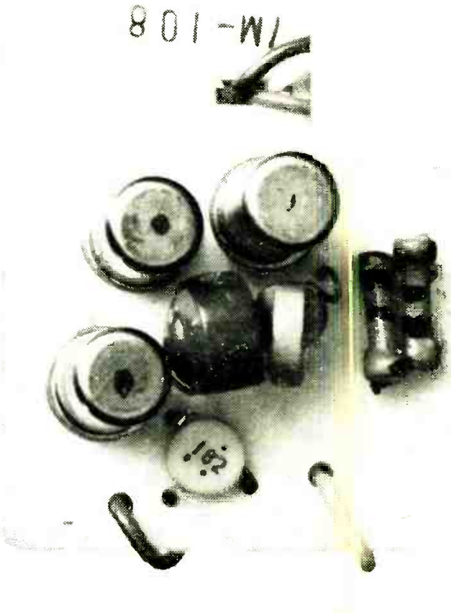
With too much light, the value of R2 is lower than R1, and both Q1 and Q2 conduct. Now Q4, the only npn-type of the series, conducts and the "over" lamp lights.

When the correct setting is reached (arrows in the viewfinder indicate what direction the aperture ring must be turned), values of R1 and R2 balance. Q1 is on, Q2 is off and both Q3 and Q4 are off. The values selected for fixed resistors R3 and R4 determine the "light out" range of the circuit. The thermistors mounted on the ceramic baseboard provide temperature compensation.

West German electronic camera design can be seen in the new Kodak Instamatic Reflex made abroad for the US-based company. The Instamatic is one of the few 35mm's on the market coupling a single-lens reflex system with an electronically controlled shutter. (Most "automatic" cameras rely on the mechanical transmission of meter deflection to set shutter speed and/or lens aperture. Electronic shutters provide immunity from low temperatures that can stiffen mechanical linkages.) Inserting a 126 film cartridge into the camera automatically programs an ASA parameter into the exposure circuit.

Here's how an exposure is made (see Fig. 3). The winding lever cocks





the Compur shutter and contact V1 makes, shorting through R1 any charge left in measuring capacitor C1 from the last exposure. Pressing the release button causes the camera's mirror to flip up, releasing S2a, S2b and S2c from their rest position. With the battery in the circuit, Q2 and Q3 conduct, and the electromagnet holds the shutter open. Simultaneously, the CdS photoresistor conducts, its resistance determined by the light it receives, and C1 is charged to the trigger point of Q1. (Contact V1 has been opened by the shutter mechanism.) The potentiometer in Q2's emitter circuit sets Q1's trigger point. When Q1 is turned on, Q2 and Q3 are cut off and the shutter blades close without current to the electromagnet.

For flash cubes, the CdS cell has little influence. Timing is through R7 and C2, taking about 1/30 sec. Capacitor C2 is not in the circuit in electronic flash mode and consequently the shutter speed is about 1/300 sec. Kodak uses a galvanometer in the Instamatic to provide a preview of the shutter speed. If the needle is in the bracket area (see photo), this warns that shutter speed will be less than 1/30 sec.

Automatic strobes

Honeywell, one of the pioneers in electronic flash photography, introduced a strobe in 1965, the Auto-Strobonar 660, that can measure its reflected light output, and adjust this output in microseconds to the intensity needed for proper exposure of the subject. The company recently updated its entire line of strobes, offering a pint-size Auto-Strobonar, the 440, and larger, more powerful units. The automatic control circuit of the new units is basically the same as the 660's (Fig. 4), and the rest of the 660 is similar to conventional units: power supply, storage capacitor, trigger circuit and xenon flashtube.

A small, lightproof housing containing miniature filament lamp LP1 and a CdS cell is located behind the reflector on a PC board (photo). The housing lens directs reflected strobe light from a 12° angle onto the photoresistor. The lamp biases the photocell to a critical breakdown point. When the main flash tube is fired, reflected light from the subject instantly completes the breakdown, and Q3 and Q4 conduct to the threshold voltage level necessary to fire SCR2. The SCR fires and triggers "quench" tube FT2, a smaller, especially designed flashtube in parallel with and directly behind the main flash tube. The quench tube's resistance drops to almost zero ohms, and the energy stored in the main capacitor of the firing circuit is dissipated through the tube. (This energy may approach 2500 amperes for short flashes.)

It's a neat trick, relying on the time required for light to travel to and from the subject. If the distance is great (23' maximum), there is little or no quenching and flash duration is about 1/1000 sec. When the subject is nearby (3' minimum), reflected light from the subject rapidly quenches the main tube and flash duration is a weak 1/50,000 sec. There is an infinite range of flash duration times between these minimum and maximum values.

Under a patent agreement with Honeywell, another automatic strobe unit, the Mecablitz 185, is now on the market. Rollei is offering its own design. So far, only the Polaroid Land model cameras and the new Yashica EZ-matic Electronic 126 can operate fast enough to electronically regulate exposure time with strobe generated light.

Many more applications of solid-state technology to photography—from low-voltage, automatic-focus slide projectors to electronic-flash light meters—have become available at popular prices. By 1970's Photokina, the photographic electronics boom will be bigger than ever. **R-E**

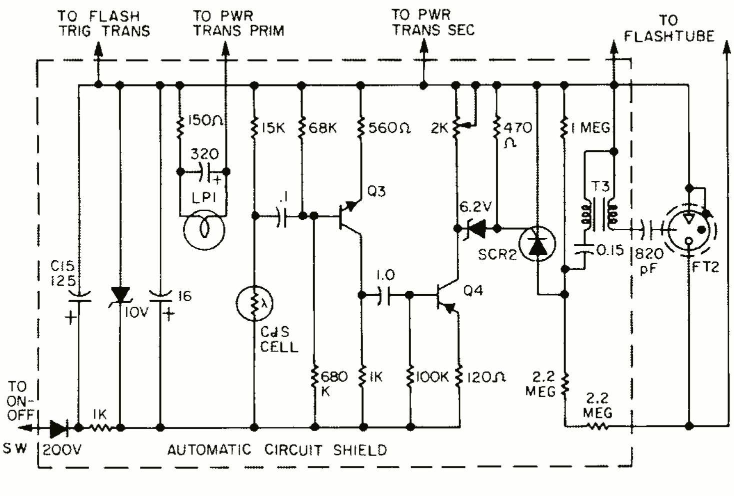
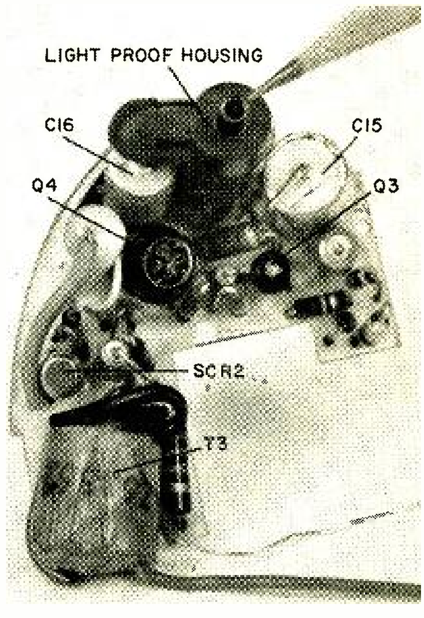


Fig. 4—Automatic-control circuit of the Honeywell Auto-Stobonar 660 adjusts light output of the strobe with ***re-****fleced light from the subject. Bias lamp LP1 is positioned in front of the CdS cell inside a light-proof housing (photo right). Light output of main flashtube is "quenched" by FT2 according to the time required for strobe light to reflect from the subject. Photos on the left show the approximate size difference between the 660 and the newer 440.*



How they work

New 1969 Color-Killers

Set makers have simplified color-killer circuits. Here's a look at some new techniques

By R. L. GOODMAN

FIRST OFF, A GLANCE AT A G-E CB color chassis (Fig. 1) makes us wonder where the color-killer circuits are hidden. How can this be? You might say by *eliminating* other tubes and color circuits. Now that we're confused, let's see how it can be accomplished. The schematic shows the 3.58-MHz color subcarrier oscillator (G-E calls it a subcarrier amplifier) is missing and the phase-detector section has also gone astray.

The grid of burst-gate tube V702-a is fed a pulse during retrace and thus a color-burst reference signal is picked off. A 3.58-MHz series-resonant trap (C711–L704) is connected between V702-a grid and ground. The gate tube is functioning as a grounded-grid amplifier, with the plate circuit tuned by the primary of

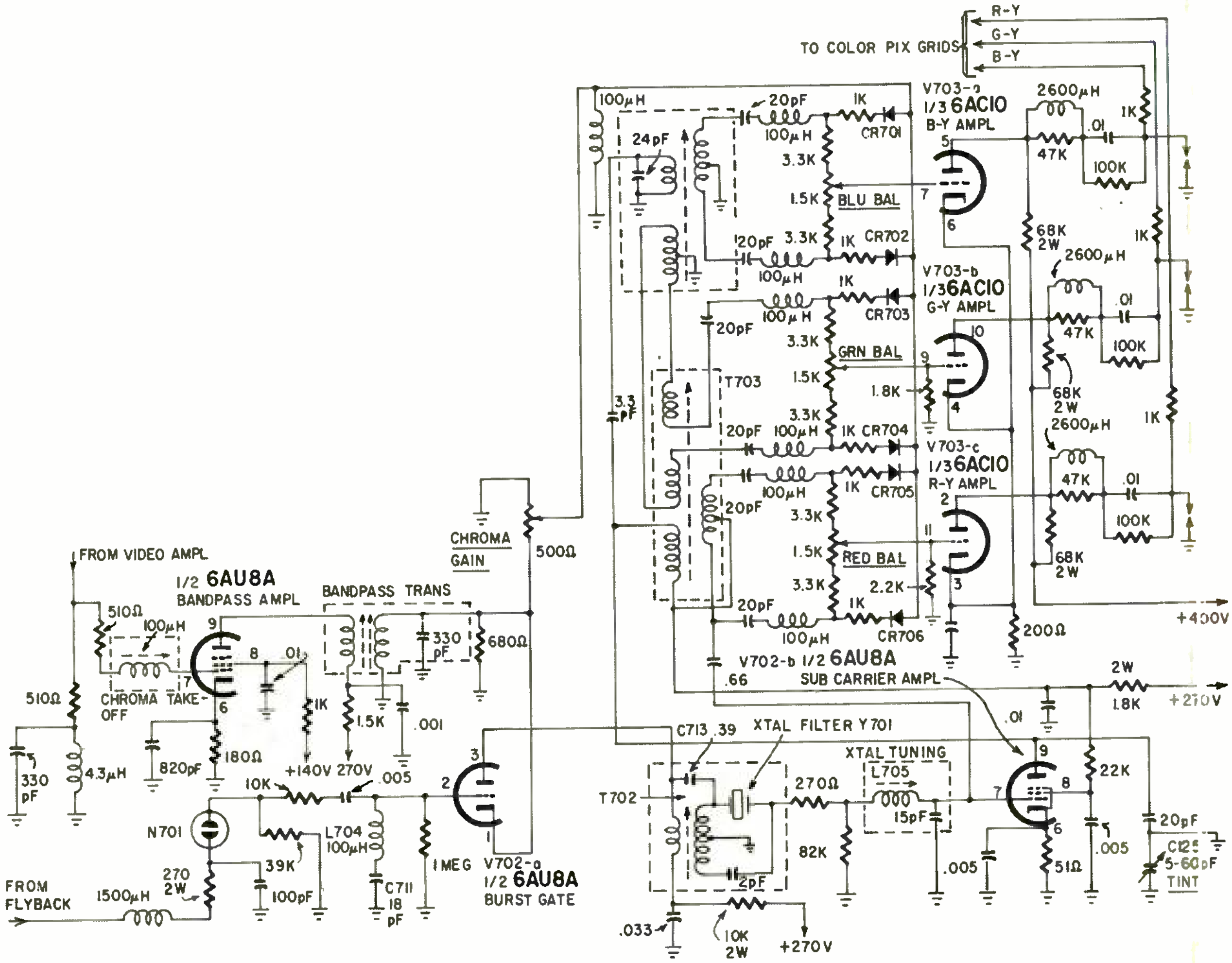


Fig. 1—This G-E CB color chassis does not need a color-killer circuit. When no color burst is present (b-w transmission), the high-Q resonant-crystal circuit on the grid of V702-b (3.58 MHz oscillator) is not excited to oscillation.

T702 for maximum output at 3.58-MHz. The burst signal, which is capacitively coupled to the bifilar-wound secondary of T702 by C713, excites (and/or rings) the high-Q resonant crystal circuit into a sine-wave oscillation that results in a 3.58-MHz wave train. Fig. 2 shows the proper wave-train pattern. This series-resonant circuit is then coupled to the grid of reference amplifier V702-b.

Tint control C125, the transformer and C725 tune the primary of transformer T703. The 3.58-MHz carrier in the primary of T703, shifted 90° from burst, is inductively coupled to both secondary windings of the transformer. These in turn supply subcarrier information to the synchronous detector diodes CR701 to CR706.

When b-w pictures are transmitted and no color burst is present, you have automatic color-killer action because the high-Q resonant-crystal circuit is not being excited. Thus, there is no color information for the synchronous diodes to detect. The days of having to zero-beat and adjust the 3.58-MHz color-reference oscillator circuits may be gone.

If intermittent color reception is noted, check to see if neon bulb N701 is firing properly. This bulb couples the horizontal keying pulse to the burst-gate stage. This has been a troublemaker.

About 30% fewer circuits are needed in this color chassis compared to previous models. You could say that 30% of potential troubles were eliminated before the set was sold. Color detection and sync take place with the minimum number of components and circuits, while color alignment is simplified.

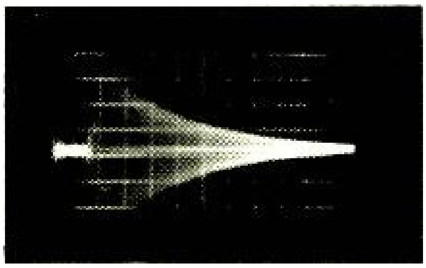


Fig. 2—V702-b (Fig. 1) requires a color signal to generate this 3.58-MHz pattern.

Color-killer circuits

Now for color-killer circuits. This set doesn't need them, so let's delve into some color sets that do.

Most color-killer circuits function on the premise that when a color burst is received the killer circuit turns on the color bandpass amplifier(s), but when no burst is present (when a b-w program is received) the color amplifier stage(s) are biased off. The killer circuit then has to receive a signal from the burst amplifier or, in some later model sets, the killer phase detector.

Let's look at the action for an early (RCA CTC5) color set (Fig. 3). A horizontal pulse, supplied from a winding of the sweep transformer, is fed to the grid of keyer V704-a. This pulse is delayed by the RC network in the grid circuit of the keyer tube to arrive at the grid simultaneously with the burst signal. Hence, the keyer tube conducts only during burst.

The burst signal is then fed to grid of burst amplifier V704-b through T703. The HUE control, R164, is combined with the capacitor in the pri-

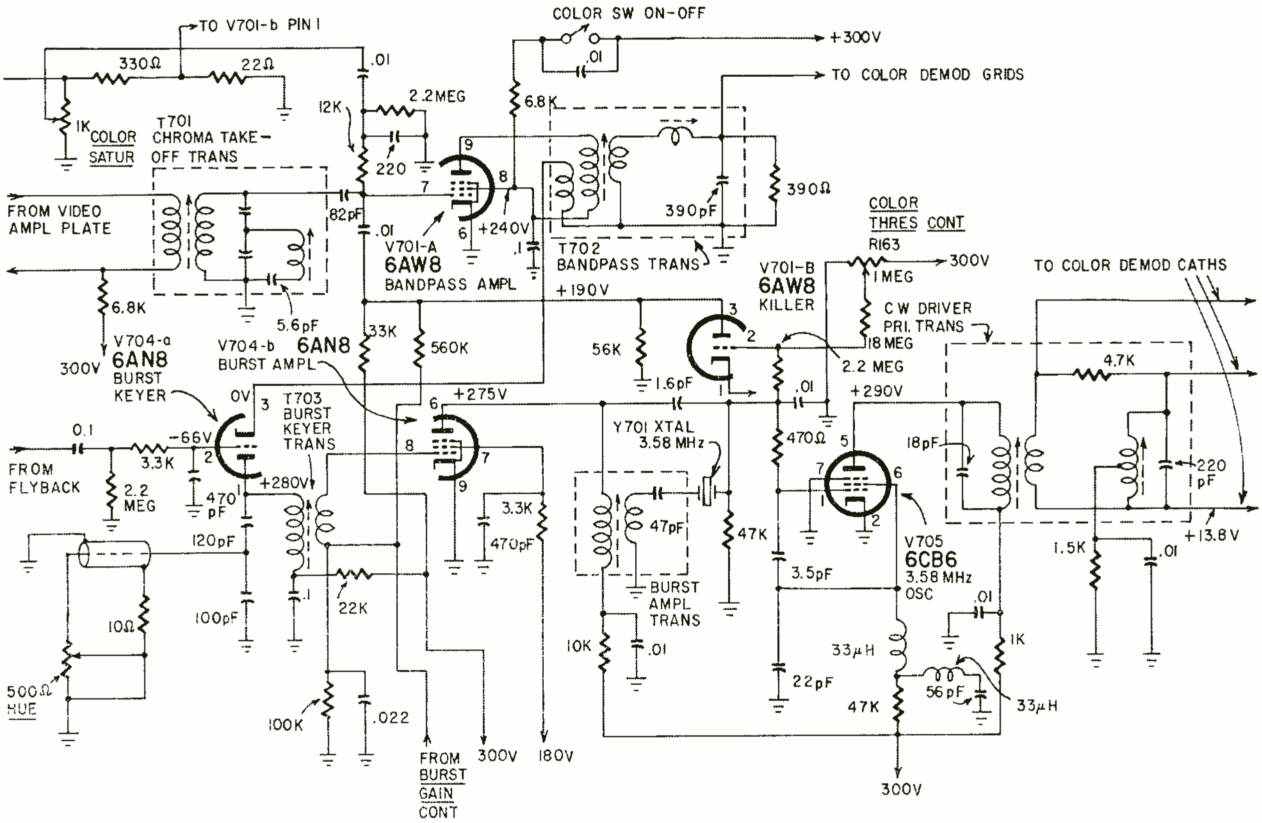


Fig. 3—Early RCA CTC5 chassis has traditional color-killer action. Burst keyer V704-a is gated on by flyback pulse only during burst. Amplified burst holds color killer V701-b at cutoff. Without burst, V701-b cuts off the color amplifiers.

mary of T703. Hue control adjustment effectively varies the load on the primary winding, which in turn changes the phase of the burst signal at the grid of the burst amplifier.

The amplified burst information is fed to the grid of the subcarrier oscillator through a filter network and crystal Y701. The oscillator is kept at the crystal frequency by the injection-lock principle.

The color-killer circuit incorporates the triode section of the 6AW8 bandpass amplifier V701-b. When burst is present in the received signal, an increased dc grid bias is present at the grid of the 3.58-MHz subcarrier oscillator. This grid bias is also used as the color-killer grid-bias source, and holds the killer tube cutoff.

A positive pulse obtained at the color-saturation control (from the horizontal-blanking amplifier) is applied to the cathode of the killer, and when the killer conducts the pulse is amplified and coupled to the grid of the bandpass amplifier. This causes the bandpass amplifier to cut off during picture time while zero bias is held during pulse time. When burst occurs during pulse time the color killer is biased off and the bandpass amplifier operates normally.

The killer threshold control, R163, is adjusted to vary the level at which the color-killer tube conducts. Thus must be set for various levels because the strength of the color signal or color-burst pulse being received will vary considerably. Should the color-killer circuit malfunction, it may kill the color amplifier during a color program and the set will receive only a b-w picture.

If the color amplifier operates when the set is receiving a b-w program, noise (colored snow) will develop due to this circuit operating at maximum gain. This is quite evident in a low-signal area. The color-killer circuit (if operating properly) will automatically bias the color amplifier stage into cutoff when only a b-w program is being received.

Killer circuit service tips

The oscilloscope is most helpful for tracking down trouble in the color-killer section. After it's certain the killer stage is at fault, voltage and resistance readings should isolate the defective part(s). Should the color chassis you are troubleshooting not have any color, don't waste too much

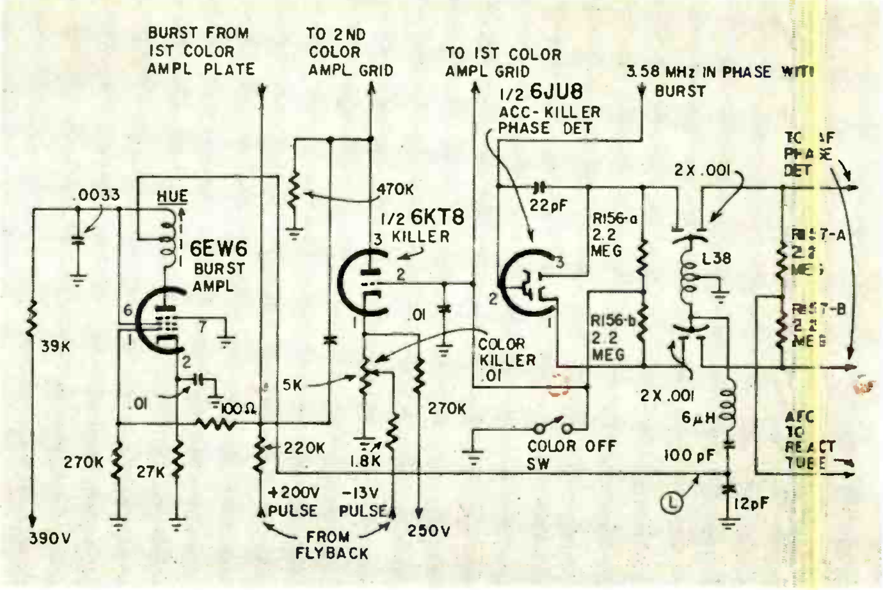


Fig. 4—A 6JU8 dual-diode is used to develop acc voltage and cut off the color killer in this Zenith chassis. Without burst, R-156 junction voltage is very low.

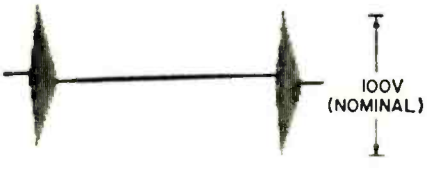


Fig. 5—Amplified burst at t.p. L (above) may appear with a gradual sawtooth voltage, due to integrating effect of probe.

time checking the color bandpass amplifiers as the killer stage could very well be defective and cause loss of color. Always ground the killer and acc (automatic color control) circuits to eliminate stages. It's best to check the 3.58-MHz subcarrier oscillator, color-killer, acc section, chroma bandpass amplifiers and color demodulators in that order for rapid diagnosis. Off-value resistors, open or leaky and shorted capacitors are usual troublemakers that can cause color-killer problems—and of course, defective tubes and transistors.

Zenith's color chassis 25LC20 (Fig. 4) has the burst signal appearing across injection coil L38 180° out of phase between the opposite coil ends. The signal at pin 1 (*cathode* of the acc killer phase detector) will be in phase with the burst, and the signal at pin 3 *plate* of the acc killer phase detector) will be 180° out of phase with burst. (When measuring the voltage waveform at test point L, only the amplified burst appears with, at times, a slight positive-going sawtooth voltage, probably caused by a slight integration of the keying pulse at the burst amplifier with the particular scope and probe you may use. Fig. 5 shows the resulting shift.)

At the acc phase detector, the signals are compared in amplitude with the 3.58-MHz reference signal. The reference signal, which is in phase with burst, is fed to the opposite plates and cathodes of the phase detector at all times. Regardless of burst signal, one diode always conducts more than the other to develop a negative voltage at the junction of resistors R156-a and R156-b. (With zero burst-signal input, the voltage at this junction is almost zero.) The junction voltage may vary from as high as −12 or −14 volts down to almost zero, depending on signal input.

The large negative voltage present during burst is used for two purposes: first, as a acc voltage for the first color amplifier; second, as a cut-off voltage to disable the color-killer stage. A "color-off switch" is connected to the acc and color-killer grid voltage. As noted, in the absence of a burst signal, this voltage is essentially removed. In either case, the color-killer tube conducts heavily during the on-time established by the pulse at its plate during the burst interval, and develops approximately 50 volts, which is applied to the second color amplifier control grid to cut-off that tube and disable the color channel.

Some new Zenith color chassis have a diode to ground in the color-killer control circuit. Some of these diodes have been known to short out, causing the amplifiers to be wide open

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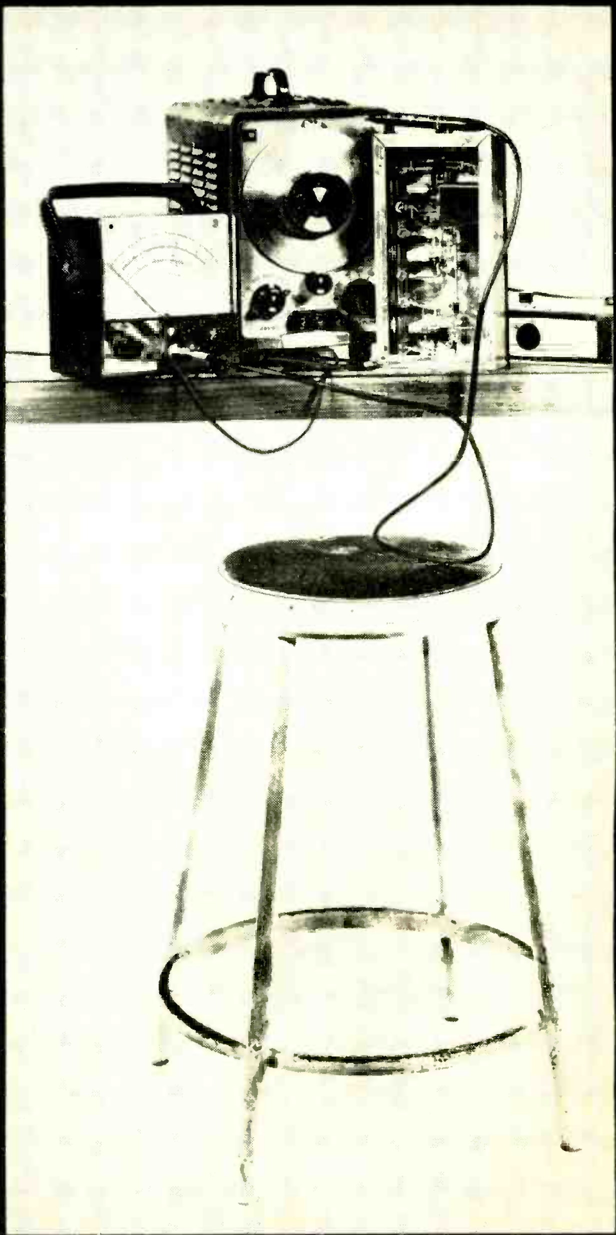

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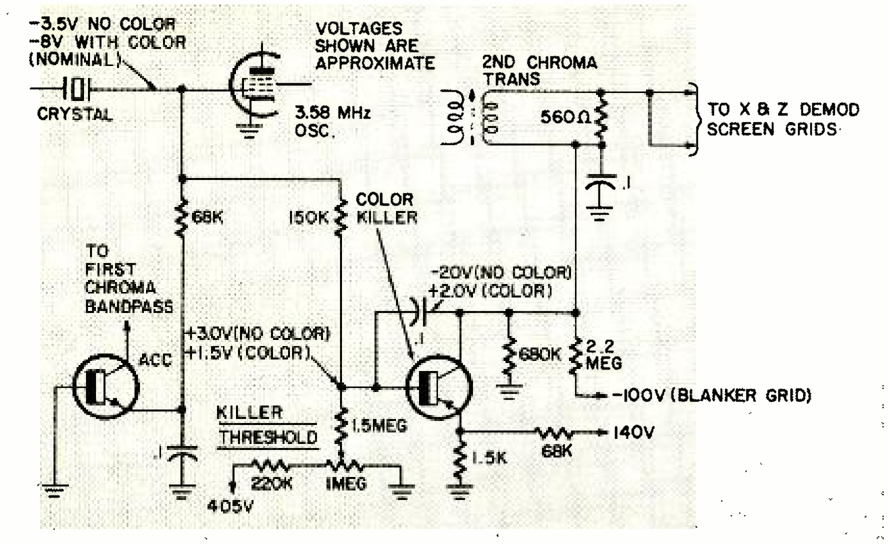


Fig. 6—Hybrid color-killer circuit used in RCA CTC31 chassis. Killer transistor detects changes in the oscillator grid bias for color and no-color conditions.

at all times. This can hurt color performance badly.

The "criticalness" of fine tuning under certain substandard transmission is lessened by a color-killer cathode bias adjustment. This adjustment in the killer tube cuts off with a lower negative grid voltage. Thus, under conditions of weak bursts, which normally would not cut off the killer tube, the control can be adjusted to cause cutoff. With the control set fully clockwise, cutoff is insured regardless of negative grid voltage. With the control set fully counterclockwise, the killer tube is more sensitive toward conduction and cutoff of the second color amplifier is insured.

However, in the full clockwise position, colored confetti may appear in b-w pictures, since the color channel would always be wide open. The reception of color would then depend strictly upon the level of color video (independent of burst level, except for developing any small acc voltage) and fine-tuning adjustment.

New RCA circuits

The CTC 31 has a transistorized color-killer stage. In this chassis, the color-killer functions to make the demodulators inoperative unless a color signal is received. Fig. 6 is a simplied diagram of the color-killer circuits. This color system, incidentally, is a closed-loop circuit, and any deviation of the signal to be controlled from a nominal reference is fed back to an amplifier that controls the gain of that signal.

The transistor color-killer circuit operates as an on–off switch: the transistor is either cut off or fully saturated. It is a pnp transistor in a common-emitter arrangement. Base bias is established by the 3.58-MHz oscillator grid and the killer threshold control network across the B+ supply. A divider network is used to fix the bias on the emitter at 2.5 volts. Collector supply voltage is obtained from the −100 volts available at the blanker grid, via the 2.2-megohm and 680,000-ohm resistors to ground.

The switching action is as follows: Under conditions of no color, the transistor is biased to cutoff—the base voltage is +0.5 volts with respect to the emitter. Approximately −20 volts is available at the collector of the transistor during cutoff. In this circuit it is necessary to apply more negative bias on the base–emitter junction of the transistor to cause condition. With sufficient bias to the base, the transistor is driven to saturation. Then the collector voltage goes on approximately +2 volts, clamping the collector to the emitter.

For a no-color condition input—at this time—the demodulators are biased off by the −20 volts at the collector. This is the effective supply voltage when the transistor is cut off. With color burst at the oscillator grid, the increase in negative voltage at the oscillator grid is sensed at the base of the transistor: base voltage at this time is about 1.5, sufficient to turn the transistor on to full saturation. The collector is clamped to the voltage on the emitter (+2 volts), applying this voltage to the screen grids of the demodulators.

Under these conditions the demodulators are permitted to conduct, passing chroma information to the difference amplifiers. Killing the demodulators prevents noise in the chroma or subcarrier CW channels (during b-w reception) from reaching the CRT.

Motorola color-killer problem

An older model Motorola TS-905 chassis (Fig. 7) seemed to loose color after operating 15 to 20 minutes. In fact, the customer said he could set the clock by this loss of color interval. After checking the set during a home service call and replacing and checking tubes to no avail, the chassis was pulled into the shop. Of course, on the bench it didn't loose color all day! I've developed a time formula for TV parts failures: After the first 2 to 7 minutes of playing time a set malfunction indicates tube trouble: from 8 to 20 minutes means a defective capacitor, and 20 minutes or more could indicate resistors or anything else you might think of.

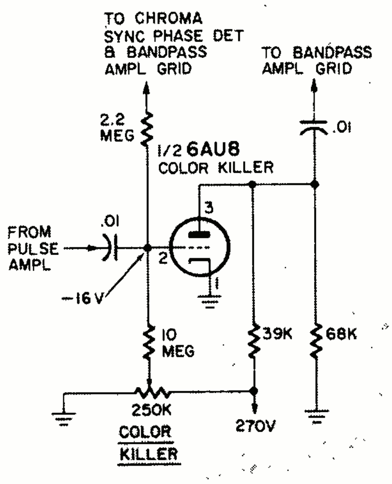


Fig. 7—Trouble in this Motorola color-killer circuit caused color loss after warmup. Coupling capacitor was leaky.

A heat lamp, vtvm and scope were used to track the loss of color. The first circuits suspected were the chroma bandpass amplifiers, but they proved OK and the last section investigated was the color killer. A vtvm was used to find −2 volts on pin 2 of color killer V22 (½6AU8), and a .01-μF coupling capacitor was found to be very leaky when temperature was high. **R-E**

BRAINS OF AUTOMATION

Fig. 1—High-speed Friden typewriter uses punched tape.

Learn how logic circuits operate today's industrial machines.

By JOHN W. DIETRICH

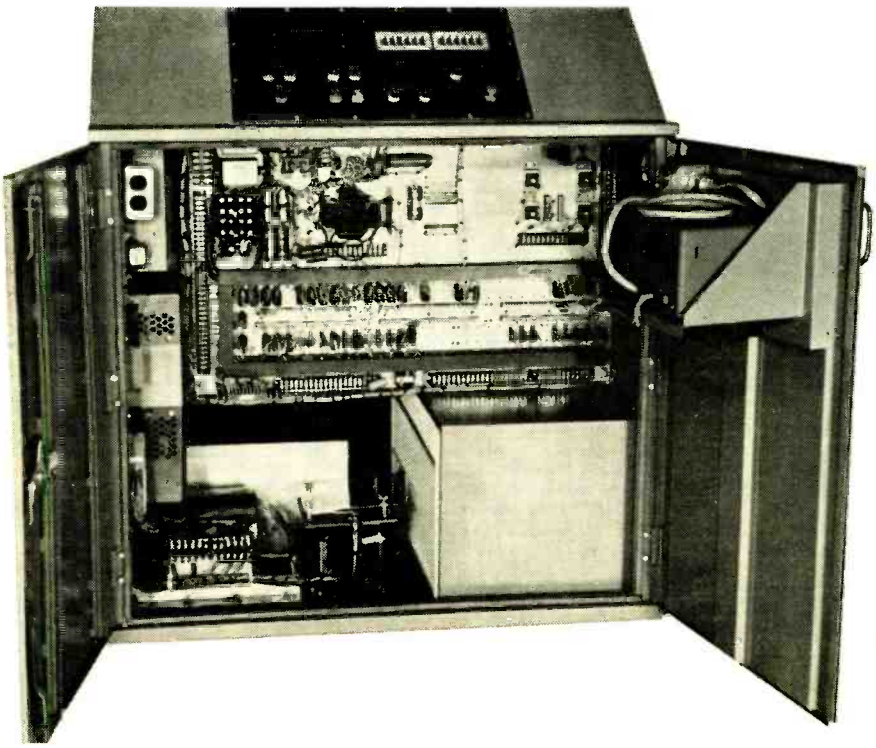
ARE YOU A FIRST-RATE ELECTRONIC technician, up to date on the newest equipment? Good! Then what is a *numerical control system?* If you know, you are probably one of a small elite group who also know *logic circuitry.* There are so few technicians in this field that jobs are going begging. And yet logic-circuit principles are far less complicated than TV! Working on such circuits is challenging. Simple logic circuits are grouped to form "thought processes" and make electronic decisions. More on that later.

Ten years ago numerical control was a laboratory experiment. By 1960 it had made some progress in actual machine applications. Today it is spreading rapidly through industry in hundreds of uses and promises to enter many new fields.

A numerical control system is a radically new method of controlling machinery. It provides a "brain" for automated machinery so that each machine can do an unlimited number of *different* jobs. Numerical control combines the latest solid-state electronics with the idea of the old player-piano roll.

Tape-controlled typing

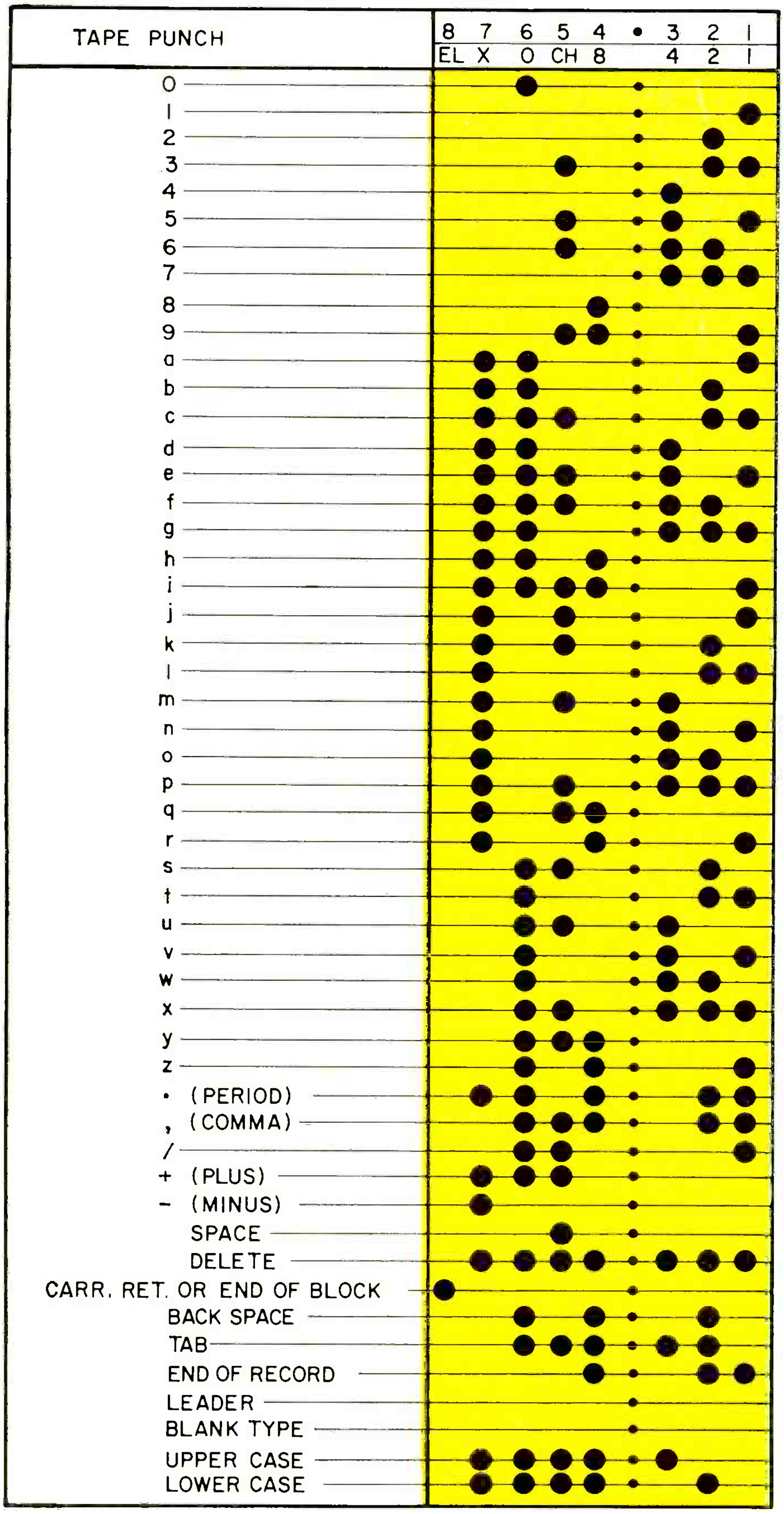
Machinery commands are typed on a special kind of electric typewriter that produces a typed page and also a punched tape copy. (Fig. 1 above is



▲ *Fig. 3—Plug-in modules used in the Mark Century control system (Fig. 2).*

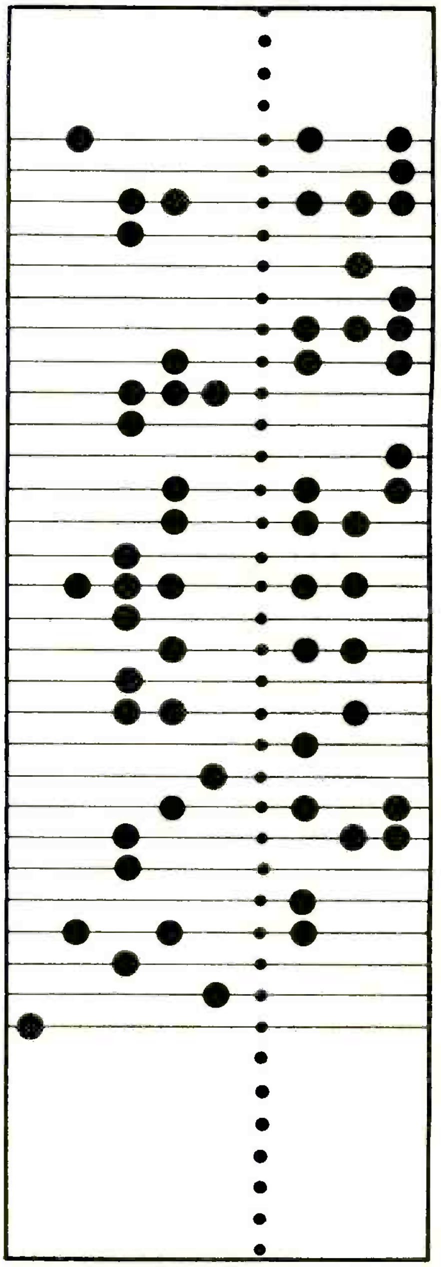
◄ *Fig. 2—Interior of the G-E Mark Century control system. Module boards are used.*

E.I.A. STANDARD CODING
FOR
1 INCH WIDE, EIGHT TRACK TAPE



one type of machine—the Friden Flexowriter.) If the tape is run through the machine again, a replica of the page is typed at high speed. When this tape is "read" in a tape reader, electrical signals are produced. These signals can be used in a numerical control system to operate machinery. The machine responds as though to the touch of a skilled machinist.

Fig. 2 shows a General Electric Mark Century numerical control system. A photoelectric tape reader is in the right-hand door. All circuits are solid-state, and air conditioning is built-in. The back doors of the cabinet



TYPICAL TAPE MESSAGE

Fig. 4-a (left)—Coding system for numerals, alphabet and 15 additional characters. b (above)—Sample tape message.

give access to plug-in module boards as shown in Fig. 3. The plug-in feature allows the service technician quick and easy access to all circuits and permits replacement of whole sections if trouble occurs. The removed boards can then be bench-tested at a convenient time, without interrupting machine operations.

Such a system is capable of controlling every operation of highly complex machines. One machine can turn out four identical, precision parts at one time. A machinist need only supervise the operation of one or more machines.

Fig. 4-a shows how a tape is punched for numerals 0 through 9, all letters of the alphabet, and for 15 other characters. No two characters are punched alike. Fig. 4-b shows a typical tape message prepared for machine control. Industry standards for tape perforations are published by Electronic Industries Association (EIA).*

Note in Fig. 4-a that there are 8 channels across the width of the tape. The binary (8-4-2-1) code is used for all numerals. A "5" is punched with 4 and 1. A "7" is punched with 4, 2 and 1.

There is a "CH" channel for *parity check* holes. A hole is punched in that channel only when needed to make an *odd* number of holes. Any character having an even number of holes is read as a *tape error*. This is an accuracy check on both tape and reader.

Channels 6, 7 and 8 are "0" (zero), "X," and "EL" respectively. Note that "X" is used to code 18 alphabet but none of the numerical characters. The "EL" is used only for an *end of block* code and causes a *carriage return* on a Friden typewriter. A *block* is one *set* of machine commands, and the "EL" code ends every block.

There is another set of holes in the tape between channels 3 and 4. They are called *sprocket holes*. Note there is one sprocket hole for each character. They serve as a timing signal source. The character holes measure 0.072″ in diameter, while the sprocket holes are 0.046″ and centered with character holes.

Note the tape coding perforations carefully. The letter "a" has character holes in the 1, 0 and X channels. Note also there are *no* holes in the 2, 4, 8 and CH channels. The absence of holes is as important as their presence. This is a "NOT" condition for those channels. In Boolean algebra a "NOT 2" is written "$\overline{2}$". A line over

*11 West 42 St., New York, N. Y. 10036. See EIA Standards RS-244 ($0.50) and RS-274 ($1.30).

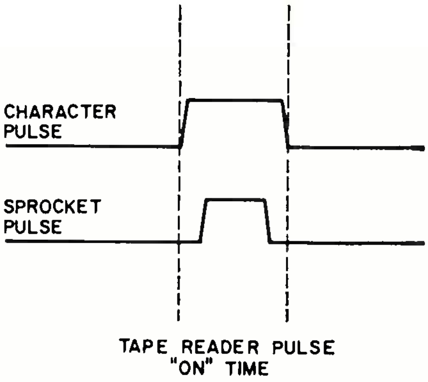


Fig. 5—For ideal character–sprocket pulse relationship, sprocket pulses are about two-thirds duration of the character pulses, and centered timewise.

a number means "NOT".

Look at the coding of letter "m" in Fig. 4-a. Here we read $\overline{1}$, 2, 4, $\overline{8}$, CH, $\overline{0}$ and X. That is NOT 1, NOT 2, a 4, NOT 8, a CH, NOT zero and an X. Thus there are seven conditions on tape to define "m"—or any other character. Notice also that CH was necessary in describing "m" so that there would be an *odd* number of holes. If any one hole gets blocked, a parity error is read.

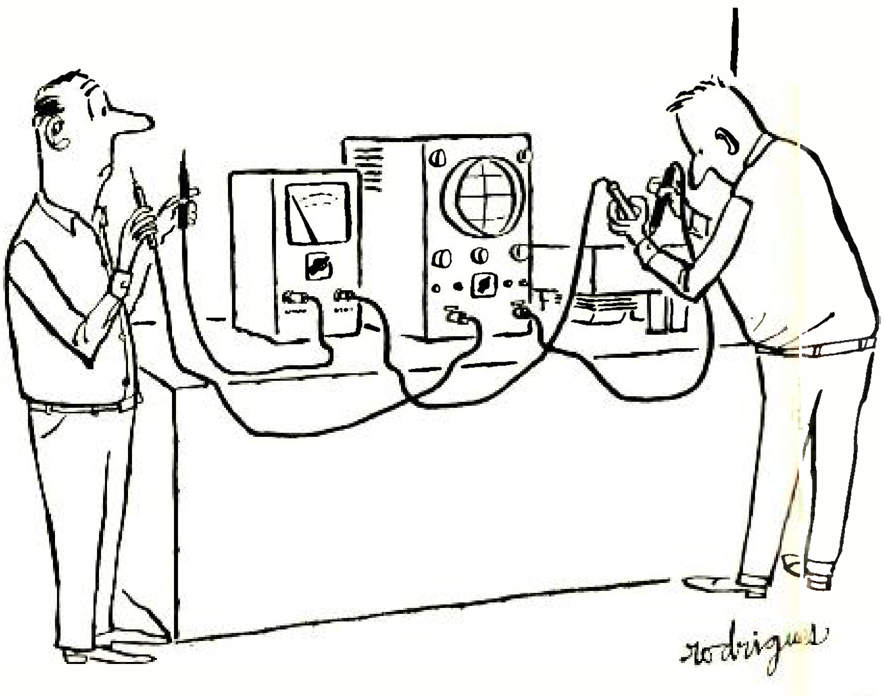
The tape coding of Fig. 4-a may also be used for magnetic tape, but such tape is not common. Perforated tape readers are of two types. One is mechanical and has a set of finger contacts for each tape channel. The tape holds the contacts open except when a hole is between the tips of the contact fingers. When the contacts close, current flows in an "on" condition. In logic vernacular, the "on" is called "true". Open contacts produce an "off" or "not true." The ideal electrical waveforms are a series of square waves for each channel punched. Sprocket pulses are about two-thirds the duration of character pulses, and center in the character pulse time. Fig. 5 shows this ideal time relationship between the pulses.

Another popular tape reader is photoelectric. This type has nine photodiodes and a focused light source. Light through a tape hole causes a photodiode to turn "on". Electrical output of this type of reader is in square-wave form similar to mechanical readers, but usually of lower amplitude. Reading speed is greater than with mechanical types, and is usually about 100 to 400 characters per second. With 10 characters to the inch, that is 10 to 40 inches per second. Tape must be opaque for use with photoelectric readers. Light leaks can cause reading errors. This may happen when ordinary paper tape gets oil-spotted and becomes translucent at those spots. Ideal tape is aluminum-backed, laminated mylar. Tape must be 1″ wide and 0.004″ thick to conform with EIA specifications

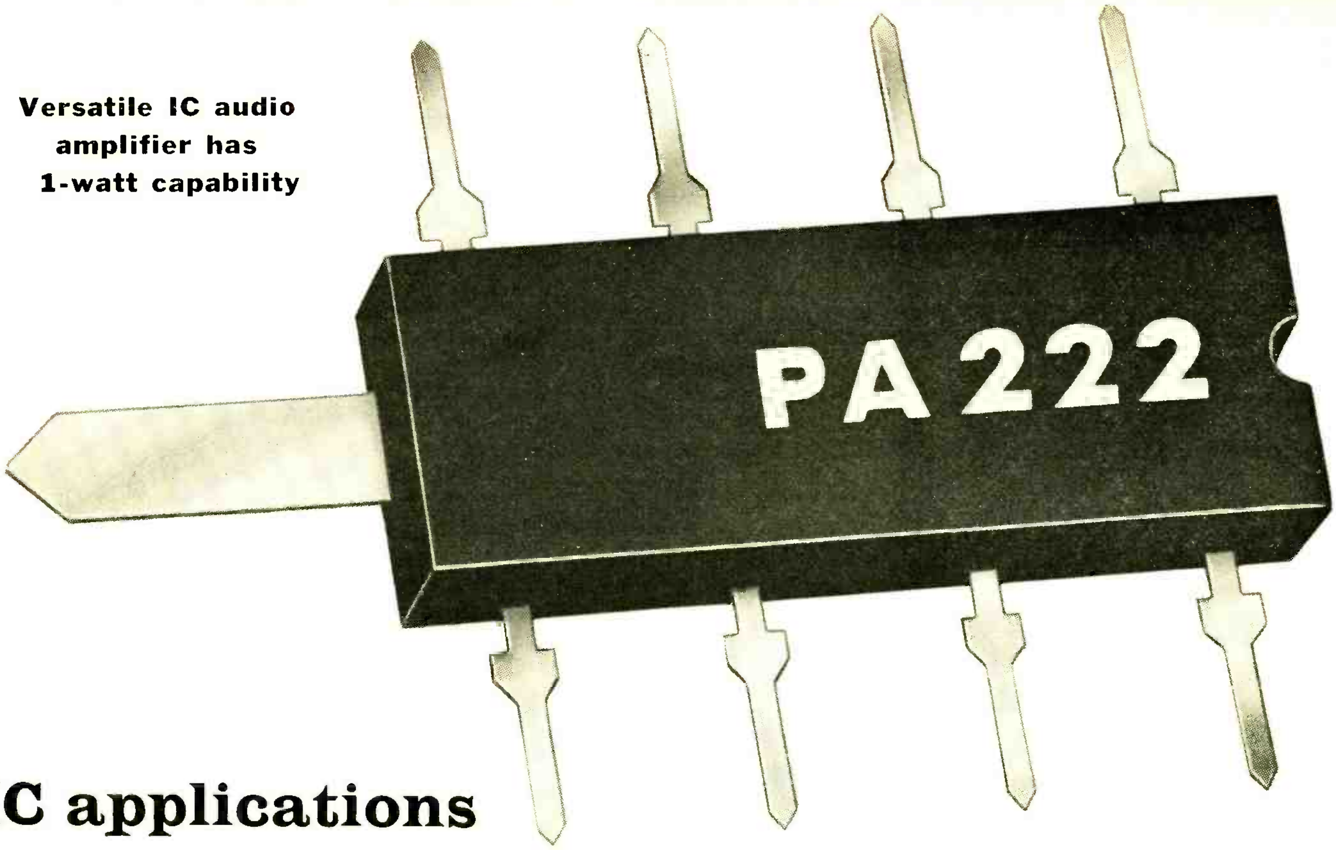
The next article of this series will show how the "true" and "not true" signals of the tape reader apply to logic circuits. **R-E**

COMING NEXT MONTH

16 Speaker Enclosures You Can Build.
In March we'll show you plans for assembling a wide range of hi-fi speaker systems. There's one to fit your budget . . . several systems can be expanded with woofers and tweeters when you're ready for "fuller" sound.



Versatile IC audio amplifier has 1-watt capability



IC applications

Use The PA-222 In Audio Circuits

By JAMES ASHE

AVAILABLE NOW AT A LOWER PRICE than many transistors, General Electric's PA222 amplifier will find wide use in the amateur and experimenter fields. The PA222 is a complete integrated-circuit audio amplifier capable of a continuous 1-watt power output. It is supplied in a standard flatpack, with enough terminals brought out to avoid limited applicability.

Apparently designed for a specific entertainment product, the PA222 is available for new use and replacement applications from all 83 of G-E's major outlets. The price is down from the former \$6 to \$3.70 each in unit purchases.

General description

The PA222 amplifier is supplied in an industry standard 14-lead flatpack for automated circuit board mounting. The tongue extending from the end is normally soldered to a heat sink, which need not be very large. G-E recommends 1" square of copper PC board surface. Six of the usual 14 leads were omitted, because the terminals were not needed. The resulting 0.2" lead spacing avoids delicate assembly problems when mounting the unit.

But the original 14-lead numbering is retained and appears in G-E's product literature (see Fig. 1). It is used in this description. The leads are mounted toward the bottom of the flatpack, and its top is marked by a shallow circular depression. The leads are numbered 1, 3, 5 and 7 on one side and 8, 10, 12 and 14 on the other. As seen from the top, the numbers start at the end opposite the tongue and proceed in a counterclockwise direction.

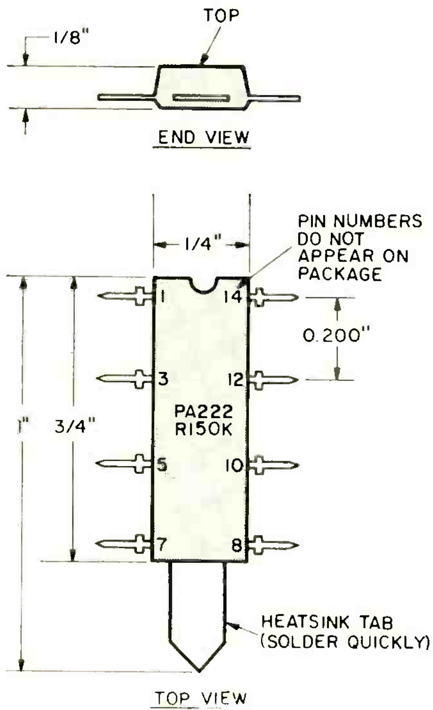


Fig. 1—Audio amplifier IC comes in standard 14-lead flatpack, but six unnecessary leads are omitted. Large heatsink tab needs only 1 square inch of PC surface.

Inside the package, a 0.050" square silicon chip is mounted on the inside end of the heat-sink tongue. The G-E specs say nothing about electrical connections to the tab, so it would probably be well to leave the tab floating electrically. The chip carries the six transistors, six resistors and diode shown in Fig. 2.

This circuit is very different from the simple audio circuits usually assembled from discrete components. One significant difference is its extended frequency response arising from the tiny transistor structures on the chip. Outside leads should not be long, but only reasonable care is required. Another difference is the use of three separate feedback loops. This complicates analysis, so there is no simple complete explanation of how the entire circuit functions.

If we ignore the feedback loops (which will be discussed later) we get this picture: Q1, the input transistor, is a common-emitter amplifier. For a positive-going half-cycle, Q1's amplified signal goes to Q2, which feeds the Darlington pair Q4 and Q5, acting as emitter followers to drive the output.

During the negative-going half-cycle, diode D1 goes into conduction, and Q2 drives Q3 and Q6, which are now acting as another Darlington pair. With their collectors connected to the low load resistance they act much like another emitter follower.

Without feedback, the amplifier shows considerable distortion, with crossover distortion being most noticeable in a scope display. The two ac feedback loops correct the distortion, and adjust circuit gain to a previously selected value. Because of the amplifier's wide-band frequency response, bandpass tailoring by adding reactive elements to the feedback loop leads to persistent oscillations.

One circuit component must be selected for the specific IC amplifier used. This is RS, which adjusts the quiescent current and output voltage. The required value appears on the top of earlier IC's in a slightly depressed circular area. It may be on the bottom of more recent samples, as it does not appear in G-E's photo (opposite page). The legend will read PA222/R150K to indicate a 150,000-ohm resistor at RS. Recent specs indicate only three values: 68,000, 100,000 or 150,000 ohms for this resistor.

Using the PA222

Four simple precautions will guarantee long life for the PA222, even in breadboard applications:

1. Do not short the output.
2. Avoid overdriving.
3. Use a heat sink.
4. Place a No. 53 or two No. 47 lamps in series, in the positive supply lead for bias checking and small-signal tests.

The lamps limit current to 120–150 mA, and if they glow brightly something is seriously wrong. They are shorted or removed for normal operation.

General Electric's basic test circuit is shown in Fig. 3. All PA222's will produce rated gain and power output in this circuit, which closely resembles G-E's circuit for its portable phono application. This circuit is not as complicated as it may seem and parts values are not very critical, although electrolytic voltage ratings should be respected. Many of its components can be eliminated or reduced in size at no cost in performance for other than hi-fi applications.

The IC's high-frequency response is controlled by adding "suppressor" capacitors and resistors. Capacitor C1 and R1 provide increased resistive load above 150 kHz, and C2 and C3 provide an additional high-frequency rolloff. These are marked in the schematic with asterisks.

Thermal runaway is eliminated by the dc feedback loop from pin 14 through R2 to pin 3. Increasing current through Q6 (Fig. 3) raises its base voltage, and this rise is applied to the base of Q1. A return turnoff signal is applied to the Q6 base terminal. G-E's tests indicate there is no combination of signal, temperature and roughly correct external circuitry that will allow the IC to go into thermal runaway.

There is some difference in am-

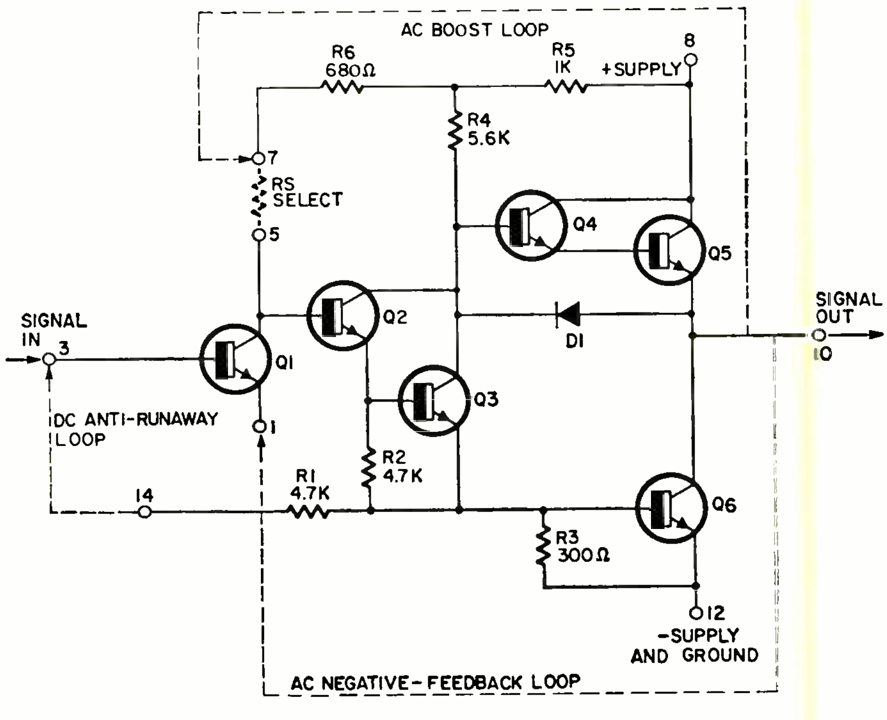


Fig. 2—Six transistors and resistors, and one diode form the PA222 circuit. Three feedback loops for low distortion are competed through external connections.

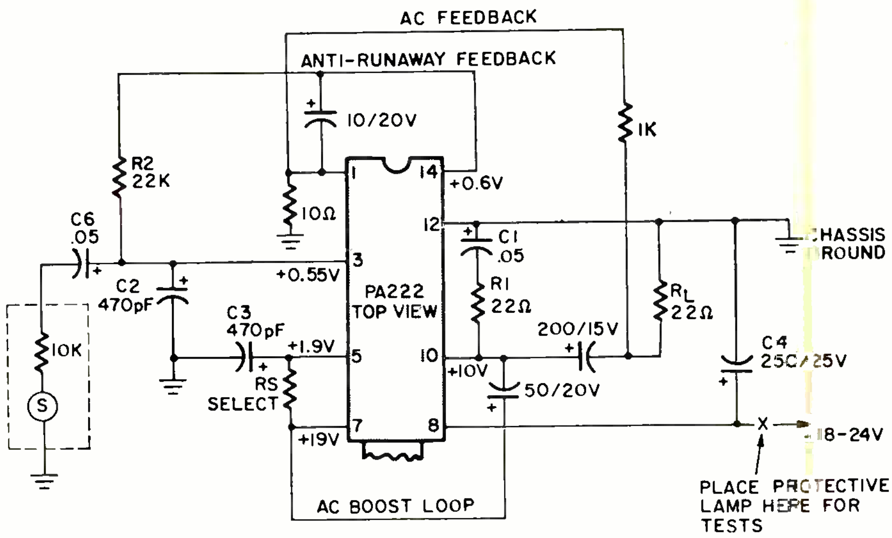


Fig. 3—Test circuit for the IC. A dc feedback loop (pin 14 through R2 to pin 3) prevents thermal runaway. Signal source resistance is about 10,000 ohms.

plifier performance for positive-going and negative-going signals. The drive-boost feedback from the output to pin 7 improves linearity by correcting the shape of positive-going signals.

Finally, part of the output signal is returned from the output terminal to the emitter of Q1. This negative feedback loop adjusts the overall gain of the circuit and reduces signal distortion to the vanishing point. Without negative feedback, amplifier gain is extremely high and there is serious distortion.

Two other details remain. The dotted box at the input (Fig. 3) represents the kind of signal source G-E has in mind for this circuit. A source resistance of 10,000 ohms is considered about right, and it could well be less. A large capacitor (C4) is placed across the supply leads. Although it seems to be a filter capacitor, it plays an equally important role as a low-impedance route for heavy output currents that must be returned to pin 8 or 12. If grounded as shown in Fig. 4, the PA222 should not suffer from the noise and feedback problems often associated with high-gain class-B audio power amplifiers.

Voltage gain is near 100, and response is 55 Hz to 15 kHz. Typical distortion at 50 mW output is 1% into 22 ohms, rising to 10% at 1 watt from an 18-volt power supply.

G-E's latest data sheet carries a simpler application schematic (Fig. 4). The drive-boost loop and its capacitor are omitted, the high-frequency suppressors are left out, and the number of components is minimized. Its voltage gain is about 100, with bandpass from 50 Hz to 100 kHz. G-E says typical distortion is up from 2% to 3%, and sine waves retain a good appearance.

Some breadboarding produced the compromise circuit of Fig. 5. It uses more components than G-E's simplest circuit, but the capacitors are smaller and the lower cutoff frequency is around 300 Hz. Lower response is not desirable for many communications applications, but can be extended by choosing larger values for C1. Fixed amplifier gain is adjusted by using different values for R1, with distortion increasing for larger values of R1. The drive-boost loop contains a small capacitor, and improves linearity at moderate signal amplitudes. An overall gain control is included, but the only attempt at adjusting the high-frequency rolloff is C2. This capacitor can be increased to 0.002 μf at some sacrifice in shape of high-frequency signals. Maximum gain is roughly equal to the ratio R/R2.

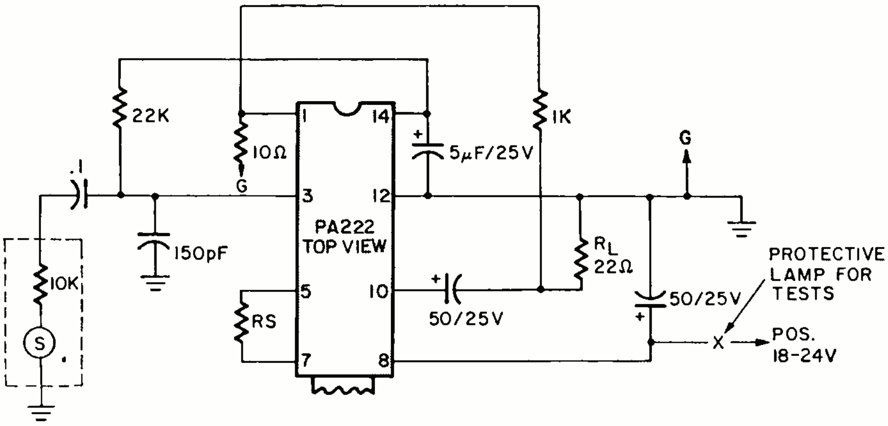


Fig. 4—Latest PA222 application schematic reduces number of external parts by omitting drive boost loop and high-frequency suppressor capacitors (see Fig. 3).

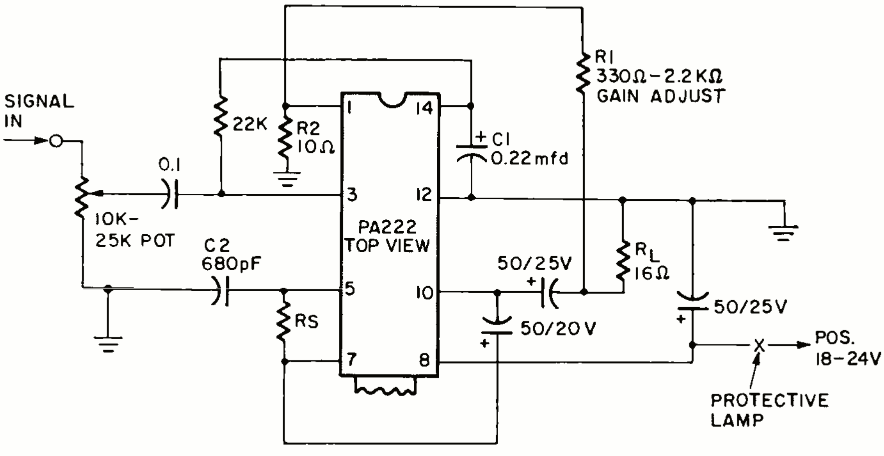


Fig. 5—Author's variation of circuit above raises low-frequency cutoff from 50 Hz to about 300 Hz. Values of R1 vary the gain; drive-loop capacitor improves linearity.

Suggested applications

Designed as a loudspeaker driver, the PA222 will do a fine job with standard hi-fi headphones. The phones should be wired in series to provide the relatively high-resistance load required by the amplifier. Used in a circuit resembling Fig. 3, the PA222 will do very well in wide-band, low-distortion hi-fi service.

The PA222's adjustable high gain is well adapted to service as a complete radio receiver audio section for phones or a small speaker. It could also be used as a small modulator for a transistor transmitter or as the driver for a larger power amplifier. Output should be connected to the modulator or interstage transformer primary through a large capacitor, to avoid a dc short from output to ground.

Microphones generate very small signals, and sometimes the audio cannot compete with noise picked up by a cable run of a few tens or hundreds of feet. The PA222 is appropriate for low-gain, low-output resistance, line-driver application. Another similar application would be intercom service.

Some laboratory applications also suggest themselves. The high-gain, wide-band PA222 should do very well as the gain section of a feedback ac vtvm. An additional emitter follower or FET would improve input resistance. Another laboratory application might be as the basis of a signal tracer. The PA222 seems to have a very bright future indeed! **R-E**

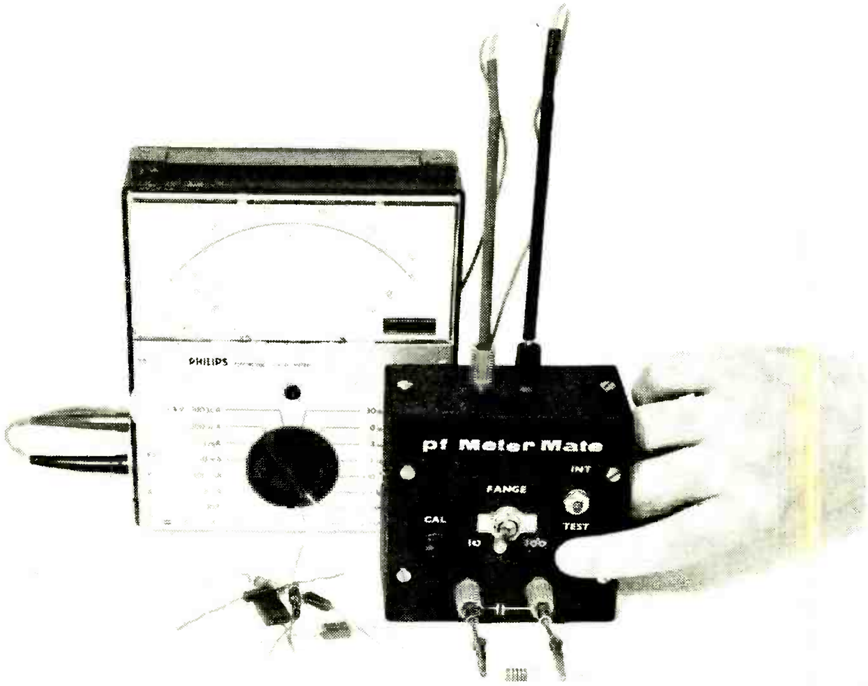
[Readers may wish to consider General Electric's PA234 for applications similar to those described. Recently introduced, the 234 offers still lower cost and improved performance. —Editor]

Check low-value capacitors

With The pF Meter-Mate

Reads up to 100 picofarads on your multimeter. Measure wire, cable, switch, tube capacitance and more . . .

By WILLIAM G. MILLER



THE PF METER MATE IS A COMPACT, direct-reading capacitance meter that will measure from 0 to 100 picofarads (pF) in two ranges. It is designed to work with any existing multimeter that has an input resistance of 20,000 ohms per volt or better.

All parts are widely available, and total cost is less than $7 at list prices.

Many capacitance meters are commercially available but very few can measure values under 100 pF, and only laboratory types will accurately measure under 10 pF. If you're interested in checking those small TV tuner and rf caps or even measuring the capacitance across the contacts

PARTS LIST

All resistors ½ watt, 10% or better
R1—75 ohms
R2, R5—1000 ohms
R3, R4—6800 ohms
R6—68,000 ohms
R7—3,300 ohms
R8—1.5 megohms
R9—2000 ohms
R10—10,000-ohm potentiometer
R11—33,000-ohms
R12—3000 ohms
Capacitors
C1—50 μF, 15V or better
C2, C3—.001 μF, 15V or better
C4—10 pF, 5% (see text)
C5—100 pF, 5% (see text)
C6, C7—1 μF, 15V or better
Semiconductors
D1—Zener diode, 15V, ½ Watt
D2, D3—1N34 germanium diode or equivalent
Q1, Q2—2N414 germanium transistor
Q3—2N1302 germanium transistor, i.f. npn type, or equivalent
Other parts
J1–J4—5-Way binding posts, Olson HW-61 or equivalent
S1—Miniature momentary pushbutton spst or spdt switch.
S2—Subminiature momentary spst n.o. switch, Laf.99H6159, B.A.17C3[illegible] or equiv.
SW3—Dpdt toggle switch
B1, B2—9-volt transistor battery (Eveready 216 or equivalent)
MISC—Steel wrinkle-finish box, 4"x4"x[illegible]" (Allied 42E7856 or equivalent). 6" strip of linoleum tape or similar plastic. 6-32 screws with nuts and lock washers. Mounting brackets.

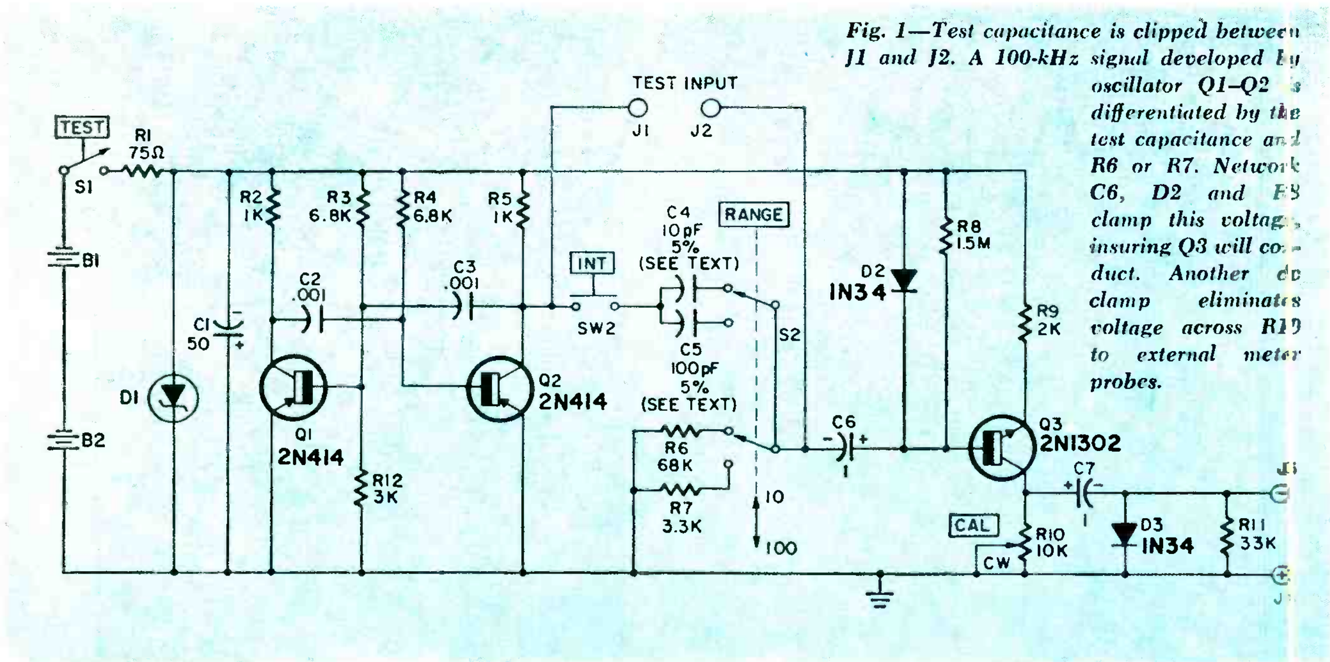


Fig. 1—Test capacitance is clipped between J1 and J2. A 100-kHz signal developed by oscillator Q1–Q2 is differentiated by the test capacitance and R6 or R7. Network C6, D2 and R8 clamp this voltage, insuring Q3 will conduct. Another dc clamp eliminates voltage across R10 to external meter probes.

of an open switch, this instrument will do the trick.

How it works

In Fig. 1, transistors Q1 and Q2 form a 100-kHz square-wave oscillator. The output is connected to J1, one of the input binding posts for the capacitor under test. The 100-kHz signal is coupled through the test capacitor and developed across either R6 or R7, depending on the position of range switch S3. These resistors, together with the test capacitor, form a differentiator network, and the average differentiated voltage developed across them will vary directly with the value of the test capacitance.

The resistor voltage is fed to the C6, D2 and R8 network, which forms a positive dc clamp. The positive clamp guarantees that all pulses felt at the base of Q3 will be of such polarity as to cause Q3 to conduct.

Transistor Q3 amplifies the signal and the output is coupled to still another dc clamp consisting of C7, D3 and R11. External voltmeter connections are made to J3 and J4.

A dc clamp is necessary at the output to eliminate "offset," which is the dc voltage present across R10 when no signal is on the base of Q3.

Zener diode D1 is included for voltage-limiting purposes and keeps the instrument operating linearly.

PC pattern transfer

The following system for making the printed circuit board can be applied to any project where the full-scale pattern is printed on paper.

First, saw or shear a piece of copper-clad board to the size shown in Fig. 2. Cut Fig. 2 from the page and tape it in place over the copper side of the circuit board. Place a centerpunch or sharp nail on each indicated drill hole and tap lightly with a hammer. This will complete the important positioning the holes.

Remove the drawing and use a No. 55 or similar size drill to make holes where centerpunch marks appear.

The circuit pattern or "lands" can now be sketched on free-hand, using a resist ballpoint pen. As long as it's electrically correct, don't worry about irregularly shaped lines or circles that blossom.

Resist ballpoint pens are listed by all major mail-order houses and are also available at many parts stores. Their price is less than $1.50 and they are good for over 50 similar projects. If one of these pens is not available, fingernail polish or other forms of resist can be used.

The next step is to let the resist dry about 30 minutes and place the

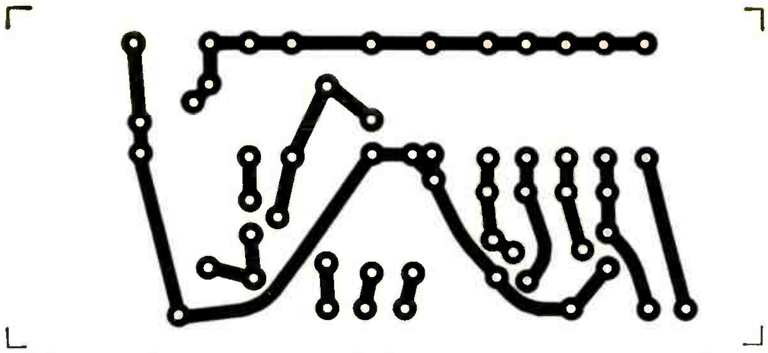


Fig. 2—Pattern used on author's PC board. Drawing is actual size.

board (copper side down) in a pan or dish of commercial etchant (ferrous chloride). After about 20 minutes or more when the copper has been etched away, the board can be removed and rinsed with water. The resist is now removed with a solvent or nail polish remover, and the completed board is again washed in water. Use a needle or drill point with the solvent to clean the drill holes.

If you'd rather not use a printed circuit, you can cut a vector board to the dimensions shown in Fig. 2.

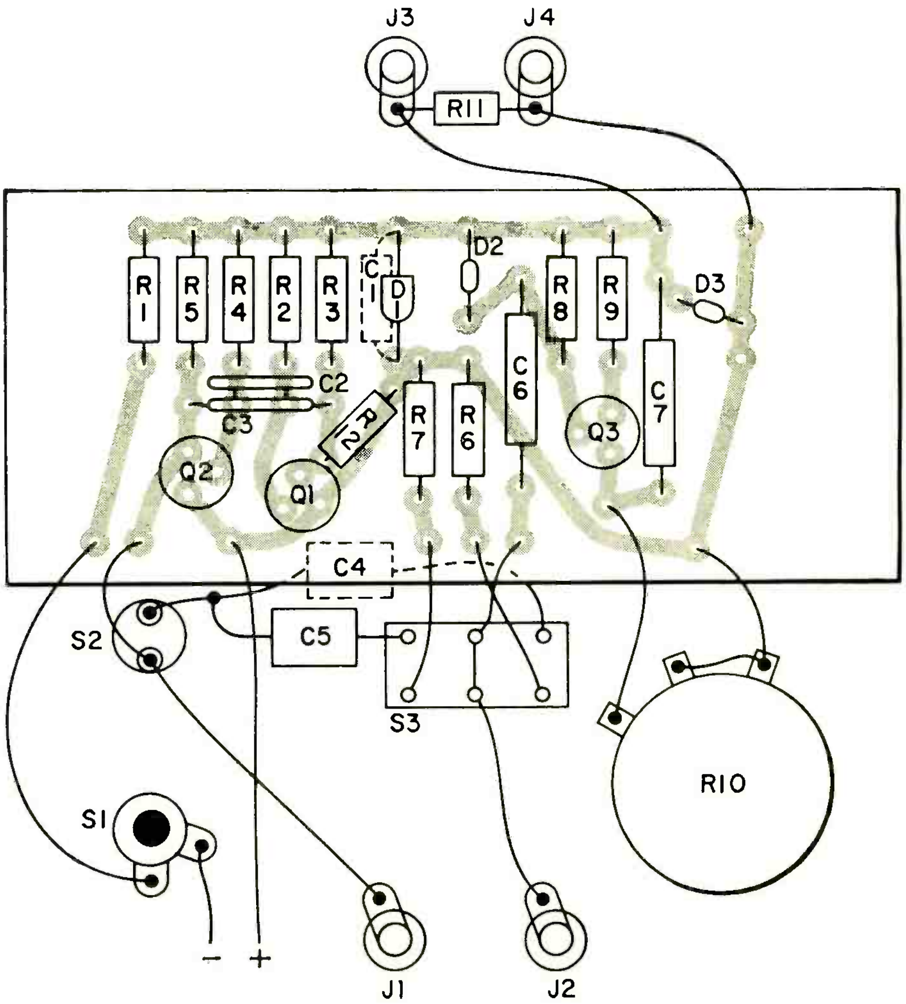
The board should be a Vector 85 G24EP or equivalent, since this type has a staggered 0.1" grid and the holes correspond exactly to the holes in Fig. 2 to ease wiring.

Insert a "flea" clip in every hole that represents a drill hole and solder the components to the clips. The "lands" are simulated on the reverse side of the board by joining the proper clips with hookup wire.

Construction

Capacitor C1 is the only component mounted on the copper side of the board, in order to allow for a wide variety of physical sizes. Capacitors C4 and C5 are used to calibrate the instrument and because of physical size are omitted from the circuit board and wired switch-to-switch (Fig. 3). Resistor R11 is soldered directly

Fig. 3—Component placement for the Meter Mate. C1 is on copper (other) side.



across meter jacks J3 and J4.

Terminal J4 must be connected to chassis ground. This can be done by omitting the insulating washers when J4 is initially mounted. Keep all wiring as short as possible, and position the lead from J1 to SW2 close to the metal chassis. Twist together the ground and collector leads at R10.

Battery clips for B1 and B2 were secured by prying open several discarded 9V batteries and using the top terminal board.

Any suitable metal container can be used to house the instrument, but a black wrinkle-finished steel box was selected for economy, ruggedness and the ease with which transfer letters can be applied.

The pF Meter Mate has virtually no critical components, except for S2. All tolerances are wider than indicated by the materials list, so many substitutions can be made.

Switch S2 should not be replaced unless you are certain that the new switch is a low-capacitance type. Also exercise extreme caution and use a low-wattage iron in soldering pretinned leads to S2. The *plastic housing* that supports the internal elements melts easily.

Transistors Q1 and Q2 can be changed to any pnp transistor, silicon or germanium, that is capable of operating at 100 kHz, and can stand off 15 volts with 30 mA collector current.

Transistor Q3 is replaceable by most i.f. npn germanium types with a 15-volt rating. Do not use silicon types for Q3 because operation would be nonlinear due to the high emitter-to-base voltage drop.

Using the instrument

Connect your multimeter to J3 and J4 with the polarity indicated, using a low-voltage dc scale. A 1-volt scale is ideal, but the multimeter will work just as well on a 3-volt range although only one-third of the scale is used.

In other words, when the pF meter RANGE switch is in the "10" position, 10 pF will equal 1 volt, and when the RANGE switch is in the "100" position, then 100 pF will equal 1 volt.

If you have a meter similar to the Simpson 260 series, where the lowest range is 2.5 volts, and you would still like a full-scale deflection for 1 volt, set the meter up to measure current on the 50-μA scale and connect a 20,000-ohm resistor in series with either lead. The reading can now be taken from the 0–10 scale.

Vtvm's, fetvm's and trvm's can also be used as the output indicator, provided the instrument doesn't use a chopper or sample the input.

The signal at J3 is pulsating dc, and only the average value will give an accurate indication.

Before the instrument is ready for use, it must be calibrated or set up in much the same way an ohmmeter is:

1. Put the range switch in the desired position.
2. Depress the INT and TEST buttons.
3. Adjust the CAL knob for a reading of exactly 1 volt.
4. Release the pushbutton and connect the capacitor to be measured to J1 and J2.
5. Press the TEST button and take the reading directly from the voltmeter.

A reading of 0.3 volt indicates a capacitance of 3 pF if the RANGE switch was set at 10, or 30 pF if the RANGE switch was set at 100 for this reading.

The CAL switch must be readjusted every time the position of S3 is changed.

If you want to measure a capacitor that cannot be connected to the binding posts, use a pair of test leads made from 300-ohm twin-lead wire. Solder alligator clips to each conductor at one end and connect the other ends to the binding posts. Use banana jacks for plug in leads.

With no capacitor connected, depress the TEST button and you will read the capacitance of the test leads. Now connect the capacitor to the clips and test again. Record the reading and subtract the previous test-lead figure to get the true capacitor value.

Since the value of the test-lead capacitance will never change, this test has to be made only once and the value can then be marked on the twin-lead.

The pF Meter Mate can be used to measure the capacitance between tube elements, switch contacts, parallel conductors etc. It can measure wire and cable capacitances in harness work as well as check the range of a small trimmer capacitor. Further applications are limited only by the imagination of the user.

Troubleshooting

Under initial conditions, with the range switch set to 10, depress the TEST and INT buttons while adjusting the CAL knob for a reading of 1 volt. Release the INT button and observe the reading. The indication should be less than 0.05 volt (0.5 pF). You are actually measuring the stray capacitance between J1 and J2, so a higher reading would indicate faulty wiring, excessive lead length or high open-contact capacitance at S2.

If for some reason the unit fails to operate, check the battery voltage first. This voltage can be as low as 14 volts with the TEST button depressed. Under these conditions the voltage across D1 will be even less due to series resistor R1.

An oscilloscope check between J1 and J4 should show a square wave with a minimum p-p amplitude of 10 volts.

If the oscillator is not functioning and the supply voltage is o.k., check Q1 and Q2 for a minimum beta of 20. This is well below the 2N414's guaranteed minimum value.

With the INT and the TEST buttons both depressed, a differentiated wave should appear between J2 and J4.

If a waveform appears at J2 and there is still no output, check Q3 and associated components. **R-E**

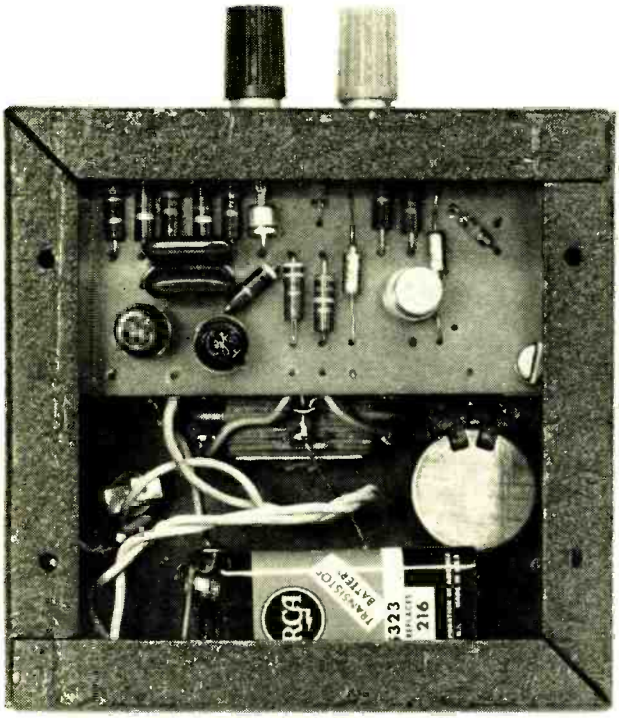


Photo shows partial layout of components.

ABC's of Transistors

Test Transistors Fast

Learn how ohmmeters and transistor testers show solid-state faults. Study new agc and horizontal circuits

by SYLVANIA TECHNICAL STAFF

OHMMETER TESTS WILL WEED OUT definitely defective transistors. Since a transistor can be considered as two diodes connected back-to-back, the equivalent circuit (Fig. 1) is a guide to making simple resistance tests. For example, you should find a reasonably high front-to-back ratio between emitter and base, as well as between collector and base.

If you find a low resistance when the negative ohmmeter lead is connected to the emitter and the positive lead to the base, the transistor is an npn type. A high resistance here indicates a pnp type.

You may or may not measure a substantial front-to-back ratio from emitter to collector, even if the transistor is in good condition. A few transistors are symmetrical, meaning that the emitter and collector junctions have identical characteristics. For such devices the front-to-back ratio from emitter to collector is unity. On the other hand, most transistors are unsymmetrical, and you will measure a definite front-to-back ratio from emitter to collector although this ratio is usually lower than the other two ratios. Ohmmeter measurements on a "good" transistor selected at random are noted in Fig. 1.

Junction resistances

Simple transistor testers are basically ohmmeters. A common follow-up test is to measure junction back resistances in terms of current flow. Nearly all testers provide an I_{CBO} test, which measures leakage current. It applies a moderate reverse voltage between collector and base with the emitter open, as in Fig. 2. A microammeter in the collector circuit indicates whether the back resistance of the collector junction is acceptably high. Manufacturers list I_{CBO}.

An I_{CES} test is made the same way, except that the emitter is shorted to the base. The I_{CES} current flow is normally somewhat greater than I_{CBO} current flow. Transistors are customarily rated for I_{CES} as well as I_{CBO}. Simple transistor testers seldom provide an I_{CES} test.

An I_{ECS} test is basically the same as an I_{CES} test, except that emitter and collector terminals are reversed. The reverse emitter-junction current is measured with the collector shorted to base. In a truly symmetrical transistor, I_{ECS} and I_{CES} readings are normally the same.

Many transistor testers do provide an I_{CEO} test. An I_{CEO} reading is normally greater than an I_{CBO} reading because the reverse current is increased by emitter-base junction action. This test, as well as the foregoing tests, are provided by instruments with maximum flexibility for dc tests.

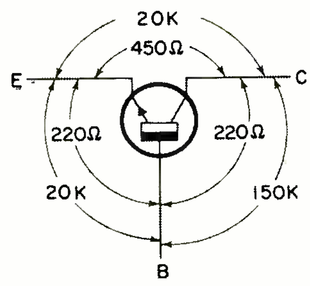
Alpha and beta

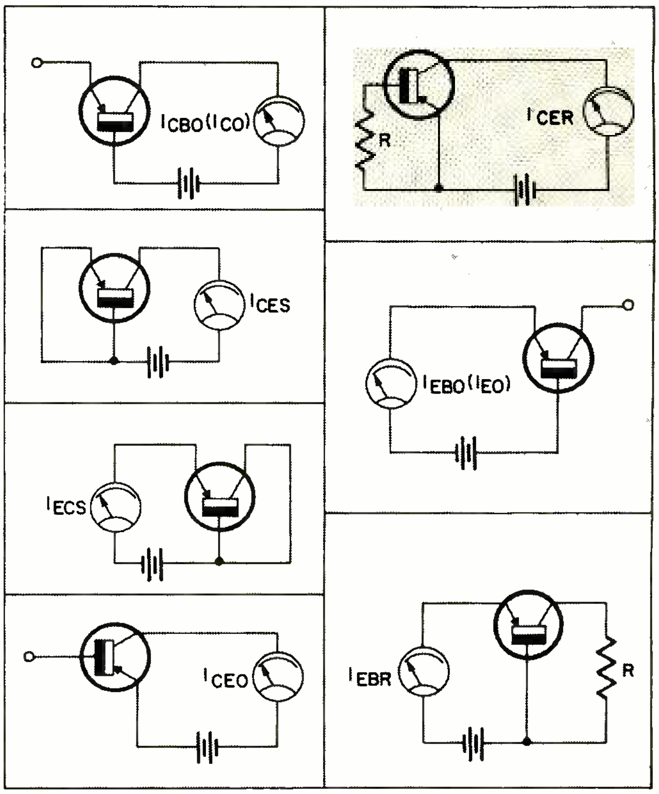
A more critical test of a transistor is to measure its alpha or beta (see Fig. 3). Basically, this is a measurement of transfer resistance. As shown in Fig. 3-a, the emitter is forward-biased, and the collector is reverse-biased. A forward emitter-bias lowers the emitter junction resistance, which is transferred by lattice action as a lowering of the collector junction resistance. Alpha is defined as the ratio of collector-to-emitter current. Beta is defined as the ratio of collector-

Next Month

This feature is devoted to In-Circuit Testing Techniques. Do not miss this special feature.

1





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to-base current of the transistor.

The simple ratio of input to output currents gives the dc (static) alpha or beta of a transistor. This is a test that simulates large-signal operation of a transistor, where the input signal drives the transistor over a large excursion of its characteristics. On the other hand, transistors are commonly rated for small-signal operation, and published values of alpha and beta must be checked by a slightly modified procedure.

Small signal alpha and beta

To check small-signal alpha and beta, input current is set to an operating value specified by the transistor manufacturer. This establishes an operating point at a median in the characteristics, as might be used for class-A amplification. Then, input current is increased by a small amount. The corresponding change in collector current is noted. The small-signal alpha or beta is then given by the ratio of input-current change to output-current change. Alpha and beta are simply related to each other, as in Fig. 3.

The dc alpha or beta will not be the same as the small-signal alpha or beta because the transfer resistance of many transistors is nonlinear (Fig. 4). Note that a base-current change from 0 to 0.3 ma produces a much larger collector-current change than a base-current change from 0.9 to 1.2 ma. Hence, this transistor will measure a larger dc beta than its small-signal beta.

Transistor circuit applications

Automatic gain control: The agc system develops a dc voltage in a tv receiver that has a direct relationship to signal strength. This voltage controls the gain of rf and video i.f. stages to limit picture variations due to changes in signal strength. For the most accurate agc, the system is referenced to the portion of the signal which does not vary as a function of video information. These systems are keyed or gated and referenced to the signal during horizontal sync pulse time, which represents 100% carrier power of the input signal. To reference at any other time could produce an agc voltage that would vary as the picture content varied; i.e., more agc voltage on black scenes and less agc voltage on white scenes, etc. Also the effects of noise on the agc system should be minimized.

In most receivers, the chassis operates at maximum sensitivity when no signal is being received. When a signal is received, a voltage is developed that is proportional to the strength of the incoming signal. This agc voltage is used to control receiver gain. In a conventional tube-type tuner, a negative voltage controls tuner gain. Deviation occurs when gain reduction is applied to the video i.f. of solid-state sets. Here, gain reduction is handled by increasing the forward bias, which increases collector current in the transistor. Since a positive-going voltage is required to increase the npn transistor's forward bias, the negative agc voltage is used to control an agc amplifier stage which, in turn, produces a positive voltage change at the base of the i.f. transistor controlled by agc. When an incoming signal becomes stronger, the negative agc voltage increases and increases in the positive voltage on the base of the i.f. transistors (reducing i.f. gain).

The basic principle involved in using an increase in forward bias to reduce amplifier gain is shown in Fig. 5.

In some sets special circuits are used so that above a certain level, the i.f. and tuner receive different bias voltage ratios. The signal compared to bias for both i.f. and tuner is shown in Fig. 6.

Different voltages are used for the tuner and i.f. to keep the tuner in its best response range. The graph also shows noise and tweet extremes in tuner agc levels.

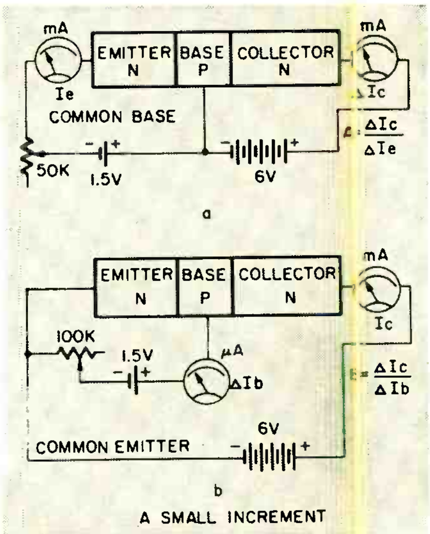
Signal strength is determined by "measuring" the horizontal sync pulse amplitude. This is the conventional means with keyed agc systems. The average video level is not used since scene changes would appear as signal strength changes.

Composite video is taken from the collector of the first video amplifier. The signal at this point is positive sync. This signal is applied to the base of the agc keyer. Since the agc keyer is an npn transistor, the positive sync tends to make it conduct (see Fig. 7).

The keyer has the agc control in the emitter leg, which changes the gain of the keyer.

The agc keyer has no collector supply except for a positive pulse during the horizontal sync time. A diode connected in series with this pulse prevents the keyer from conducting except when the positive pulse is present. The agc coil also has a negative excursion which would forward bias the keyer's collector and destroy the transistor.

The positive keying pulse is supplied from a coil on the flyback transformer, the return leg of the agc amplifier. The



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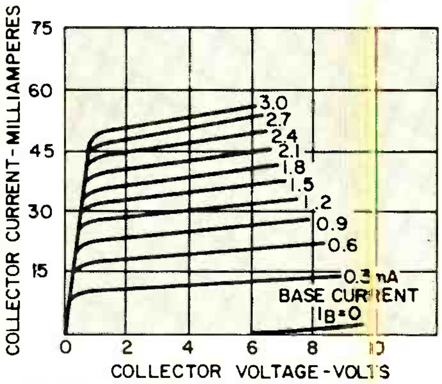

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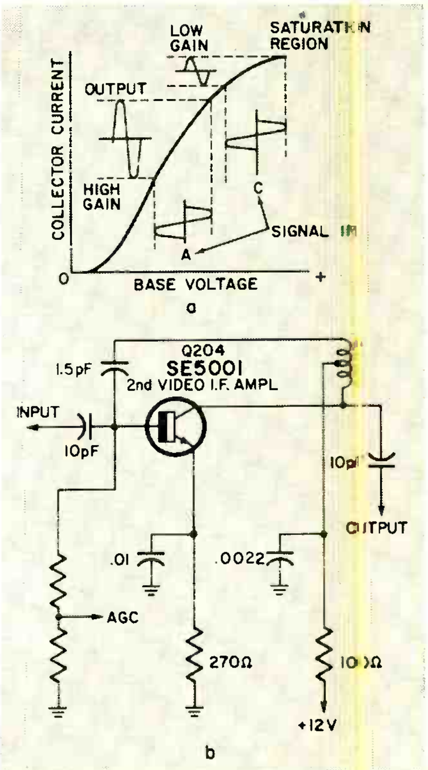

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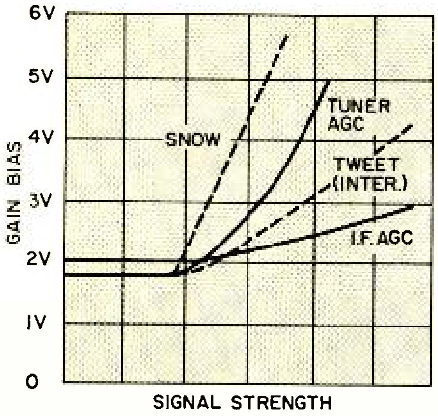

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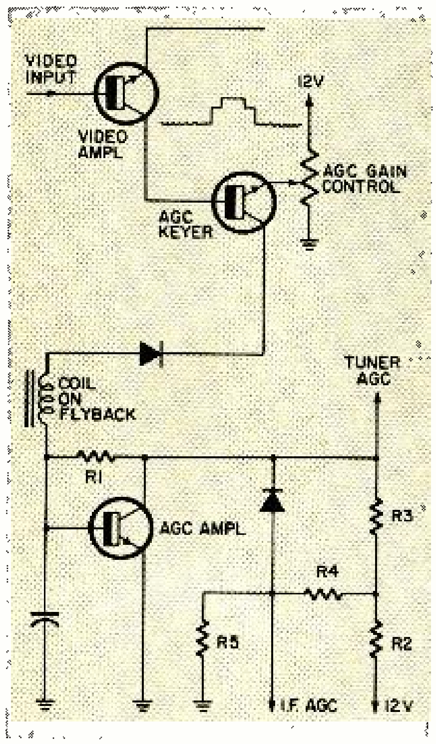

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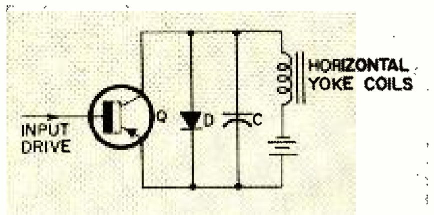


amount of current drawn from the agc amplifier base circuit is proportional to the amount which the keyer is conducting which, in turn, depends on the sync pulse amplitude.

A capacitor in the base circuit of the agc amplifier charges to some value through R1. The higher the sync pulse amplitude, the greater the drain on the capacitor's charge. The less the charge on the capacitor, the less the agc amplifier conducts.

We then have a system which causes the agc amplifier to conduct more as the signal weakens and conduct less as the signal increases. Consequently, under maximum signal conditions the agc amplifier is driven toward cutoff and the collector voltage is at maximum. Maximum positive agc causes amplifier gain.

The collector voltage is fed directly to the tuner agc line. Under maximum signal conditions, the i.f. agc voltage is divided first by R2 and R3 and then by R4 and R5. Since conduction through R3 and R4 is light, the reverse voltage difference across the diode is large and it remains non-conducting.

As the signal weakens, the agc amplifier begins to conduct, which causes the reverse voltage differential on the diode to decrease. At some point, the diode conducts and places almost the same agc voltage on the i.f. as the tuner.

Horizontal deflection

The horizontal deflection requirements for a TV set call for a magnetic field capable of linearly deflecting the beam across the tube face and returning it to a starting point 15,750 times per second. An equivalent form of deflection circuit is in Fig. 8.

The transistor acts as a switch across the entire coil and power supply network. If the transistor is switched on, the yoke coil's current increases at about a linear rate. When a set time interval elapses the transistor is turned off. The inductive kick from the coil is impressed on the transistor diode and capacitor C. The coils and capacitor form a tank circuit and tend to oscillate or ring. The diode acts as a short or closed circuit on the opposite polarity of each "ring" cycle. By proper timing of transistor and diode switching, a sawtooth current passes through the coils. This current averages out to be near zero, provides circuit efficiency, and removes the need of beam decentering. Beam decentering means the need for its starting point to always be at one extreme side of the screen.

After the transistor is switched off and coil energy is transferred from the capacitor back to the coil, polarity reversal occurs and the damping diode conducts. The current is now flowing in the coils in the reverse direction and approaches zero. When zero is reached the transistor is again turned on, starting another cycle.

Horizontal oscillator

The horizontal oscillator circuit in the Sylvania A02 chassis (Fig. 9) is an emitter coupled, two-stage multivibrator. Regenerative feedback voltage between stages is developed across the common emitter resistor.

When Q400 is at cut-off, collector voltage is about equal to battery voltage. This positive voltage is coupled to Q402 by C416, placing a forward positive voltage on the base of Q402. Q402 then goes to saturation and minimum collector voltage results. The positive voltage developed across R430 maintains a reverse bias on Q400, emitter to base. As the more negative base voltage of Q400 is neutralized (depending on the horizontal hold control setting) by the plus 12-volt supply voltage, the transistor goes back into conduction. Its collector voltage drops, applying a negative voltage to the base of Q402 and driving it to cut-off. This results in loss of emitter voltage on Q400, which is again biased off and the cycle repeats itself.

Horizontal output circuit

The horizontal oscillator input (in a Sylvania A02 chassis) to driver stage Q404 is approximately a square wave at about 3.8 volts peak-to-peak (see Fig. 10). It is amplified by the driver stage to a 25-volt peak-to-peak pulse. It is then applied to T400 to drive the final output Q406. This transistor normally conducts at saturation, and when the driver pulse is applied is cut-off almost instantaneously. This is a positive pulse from T400 and reverse biases the emitter base junction of Q406.

When Q406 stops conducting, the heavy B-plus current flowing through the transistor, through T402 winding (4 to 3 taps) and then through diode SC404, is cut-off. The resulting inductive "kick" by autotransformer action produces a 230-volt peak-to-peak spike on Q406's emitter and across the yoke coil network. The spike aids the driving pulse to Q406 from the driver stage through the low impedance path between emitter and base.

The SC409, C437 and R441 network across the yoke coils and C436 tends to clamp Q406's emitter to about a maximum of 240 volts peak-to-peak. This protects the transistor from breakdown due to voltages over this value. The clamping network is placed on the yoke only as a convenience.

The T402 secondary provides blanking, agc and high voltage spikes. SC411 rectifies the high-voltage spikes to provide 11kV to the picture tube.

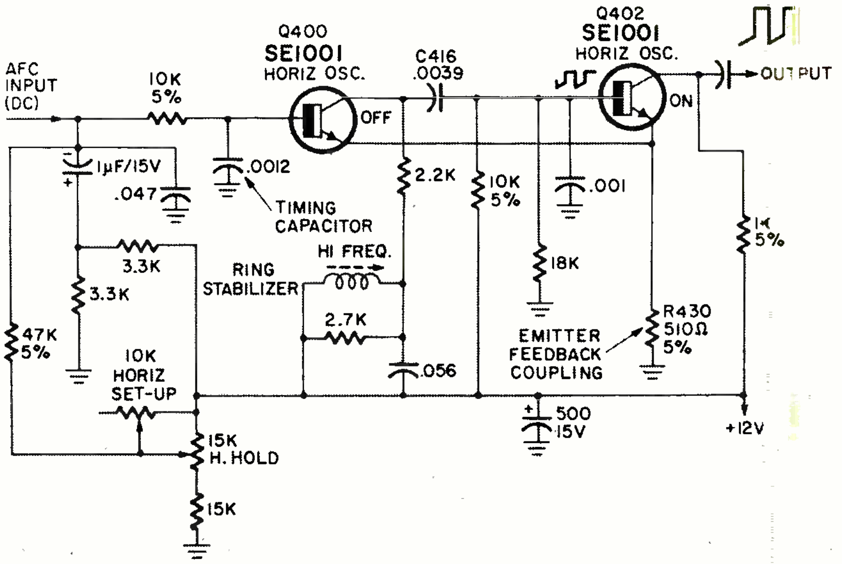
Part of the autotransformer's primary is applied to diodes SC404 and SC406, which then act as voltage doublers to provide 120 volts. This voltage is used on the final video amplifier and G2 and G3 picture tube grids.

Damper diode SC407 is cut-off during positive excursions of the emitter spoke. When the negative excursions occur the circuit inductance tries to make the emitter voltage go negative. This is clamped to ground potential by the diode and will not go below 0 volts.

Capacitor C436, in series with the horizontal yoke, provides linearity correction for wide angle picture tube scanning. This capacitor causes dc to pass through the flyback. A parabolic waveform is developed across the capacitor so that yoke voltage is less at the ends of the sweep than at the middle. This capacitor actually provides a series resonant current at about 5kHz to cause an S shaped current portion of a sine wave to flow. The S shaping capacitor is placed between the collector and emitter so yoke current does not have to flow through the power supply.

Operation of the horizontal output stage may be summarized as follows:

1. Output transistor has about 50% duty cycle.
2. Emitter voltage waveform is approximately the same as the base waveform.
3. C430 is a yoke retrace and boost capacitor.
4. The capacitor in series with the yoke is for linearity correction commonly referred to as "S" shaping. Peak-to-peak yoke current and flyback voltage is increased 10% by its use.
5. The flyback secondary uses third harmonic tuning. This provides a narrow secondary spike (10% of the cycle) and allows a lower peak-inverse voltage rating of the high voltage rectifier.
6. Third harmonic tuning is a function of leakage induction, winding spacing and distributed capacitance.
7. The average emitter dc voltage is 26 volts. This is actually a result of positive spikes 150 to 200 volts in amplitude. **R-E**



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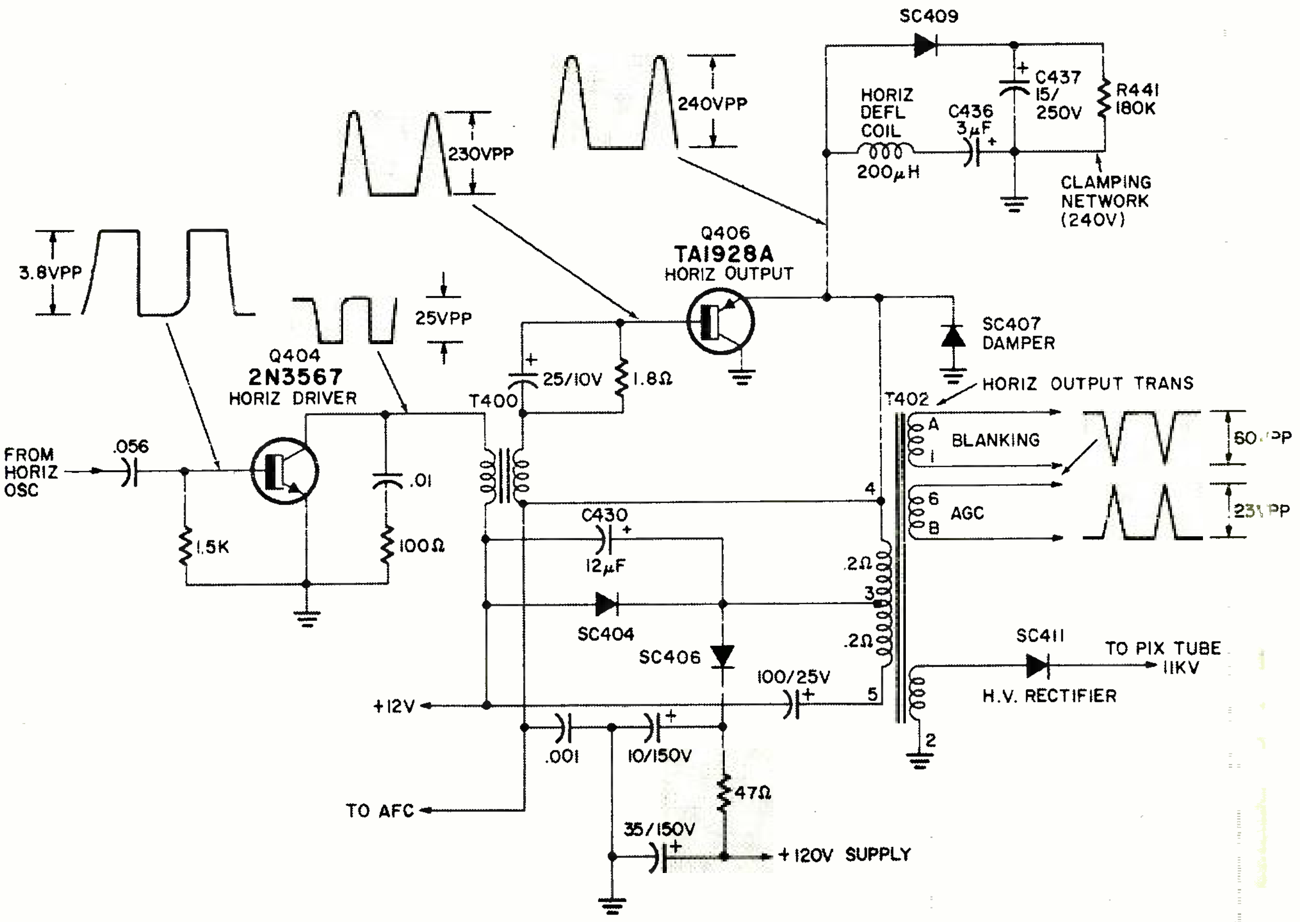

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"He's a good worker. I'd promote him right now if he had more education in electronics."

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.

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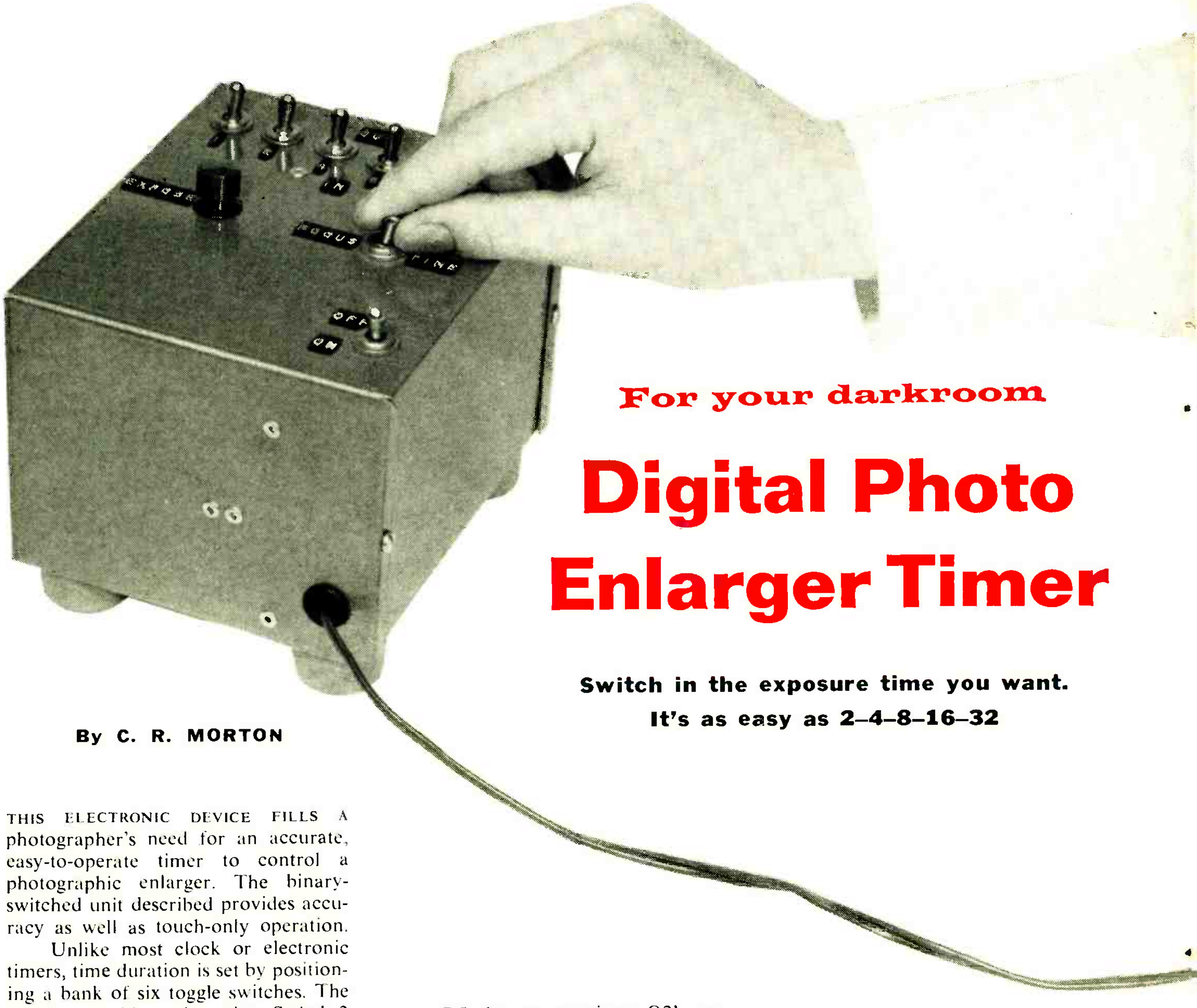


For your darkroom

Digital Photo Enlarger Timer

Switch in the exposure time you want. It's as easy as 2–4–8–16–32

By C. R. MORTON

THIS ELECTRONIC DEVICE FILLS A photographer's need for an accurate, easy-to-operate timer to control a photographic enlarger. The binary-switched unit described provides accuracy as well as touch-only operation.

Unlike most clock or electronic timers, time duration is set by positioning a bank of six toggle switches. The switches are binary in action. Switch 3 has a time value of 1 second; switch 4, 2 seconds; switches 5, 6, 7 and 8—4, 8, 16 and 32 seconds, respectively. Thus any setting between 1 and 63 seconds in 1 second steps may be selected by switching in appropriate switches. The schematic is in Fig. 1.

How it works

Relay RY1 applies 117 Vac to the outlet receptacle when energized. Switches S3 through S8 are the binary selection switches. EXPOSE switch S1 initiates the timer sequence. FOCUS-TIME switch S2 bypasses RY1 to provide a constant 117 Vac to the outlet socket during focusing, negative selection etc.

An emitter-coupled, monostable circuit, Q1 and Q2, is the timer. Transistor Q1 is normally held off by bias resistors R2 and R3 and the voltage across R5 due to transistor Q2's on current. When S1 is depressed, R1 is connected to the base of Q1, turning Q1 on. Transistor Q2 is then turned off by the discharge of C1 through R6, the bias source for Q2, and switched-timer resistors R10 through R15.

Prior to Q2 turnoff, power-transistor Q3 is held off by the low collector voltage of Q2 and the emitter-biasing network, 8.2V Zener diode D2 and R8. When Q2 turns off, the collector voltage rises, causing Q3 to saturate and relay RY1 to close. The 75,000-ohm biasing resistor for Q2, R6, would normally determine the discharge time of C1. However, R6 is connected to −18V by normally closed contacts 5 and 6 of RY1.

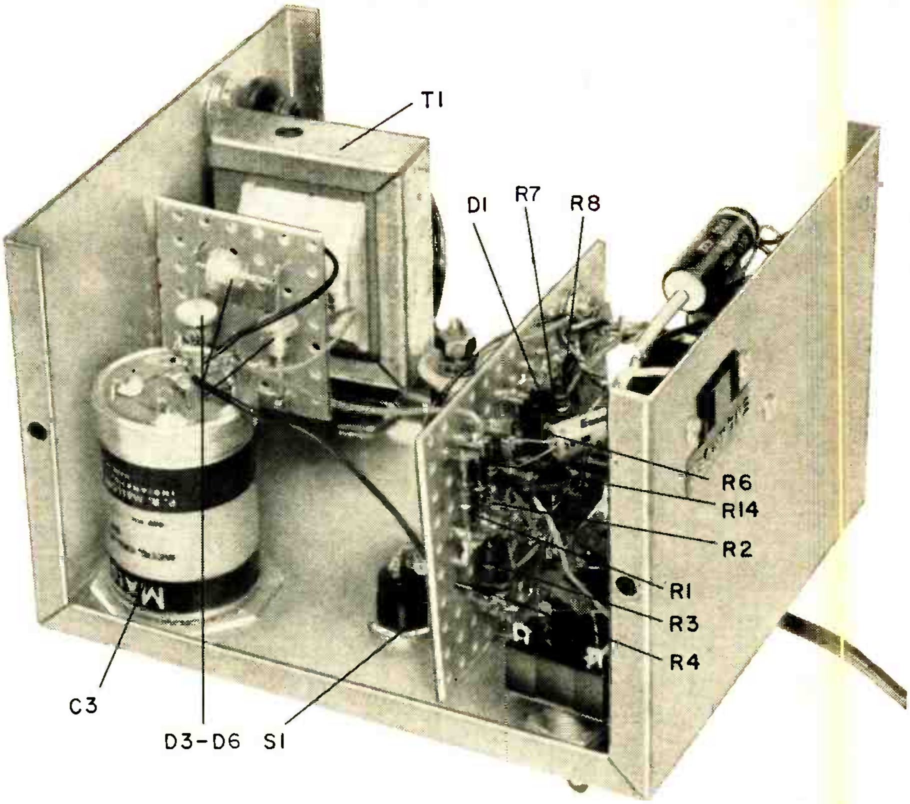
When RY1 energizes, contacts 5 and 6 open, removing R6 from the circuit. Contact 6 now makes with 7, connecting −18V to the timer resistors through D1 and the wiper of calibration potentiometer R9. Thus C1 discharges through the timer resistors only. Potentiometer R9 provides calibration by varying C1's discharge voltage. Diode D1 is reverse-biased when RY1 is de-energized and Q2 is conducting; thus D1 removes the timer resistors from Q2's bias path.

Collector-to-base leakage in Q2 would reduce accuracy on long time settings. A silicon transistor is used to reduce this effect. Switch S2 bypasses RY1 when continuous operation is desired. Capacitor C2 bypasses contacts 9 and 10 of RY1 for arc suppression.

The power supply is a full-wave bridge type and provides −18 Vdc unloaded and −15 Vdc when loaded by transistor Q3.

Construction

Drill and punch the cabinet, a 6″ x 5″ x 4″ utility box. The switches, power transformer, filter capacitor, outlet and relay were mounted as shown in the photographs. The bridge rectifier for the power supply was mounted on a 2″ x 2″ square of perforated board and attached to the cabinet with an aluminium bracket. Screws or pop rivets were used to mount the hardware and board. Ca-



Another view of the timer interior. This time the power supply elements can be clearly seen. Parts arrangement is not critical.

PARTS LIST

Resistors R1–R8 ½ watt, 10%
- R1—5600 ohms
- R2—18,000 ohms
- R3—1200 ohms
- R4—12,000 ohms
- R5—330 ohms
- R6—75,000 ohms
- R7—1800 ohms
- R8—3300 ohms

Resistors R10–R15 ½ watt, 1%
- R9—1000-ohm linear potentiometer (Mallory subminiature Minitrol 13L.)
- R10—11,000 ohms
- R11—22,100 ohms
- R12—44,200 ohms
- R13—88,700 ohms
- R14—178,000 ohms
- R15—357,000 ohms

Capacitors
- C1—50 μF, 25 Vdc, low leakage (Sprague TE 1209 or CD NLW50-25)
- C2—0.033 μF, 600 Vdc
- C3—500 μF, 25 WVdc

Semiconductors
- D1—1N91 diode
- D2—8.2 V, 10-watt Zener diode (a 3.5-watt IRC 1N1592 may be used)
- D3, D4, D5, D6—100 V piv diodes (IRC 10C1 or similar)
- Q1—2N526 transistor
- Q2—2N4037 transistor
- Q3—2N627 transistor

Other parts
- S1—Pushbutton switch, momentary on (Grayhill 4001)
- S2, 9—Spst toggle switch (Cutler Hammer 8280K16)
- S3–S8—Spdt toggle switch (Cutler Hammer 8282K14)
- T1—12.6 V, 1-amp filament transformer (Radio Shack 27-1505 or similar)
- RY1—2PDT, 6 V, 52-ohm coil (dc) (Allied Control TF154-2C)
- MISC—6″ x 3″ vector board and terminals, ac socket (chassis mounting type), 6″ x 5″ x 4″ utility box, line cord, rubber feet and mounting hardware.

Note: RY1 is rated at 5 amps. For enlargers or other devices rated above 500 watts, use a relay with 10-amp contacts. For a relay with a 6 Vdc coil resistance of 25 ohms or less, make the following changes: R5, 270 ohms; R6, 56,000 ohms; R7, 1200 ohms.

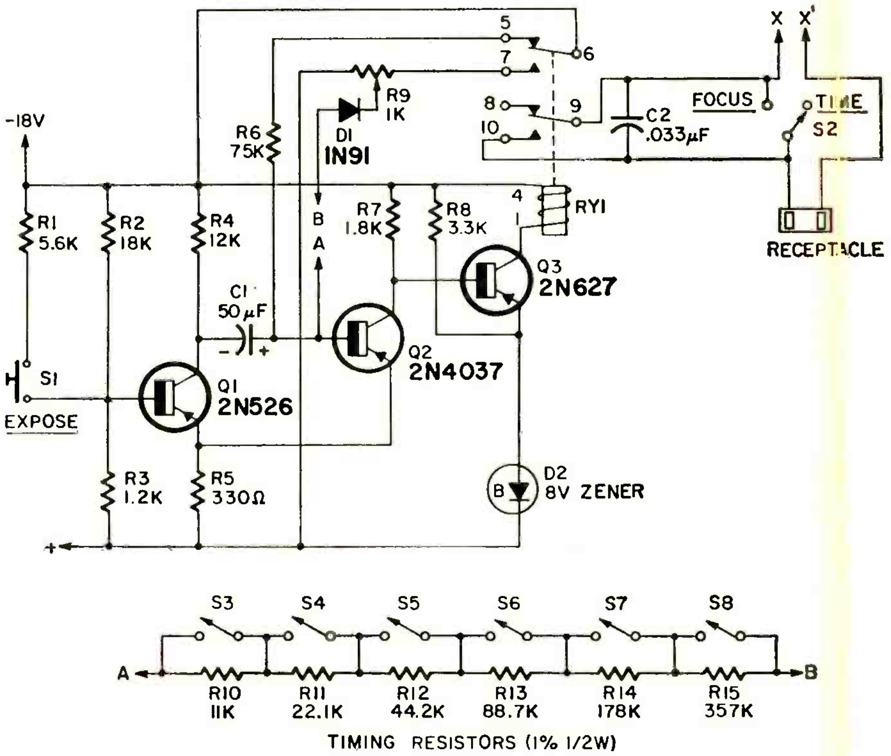
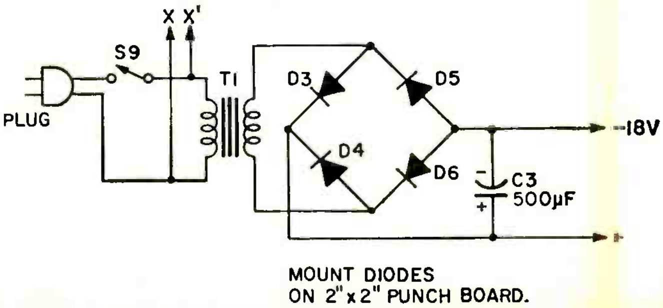
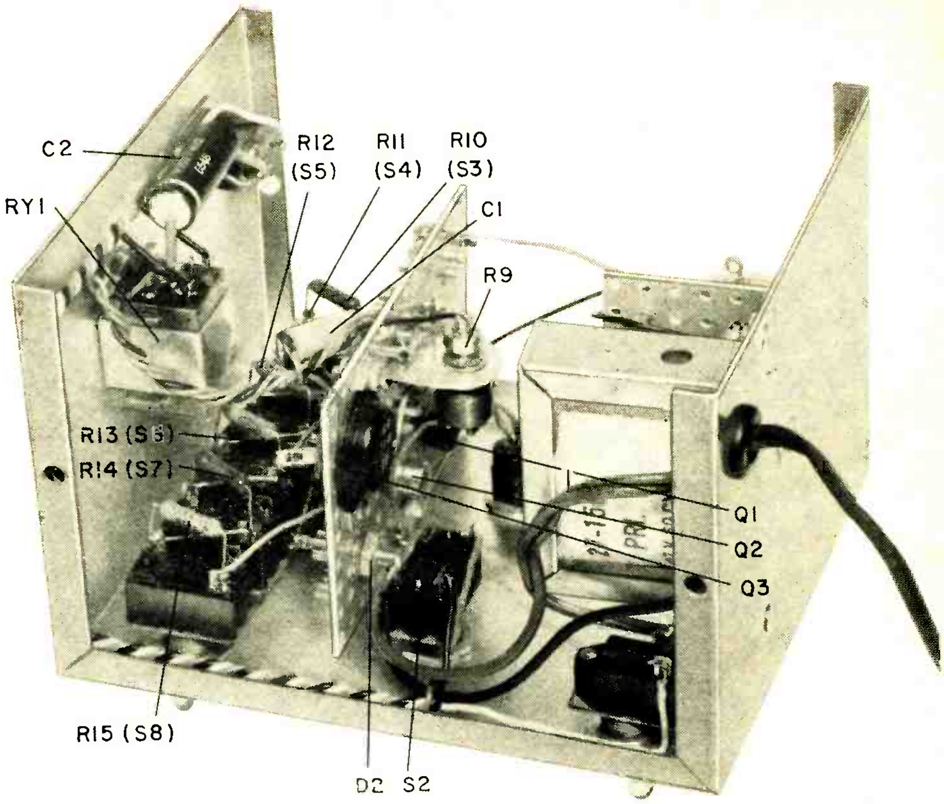


Fig. 1—Complete circuit of the digital enlarger timer. Note that timing accuracy is directly dependent upon the precision of the timing resistors, so check these units carefully before installing them in your unit.



pacitor C3 must be insulated from the cabinet if a metal case is used. The capacitor was connected to a piece of perforated board and the board cemented to the cabinet with epoxy cement. A drop of epoxy cement was applied to the switch mounting nuts to insure they would not loosen during use. Precision timer resistors are then mounted to the binary switches.

A wiring harness for ac distribution may be made by twisting three colored wires together and running them along the cabinet. Fig. 2 shows a suggested component layout for the main circuit board. As the board is mounted vertically, calibration pot R9 should be attached to the board with an angle bracket for accessibility. Transistor Q3 may be mounted directly to the board as long as the coil resistance of RY1 is greater than 25 ohms.



Inside view of the timer. From this angle you can see the timing resistors connected across the individual selector switches.

Calibration and use

Before connecting the power supply to the circuit board, carefully check all connections. Turn the power on, and make sure the output voltage supply is about −18 Vdc. The power supply may then be wired to the circuit board.

Set R9 to mid-range, the 2- and 8-second switches in, the FOCUS-TIME switch to TIME. When the unit is turned on, RY1 should energize and de-energize immediately. Allow about 10 seconds for C1 to charge, then press the expose switch. The relay should energize for 6 to 15 seconds. R9 is now set for an on time of 10 seconds. (Note: allow at least 10 seconds for C1 to recharge before cycling the unit during calibration and use.)

Reset the switches for an on time of 32 seconds and cycle the unit. The relay should now energize for 28 to 32 seconds, depending upon initial calibration. Potentiometer R9 is now carefully adjusted for a duration of 32±0.5 seconds. The timer's accuracy is dependent upon how accurately this adjustment is made.

A time check should now be made for all ranges. If the 1-second setting is short and all others within 2% to 5%, C1 is probably low in value and should be replaced. Loss of accuracy on the time settings 45 seconds and longer is normally caused by leakage in C1 or Q2; C1 should be suspected first. The unit is capable of 2% accuracy from 1 to 63 seconds.

To use the unit, plug the enlarger into the output receptacle of the timer and turn on the enlarger switch. The enlarger sequence is now controlled by the timer. To focus, select negatives or make exposure readings, set the FOCUS-TIME switch to FOCUS. After determining the correct exposure time, set the desired time value with the binary switches and set the FOCUS-TIME switch to TIME. Exposure is then initiated by pressing the EXPOSE switch. A little practice will enable you to vary the time setting in total darkness, reading the binary settings by touch only. **R-E**

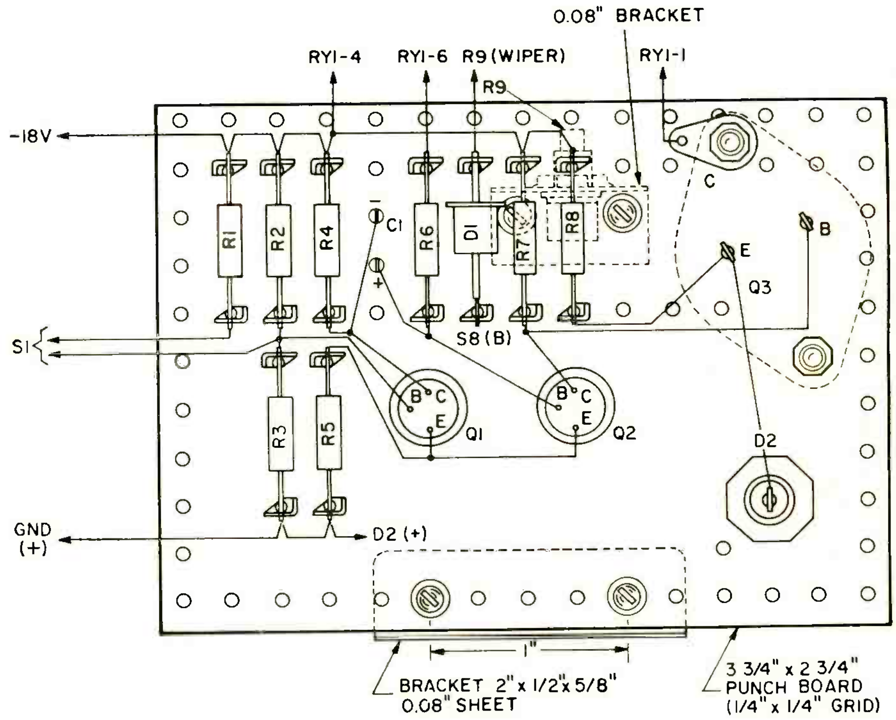


Fig. 2—Suggested parts layout for components that do not mount directly on the case of the unit. It will ease construction if followed closely.

EQUIPMENT REPORT

Heathkit AJ-15 FM Stereo Tuner

For manufacturer's literature, circle No. 43 on Reader Service Card.

HEATHKIT'S ENGINEERING OPERATION on its AR-15 receiver has resulted in separate tuner and amplifier kits "for the man who" already owns a quality amplifier or tuner.

After assembling the AJ-15 tuner half of the operation, and enjoying it for a month, I can say the operation was a complete success. In a few respects the AJ-15 is superior to the tuner portion of the AR-15—despite identical performance specifications.

This is because Heath has put the extra panel space created by removing the amplifier to good use, placing formerly concealed adjustments on the front panel. Squelch can be easily set to cut interstation hiss, or turned off completely for DXing weak FM signals. A pull-to-adjust control permits adjustment of the 19 kHz pilot signal. The control is adjusted for an audio null on each stereo station if maximum stereo separation is desired. Also, of course, the tuner runs cooler without sharing its case with a hefty power amplifier.

The function switch selects FM in either MONO, AUTO or STEREO. The automatic mode receives both monophonic and stereo broadcasts, and in the stereo mode the tuner will only operate with stereo signals.

For initial listening tests, the tuner was plugged into an auxiliary input of Heathkit's AR-13A stereo receiver. This enabled A-B comparison tests with a receiver whose tuned-transformer FM i.f. section is typical of most tuners, as well as a familiar "FM sound."

The AJ-15 demonstrated its wide frequency response, selectivity and sensitivity in monophonic operation even before the multiplex board was adjusted for stereo reception. A few seconds after the "on" switch was pushed, I stumbled on a station playing a badly warped record. Through the AJ-15, the low-frequency 33⅓ rpm "thump" was quite distinct and quickly became annoying. On the AR-13A, however, the thumping was just perceptible, and only became a distraction when the bass control was advanced.

Another quality of the new tuner that is quickly noticed is a *total* absence of noise during most program reception—especially FM stereo. This faint hiss, which is most obvious when wearing headphones, is heard on almost all stations through the AR-13A, and is present in other quality tuners and receivers.

Stations in the New York City area were logged and rated on both tuners to compare sensitivity and selectivity. Pickup was via a MATV system equipped with an FM antenna. The AR-13A received 28 stations; 21 were considered acceptable for listening. Of the 10 stereo stations received, 6 were listenable, although all but one had a background hiss. The AJ-15 logged 35 stations, 28 were judged acceptable for comfortable listening, but *all* 10 stereo stations received were crystal clear, with one station requiring the front-panel NOISE switch to suppress apparent SCA interference. (The NOISE switch is effective only on stereo broadcasts, and produces only a faint perceptible cut in high frequencies.)

Spurious rejection is another plus for the AJ-15. The tuner's ability to reject spurious signals exceeds 100 dB, which is very useful in high signal strength areas where strong stations may appear at several points on the dial. (See circuit description in "What's New In FM Tuners," RADIO-ELECTRONICS, October 1968, page 50.)

The filter-transistor-IC combination in the i.f. strip gives the AJ-15 beautiful bandpass characteristics, and eliminates the need for initial or periodic alignment of the i.f. circuits. A scope shows the bandpass curve of the i.f. section to have very steep skirts and a flat top, unlike the bell-shaped curve of the traditional double-tuned i.f. strip. The steep i.f. curve gives the tuner its razor sharp selectivity, enabling it to tune a relatively weak station located only 200 kHz on the dial from a strong station.

The squelch circuit uses a filtered portion (100 kHz) of any noise managing to sneak through the i.f. circuits to the multiplex circuit board. This noise signal is amplified and used in conjunction with the front-panel SQUELCH control and the stereo threshold circuits. Listeners can determine what noise level is acceptable on stereo broadcasts by placing the front panel STEREO THRESH switch in its minimum position and adjusting an associated potentiometer until the tuner switches from stereo to monophonic operation.

Stereo signals with noise levels exceeding this setting automatically switch the tuner to the monophonic mode. The MAX position of this switch bypasses the threshold setting.

Assembly and alignment of the AJ-15 were surprisingly easy. I spent about 23 hours putting it into operation. Two printed circuit boards and a single precut cable simplify construction.

Both the TUNE and SIGNAL meters are used to align the FM and multiplex sections of the tuner. I found no need to perform any FM section adjustments. But zero-beating the tuner's 38-kHz oscillator to a FM station's stereo subcarrier proved extremely critical. Headphones help here.

In a word, the tuner can only be described as spectacular. Heath's innovative use of crystal filters and IC's in the i.f. section provide a great improvement in FM tuning.—*John R. Free*

MANUFACTURER'S SPECIFICATIONS

FM MONOPHONIC: Tuning range: 88–108 MHz. I.f.: 10.7 MHz. Frequency response: ±1 dB, 20 Hz to 15 kHz. Volume sensitivity: below measureable level. Selectivity: 70 dB (IHF). Image rejection: 90 dB. I.f. rejection: 90 dB minimum (IHF). Capture ratio: 1.5 dB (IHF). AM suppression: 50 dB (IHF). Harmonic and intermodulation distortion: 0.5% or less (IHF). Hum and noise: 65 dB (IHF). Sensitivity: 1.8 μV (IHF). Spurious rejection: 100 dB (IHF). **FM STEREO:** Channel separation: 40 dB or greater. Harmonic distortion: less than 1% at 1000 Hz with 100% modulation. 19 and 38 kHz suppression: 55 dB or greater. SCA suppression: 50 dB. Output voltage: tape and fixed, 1.5V rms nominal (100% modulation), less than 0.5% harmonic distortion. Phone and variable, 0–4V before clipping (100% modulation). Less than 0.5% harmonic distortion. Output impedance: tape and fixed approximately 9000 ohms, phone and variable, 100 ohms. $189.95, less cabinet.

EQUIPMENT REPORT

Sencore CR-143 CRT tester.

For manufacturer's literature, circle No. 44 on Reader Service Card.

A GOOD CRT TESTER IS GOING TO BE A vital part of our arsenal from now on. It should have been with b-w, and with the added complexity of color tubes, it's essential. Sencore's CR-143 Champion CRT tester provides for testing most anything you want on any picture tube.

For b-w tube testing it will read total emission, grid cutoff voltage, shorts or leakage. For the low-G2 types, a variable screen-voltage supply is provided. A heater voltage selector switch goes from 1 to 12 volts in 1-volt steps. A LINE ADJUST control allows setting to the correct voltages.

Many old CRT testers applied raw ac to everything but the cathode of a CRT, then read the rectified current, for emission tests. The CR-143 uses well-filtered dc on all elements (except the heater, of course).

The control-grid voltage is variable. It is set to a reference line on the meter, which is "cutoff". Then, the EMISSION-TEST button takes off the bias, and the total emission is read at zero bias. Since the G2 (screen) voltage in color tubes also affects the cutoff, this is also variable for each gun or for b-w tubes.

The FUNCTION switch provides the ac line on-off switch, a LINE-ADJUST position, SHORTS TEST, EMISSION TEST, and a REMOVE-SHORT position, besides the three REJUVENATE positions. In REMOVE SHORTS, a voltage can be applied between cathode and control grid to blow out possible particle shorts.

The CR-143 uses a novel rejuvenate circuit. Instead of applying the flashing voltage continuously, it's applied by discharging a big capacitor through a switch

COMING NEXT MONTH

Attention all audio buffs. Here come 5 articles prepared especially for you.

- **Crossovers**—Which kind is best? Electrical or Mechanical? Norman Crowhurst gives us a quick rundown on the pros and cons as seen from both sides.
- **Crossovers**—Do we need them at all? Bose Corporation engineer tells why the fabulous new Bose speaker system doesn't use any at all.
- **Speaker Enclosures**—Complete plans for building 16 different kinds. You're bound to find a cabinet that fits your needs somewhere in this group.
- **Portable IC Stereo**—A complete battery powered stereo phono. And the IC amplifiers are located *in* the pickup arm. A really fun project.
- **Get Better Sound From Inexpensive Speakers**—It's relatively easy when you know how. See how you can easily add wizzers, boost cone compliance, etc. for better sound.

AND THERE'S MORE . . . . .

Use The Wired Board Technique—How to reap the benefits of a printed circuit board without making a printed circuit.

Ten Emitter-Coupled Circuits—Emitter-coupled circuits make great amplifiers. Make some yourself. Experiment with these.

Alphanumeric Nixie Fun—Games, fun, and education in a simple gadget that teaches how the alphanumeric Nixie works and acts as a great toy for the kids.

AND THERE'S SERVICING . . . . .

In-Circuit Testing Techniques—How to handle transistors without taking them out of the equipment being serviced.

Troubleshooting Special Solid-State Circuits—Matt Mandl tells how to handle the offbeat transistor circuits in solid-state TV.

In The Shop—Jack Darr hits a heartbreaker, How Effective are Rejuvenators for Color CRTs.

Service Clinic—Your servicing problems, tackled by our expert, to make your day go a bit smoother.

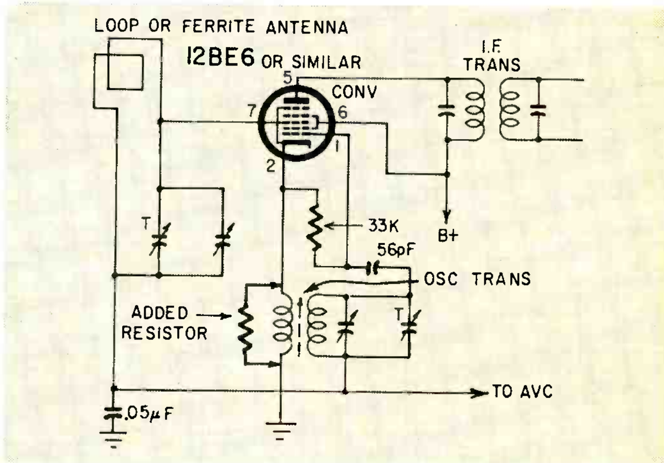
Remember—Don't Miss the March Radio-Electronics

TECHNOTES

BIRDIES IN AC-DC AM SETS

A frequent complaint against 5-tube ac-dc radios is whistles or "birdies" at certain points on the dial. This is often caused by image interference due to the lack of adequate selectivity ahead of the converter stage. There is also another cause of these objectional noises. The local oscillator is delivering too strong a signal. This signal produces harmonics which beat with the fundamental to produce the birdies.

This can be determined by shorting the antenna section of the set's tuning capacitor and then turning it through its



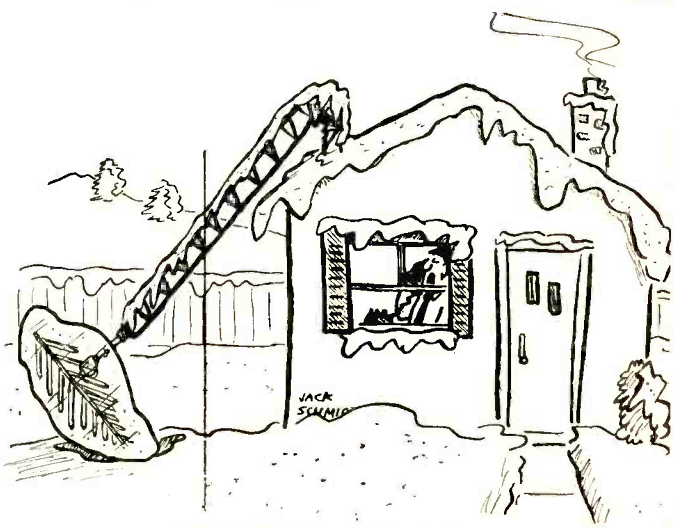
range. If the oscillator signal is too strong, birdies appear at multiples of the i.f. If this is the case, the remedy is simple.

The diagram shows a typical converter stage. All that is necessary to lower the oscillator output is to shunt a resistor across the secondary of the oscillator transformer. Use the highest value of resistance that causes the birdies to disappear. In one particularly troublesome receiver, a value as low as 220 ohms was required. Touch up the oscillator adjustments after installing the resistor.—*Irwin Math*

ZENITH 29JC20 CHASSIS

Complaint: Severe multiple ghosts in b-w and color broadcasts.

Remedy: If symptoms are present on all active channels, check the termination potentiometer at the ground end of the delay line. You can expect these symptoms if the pot opens up although an open delay line will cause the same trouble.—*Jim Wilhelm* R-E



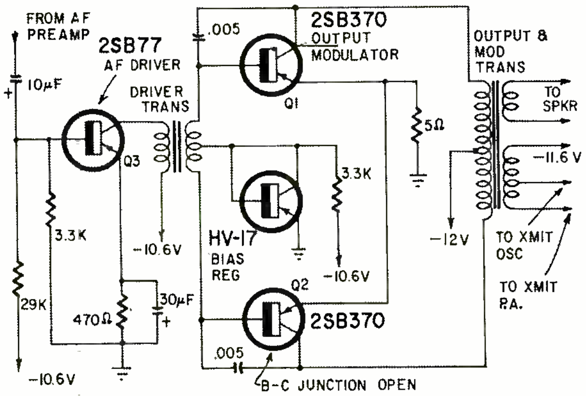
I Think My Rotor Is Frozen . . .

CB Troubleshooter's Casebook

Compiled by Andrew J. Mueller*

Case 1: Distorted and low modulation. Receive function distorts at medium volume.

Common to: Lincoln L-2542

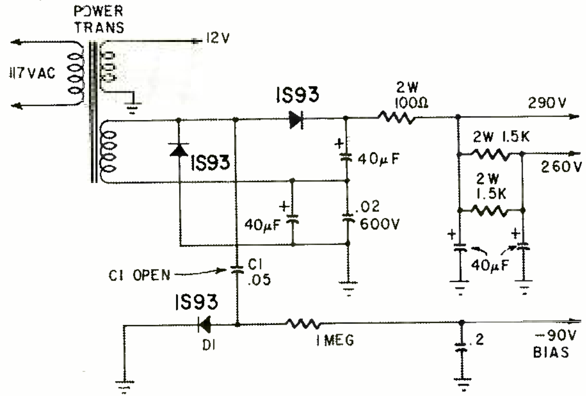


Remedy: Replace transistor Q2.

Reasoning: When Q2 opens, only half of the push-pull output stage operates. This causes distortion at moderate volume levels. Under transmit conditions, the distortion is worse because extra power is needed to fully modulate the power amplifier. If possible, replace both Q1 and Q2 to insure proper balance of the modulator stage. This will keep distortion to a minimum.

Case 2: No squelch. Transmit and receive functions are ok.

Common to: Lafayette Comsat 19



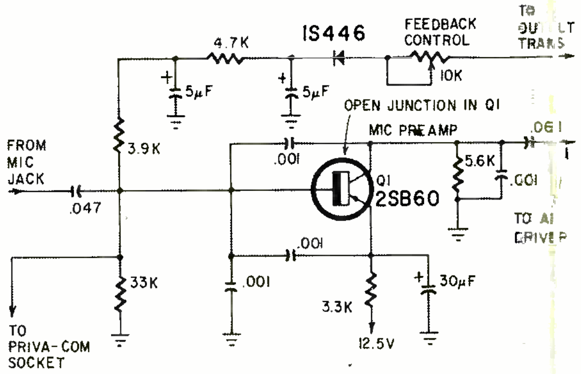
Remedy: Replace capacitor C1.

Reasoning: When C1 opens, it presents an extremely high resistance to ac. Since C1 is in series with D1, the bias rectifier, only a very small dc voltage is developed across D1. Therefore, not enough bias is developed. This bias is used to cut off the squelch tube when the squelch control is advanced.

*Service Manager, Tel-Air Communications, Inc., Pewaukee, Wis.

Case 3: Intermittent modulation. Receive function is ok.

Common to: Lafayette HB-525A.



Remedy: Replace transistor Q1.

Reasoning: In this case Q1 has an intermittent base-collector junction. This causes improper operation of the microphone preamplifier stage. Transistor Q1 was suspected after the mike cartridge, cord and mike plug were thoroughly checked. Voltage measurements verified the trouble when the unit failed. R-E

COMING IN MARCH

Ins and outs of hi-fi crossovers for speaker systems. Two experts present their cases for electronic crossovers, mechanical crossovers and no crossover at all.

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   For literature on products **advertised** in this issue, circle the number on the card that corresponds to the number appearing at the bottom of the advertisement in which you are interested. Use the convenient index below to locate quickly a particular advertisement.
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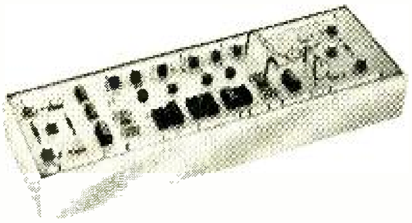
NEW PRODUCTS

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.

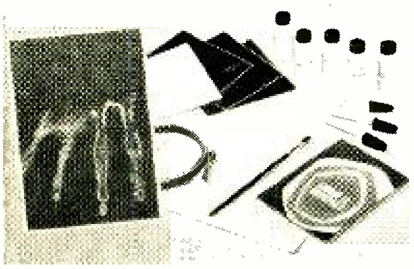
IC KIT, *29X*, provides easy interconnecting of nearly all configurations of IC's for experimenters. Included are *T42-1* push-in *Micro Klip*, *K24C* pins, 14- and 16-pin D.I.P. sockets with wire-wrap tabs. Cir-



cular lead TO-5 type IC's are mounted on the rectangular grid with adapter wafers or sockets. Flat-packs with 0.05" spaced leads are adapted with wafers which plug into the main breadboard. $50 to $60, depending on quantities.—**Vector Electronic Co. Inc.**

Circle 46 on reader service card

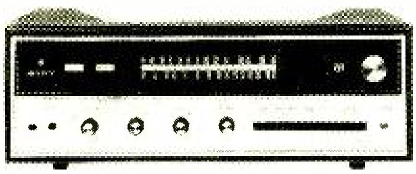
LIQUID CRYSTALS KIT includes 15-ml bottles of 3 liquid crystal solutions appearing like liquids with molecular structures similar to solid crystals. Also 15 ml



of undercoat paint, 3 droppers, four 5" x 5" plastic sheets, 4" hoop, artist brush, mixing bottle, mixing guide, booklet and sets of experiments and instructions. $19.50.—**Edmund Scientific Co.**

Circle 47 on reader service card

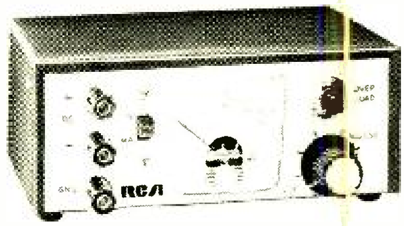
FM STEREO TUNER, *Model 312D*, solid-state, with 3 FET's in front end and integrated-circuit i.f. strip. Features



include a Comparatron circuit for silent automatic stereo switching; interstation muting control; front-panel output for direct tape recording without using a separate amplifier; ultra-wide-band FM detector circuit for minimal distortion. Sensitivity, 1.7 μV; capture ratio, 1.9 dB; cross-modulation rejection, 90 dB; selectivity, 46 dB; stereo separation, 40 dB. $319.95.—**H. H. Scott Inc.**

Circle 48 on reader service card

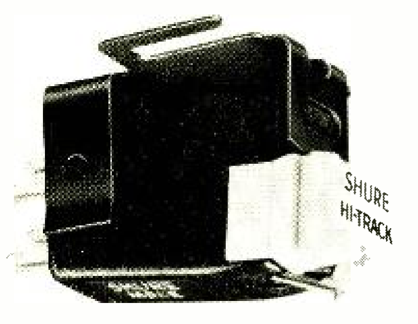
DC POWER SUPPLIES. Bench-type solid-state regulated output, *WP-700A* ($48), single unit, and *WP-702A* ($87),



dual unit, are intended for circuit design, servicing, industrial and educational applications. Adjustable from 0–20 V at current levels to 200 mA. Circuit automatically limits overload current to prevent damage to power supply. Silicon transistors and diodes are used throughout. Three 5-way output terminals; +dc, –dc and GND as well as a 3-wire ac power cord are provided.—**RCA Electronic Components**

Circle 49 on reader service card

STEREO MAGNETIC CARTRIDGES, three models, *M91E* (illus.) for auto turntables and *M92E* for manual/auto turntables track at ¾–1½ grams and are equipped with a 0.0002" x 0.0007" bi-



radial elliptical diamond stylus. *M93E* tracks in the 1½–3-gram range with a 0.0004" x 0.0007" stylus. All units under $50 feature an easy-mount design with a retaining clip which snaps into the pickup arm head.—**Shure Brothers Inc.**

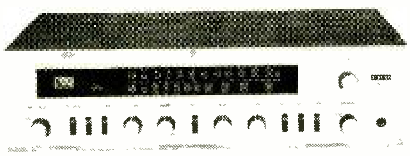
Circle 50 on reader service card

LOCK-A-PLUG prevents theft or unauthorized use of any piece of electrical equipment. Locks onto the prongs of an electric plug to prevent inserting it

into an outlet. Lock releases when built-in combination dials are set to their correct positions and release button is depressed. $2.50.—**Efston Mfg. Co. Ltd.**

Circle 51 on reader service card

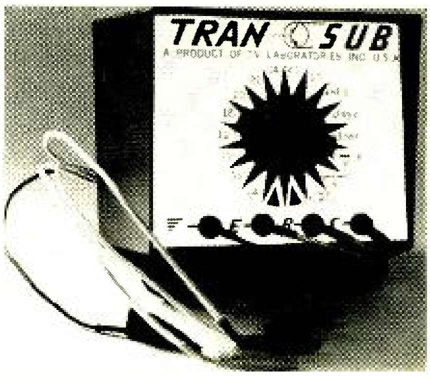
CORTINA STEREO LINE includes three solid-state units. *Sound N'Color, Model 3440* synchronizes sound with



color. Connects to any 3.2- to 5-ohm audio line. Features adjustable color crossover frequencies, silicon solid-state lamp drivers and 9 low-voltage high-intensity colored lamps. Transformer-operated and fused for perfect safety. Two stereo receivers: *Model 3770*, AM/FM, and *Model 3570*, FM, have 70-watt output with pre-assembled and pre-aligned front ends, multiplex and i.f. circuits. All available in both kit ($49.95–$189.95) and factory-assembled form ($79.95-$279.95).—**Eico Electronic Instrument Co. Inc.**

Circle 52 on reader service card

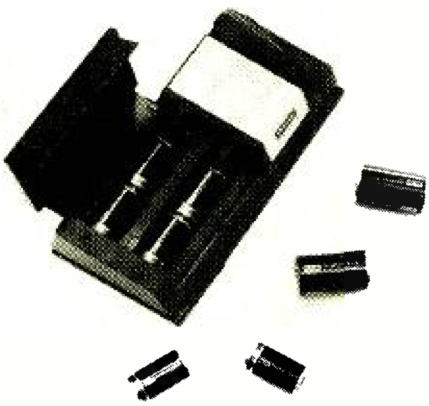
TRAN-SUB provides a transistor, diode or 3.58-MHz crystal of each basic type for substitution in a circuit where the semiconductor is in doubt, or for experimenting with new circuits. RCA replacement book can be referred to for selecting type of transistor as the num-



bers on the front panel are the last two digits of the RCA SK series replacement transistors. Emitter, base and collector clip leads are specially shielded Teflon to minimize test-lead effect on circuits.—**TV Laboratories Inc.**

Circle 53 on reader service card

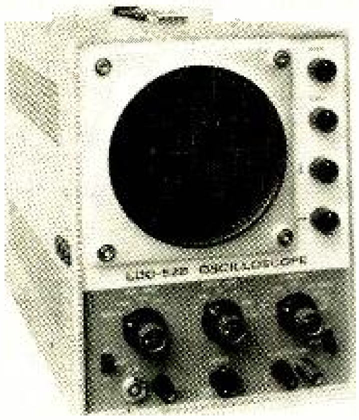
BATTERY CHARGER, *Model BC-15,* designed for use with Duracell rechargeable alkaline batteries, sizes D, C and AA (penlight). Batteries can be re-



charged 100 times. Unit operates on 110 Vac and can charge either 2 or 4 batteries in any pair combination, simultaneously.—**P. R. Mallory & Co. Inc.**

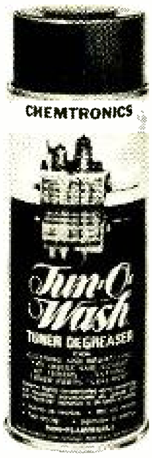
Circle 54 on reader service card

OSCILLOSCOPE, *Model LBO-52B,* with 5" screen unit has a bandwidth from dc to 10 MHz and features hybrid circuitry and 10 mv/cm sensitivity. Linear wide-sweep range has auto synchronization.



Vertical and horizontal inputs are direct-coupled to push-pull amplifiers. Unit provides vector pattern display for color TV circuits. $199.—**Leader Instruments Corp.**

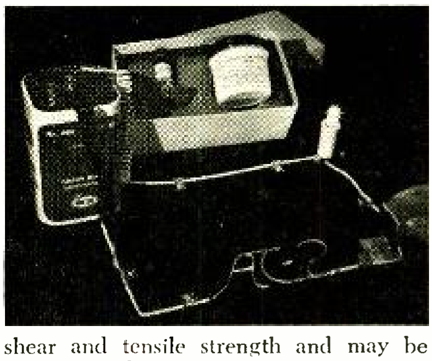
Circle 55 on reader service card



TUNER CLEANER, *Tun-O-Wash* "washes" all types of TV tuners. Removes dirt and normal corrosion accumulations. Harmless to plastics, fast drying, leaves no residue. Comes with a spray nozzle attachment.—**Chemtronics Inc.**

Circle 56 on reader service card

CONDUCTIVE EPOXY SOLDER *AC-2* is a modified resin system, 80% silver-filled. Cures in 3½ hours. Has excellent thermal and electrical conductivity, high



shear and tensile strength and may be electroplated. Use as a coating and a conductive in semiconductor, printed circuit and microminiature applications. —**Kenics Corp.**

Circle 57 on reader service card

DIODE/TRANSISTOR CHECKER, *Model DT-100,* is low-current device for testing transistors or diodes. Diodes are checked by touching leads to the binding posts on the checker. Transistors are

Circle 108 on reader service card

checked by clipping one test lead to the base and the other lead to the emitter and then to the collector. Lit indicator lamp indicates good condition. $14.95.—**Texscan, Technical Products Div.**

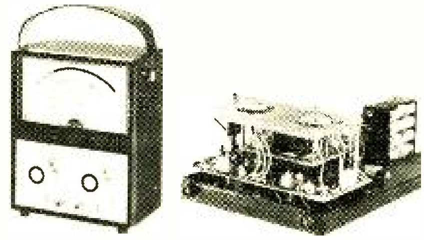
Circle 58 on reader service card

2-WAY SPEAKER SYSTEM, *Model CS-5,* 25 watts, has a smooth transient response and covers a frequency range of 35 to 20,000 Hz. Woofer uses special

cloth surround for greater compliance. Long-throw voice coil for improved bass. Cone type tweeter. Housed in walnut cabinet with removable grille. $59.—**Pioneer Electronics U.S.A. Corp.**

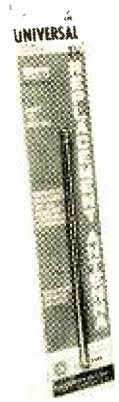
Circle 59 on reader service card

FET-VOM, *Model 3000,* bridges the gap between a multimeter and a digital voltmeter. Accurate within 2% for dc volts and dc amperes; 3% for ac volts. 5% accuracy for resistance scales from 10%–90% of scale. Input impedance; 10 meg-



ohms. 6½" x 8" x 3½"; weighs 3¼ lb. Unit features a mirror scale D'Arsonval meter, enclosed switches, protective voltage clippers and input stage with current regulator. 10-turn pots for accurate zero set and ohms adjust calibration. $74.95 assembled, $59.95 kit.—**Delta Products Inc.**

Circle 60 on reader service card



REPLACEMENT TV ANTENNA ELEMENTS come in two types: 4- and 5-section units. Both extend to 38" and provide a size and style to match the majority of indoor TV antennas in use. Supplied with a retainer screw and complete mounting instructions. —**Audiotex-Home Electronics**

Circle 61 on reader service card

MILLIOHM ATTACHMENT, *Model 870–3,* features near complete negation of normal in-circuit lead resistance and measures resistances under 1 ohm. Voltmeter is switched to 0.1-Vdc range and zero-adjusted in normal manner before

adapter cable is connected to input. With test leads unshorted, "test" button is depressed and unit simultaneously adjusted for full-scale deflection. To read 0–1-ohm resistance value, observe deflection and divide by 10.—***Amphenol Distributor Div.***

Circle 62 on reader service card

STEREO HEADPHONE, *Model F-880,* a deluxe version of *Model F-770,* fea-

tures 2 ½" hi-fi dynamic speakers surrounded by foam rubber. Air-cushioned ear pads. Frequency response: 25–15,-

000 Hz. Impedance: 8 ohms. Signal power: 500 mw. Comes with 5' cord and standard ¼" phone plug. Unit weighs 1½ lb. $17.95.—**Lafayette Radio Electronics Corp.**

Circle 63 on reader service card

TAPE HEAD CLEANER *No. 10-620* removes dirt, film and oxide buildup from audio and video magnetic-tape heads, guides and film gates. Nontoxic, non-conductive, nonflammable. Chemical will not interfere with transmission and may be applied on running tape. A 16-oz aerosol can with a 6" spray extension, $2.35.—**GC Electronics**

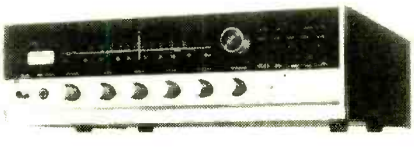
Circle 64 on reader service card

DYNAMIC MICROPHONE, *Model 38-175,* unidirectional, eliminates wind noise and controls feedback. Dual impedance, 600K and 50K ohms, 100 to 12,000 Hz.

Brushed aluminum finish; on–off switch. With 20' of cable, standard phone plug and swivel mike-stand connector. $13.95. —**AMD Electronics**

Circle 65 on reader service card

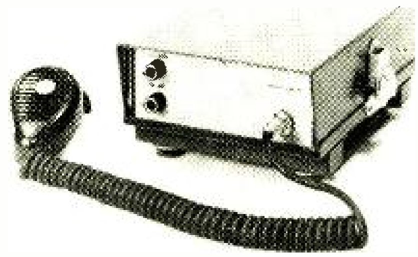
AM/FM STEREO RECEIVER, *Model 800,* 70 watts, includes FET, 3-gang variable-capacitor front end, 4 i.f. stages and 3 limiters. Frequency response, 15–50,000 Hz; power bandwidth, 20–40,000



Hz. 2 sets of output speaker terminals and a 4-way front-panel speaker selector switch. Ac outlet for powering other components. $259.95.—**Sansui Electronics Corp.**

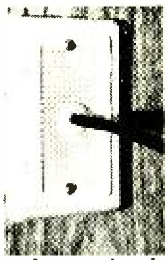
Circle 66 on reader service card

TWO-WAY RADIO, *IMP II,* solid-state, for base or mobile-station use. Also acts as a mobile public-address system. Operates on channels between 27.5–42.98 MHz. Requires 117 Vac at fixed locations; power consumption is 4 watts receiving and 15 watts transmitting. Battery drain from a 12-V vehicular electrical system is less than ½ A receiving and 1 A



transmitting. Sensitivity: better than 1 mV for 10 dB: signal-to-noise and audio power output: 3 watts nominal; modulation: to 100%.—**Kaar Electronics Corp.**

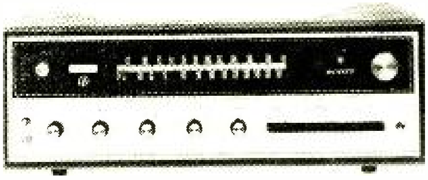
Circle 67 on reader service card



FEED-THROUGH WALL PLATES adapt to any installation not requiring a connection at the wall. Useful for multi-unit MATV–CATV systems, provide a single hole versatile enough to accept TV coax, telephone line, audio speaker line, rotor lead-in or wires up to ½" OD. *Model M-1* comes with mounting screws and *Model M1PK*, with *F9* mounting brackets.—**Mosley Electronics Inc.**

Circle 68 on reader service card

120-WATT STEREO RECEIVERS, two models: *348B*, FM, $499.95; *388B*, AM/FM, $539.95. Both have FET front ends with 3 FETS and an integrated-circuit



i.f. Sensitivity, 1.7 V; cross-modulation rejection, 90 dB; capture ratio, 1.9 dB; frequency response, 15–30 kHz, selectivity, 46 dB; tuner stereo separation, 40 dB.—**H. H. Scott Inc.**

Circle 69 on reader service card

CASSETTE SYSTEMS, 3 models. *Micro 90* playback deck plays both sides of up to 6 cassettes automatically in sequence. Deck connects to any amplifier, $129. Similar is *Micro 95* which includes two speakers powered by a 20-watt amplifier, $269. *Micro 88*, portable, provides music through 2 slide-on speakers, $199. Included with the last two units are 2 omnidirectional mikes and a record level VU meter for monitoring mike and line inputs.—**Ampex Corp.**

Circle 70 on reader service card

11-PIECE DRILL KIT, *Model 820K11*, consists of drill *Model 820*, 6 drill bits from 1/16" to ⅜", fitted carrying case with handle, 3-wire 6' cord and adapter, ⅜" geared chuck with key. Drill, in die-case aluminum, measures 9" x 7¼" x 2½" with chuck, comes with a 3.2 A 115-Vac high-torque 1100 RPM motor.

Needle bearings at heavy load points; ball-thrust spindle bearing and gear train. Kit also includes a machine-gun-grip auxiliary handle which has a locking trigger with safety release, positioned directly forward of the motor housing. $37.45.—**Wen Products Inc.**

Circle 71 on reader service card

METAL FINDER, *Model ML-11*, uses a standard 9-volt transistor radio battery in a 2" x 4" plastic case. Simple to use: just turn the knob until the meter reads upscale. When metal is located, meter

drops. Useful for professional and amateur electric equipment installers for finding studs and joists, plumbing, electrical boxes, heat ducts, nails and conduit. $32.50.—**G S Electronics Co.** R-E

Circle 72 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 Service Card facing page 78 and circle the numbers of the items you want. Then detach and mail the card. No postage required!

INTEGRATED CIRCUIT APPLICATION NOTE for Audio Driver Amplifier *Model MIC 0201*, for entertainment products and industrial communications equipment is featured with diagrams and equations in a 8-page booklet, *Form #15-4*. Circuits, 1-6 watts, are for stereo tape players and mobile communication equipment. —**P. R. Mallory & Co. Inc.**

Circle 79 on reader service card

IC CROSS-REFERENCE GUIDE, 20 pages, pocket size booklet. Provides easy comparison of the company's entire spectrum of circuit configurations with that of five other major manufacturers of the same line of devices.—**Sylvania Electric Products Inc.**

Circle 80 on reader service card

IC POCKET DICTIONARY, 18 pages, contains a glossary of more than 100 IC and IC-related terms. Dictionary also includes appendix of standardizations of input, output and switching definitions.—**Sylvania Electric Products Inc.**

Circle 81 on reader service card

COAX ACCESSORIES for 75-ohm BC 6/U uhf/vhf color/black-and-white TV are introduced with photos in 4-page *Catalog #T-401*. Designed to maintain high-Q and minimum attenuation, with high isolation and low insertion loss, devices are simple to install. Description includes six antenna coax models, 2 transformers, 2 splitters plus Roof/Thru/Wall-Thru Model M-60.—**Mosley Electronics Inc.**

Circle 82 on reader service card

TUBE ANALYZER, *Model 3444-A*, is described in a 2-page data sheet which provides specs, and lists 23 closely regulated ac filament voltages, complete ranges, available accessories, price, adapter. Suggests primary areas of application in solving tube analysis problems.—**The Triplett Electrical Instrument Co.**

Circle 83 on reader service card

HI-FI PRODUCTS constituting the new Jensen speaker systems are illustrated in 20-page *Catalog #165-P*. Line includes Sigma, Delta and Triaxial Series of coaxial and triaxial speakers plus complete series of component speakers, accessories and the HS-2 Stereo headphones.—**Jensen Mfg. Div.**

Circle 84 on reader service card

PHONO CARTRIDGES, *Easy-Mount* and others, plus tone arms, styli and headphone amplifiers are highlighted in an 8-page catalog. Also provided are specs and performance information along with charts and definitions of trackability. Application data and prices are listed.—**Shure Bros. Inc.**

Circle 85 on reader service card

28 REMOTE CONTROL CIRCUITS on 2-page *Idea Sheet*. Outlines in nontechnical language ideas on how to build typical remote circuits to control appliances, machine tools, TV commercial killers, burglar alarms and other apparatus requiring safe, remote operation.—**Alco Electronic Products Inc.**

Circle 86 on reader service card

STEREOPHONIC MUSIC SYSTEM consisting of a AM/FM receiver and two wide response, full range speakers with a special adapter circuit to provide commercial-free background music is detailed in a 4-page brochure entitled "Tired of Listening to Music Between Commercials?".—**SGA Services Co.**

Circle 87 on reader service card

1969 PINLITES CATALOG, 12 pages, fully describes the company's major product line in the *Midgi Series* as well as important new technical data, graphs and diagrams showing light life/voltage relationships, life expectancy data (up to 100,000 hours), response times, compatible connectors and mounting designs.—**Pinlites Inc.**

Circle 88 on reader service card

COLOR-LYTIC LISTING, 6 pages, provides data of every Color-Lytic electrolytic capacitor, including single, dual, triple and quadruple section electrolytics manufactured by the company. This concept uses the broad capacitance tolerances approved by industry standards. This makes it possible to replace over 2500 different exact replacements from about 250 electrolytics.—**Cornell-Dubilier Electronics**

Circle 89 on reader service card

PRINTED CIRCUIT CONNECTORS are described in a 24-page *catalog PC-5*, which features complete data on 4 PC connector families: (1) bifurcated bellows contacts, (2) tuning fork contacts, (3) preloaded cantilever contacts and (4) modular plate assemblies. Included are photos, line drawings, electrical characteristics and mechanical specs on over 100,000 different PC connector combinations.—**The Bunker-Ramo Corp.**

Circle 90 on reader service card

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

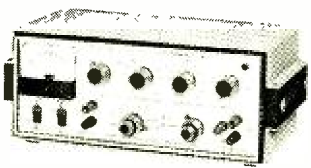
SOLID-STATE LAMP MANUAL, 64 pages with illustrations, for industrial users and educators. Contains two main sections: a discussion of optoelectronics and the most significant applications of solid-state lamps (SSL). Also sections on history of electroluminescence, SSL theory, characteristics and specs.—**$2 each** from: **General Electric Co.,** Dept. CRD #381, Nela Park, Cleveland, Ohio 44112. **R-E**

Circle 112 on reader service card

Circle 113 on reader service card

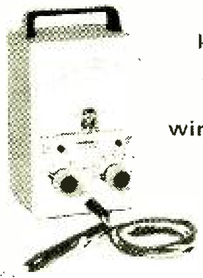
"Performance-Plus" Kits For Shop And

NEW
kit IG-18
$67.50
wired IGW-18
$99.50



HEATHKIT IG-18 Solid-State Sine-Square Wave Generator

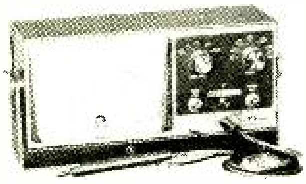
A precision source of sine or square waves at a low kit price . . . that's the new solid-state IG-18 from Heath. Delivers 5% accuracy thru the wide range of 1 Hz to 100 kHz. The sine wave section features less than 0.1% distortion thru the audio range, 8 output voltage ranges from 0.003 to 10V, switch-selected internal 600 ohm load or external load and metered output of both voltage & dB. The square wave section has a 50 nS rise time and three output voltage ranges from 0.1 to 10 V P-P. Both sine & square waves are available simultaneously and the frequency is switch-selected for constant repeatability and fast operation. Circuit board construction makes the new IG-18 easy to build . . . new Heathkit styling and engineering excellence make it easy to use. Put the new IG-18 on your bench now. 10 lbs.



kit IM-18
$28.50
wired IMW-18
$47.95

HEATHKIT IM-18 VTVM

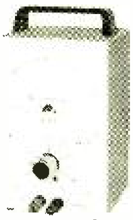
The new Heathkit IM-18 continues the features that made the IM-11 famous . . . 7 AC and 7 DC voltage ranges that measure from 0-1500 volts full scale . . . 7 ohms ranges for measurements from 0.1 ohm to 1000 megohms . . . the convenience of a single probe . . . 11 megohm input impedance . . . ± 1 dB 25 Hz to 1 MHz response . . . precision 1% resistors . . . DC polarity reversing position on the function switch . . . RMS & P-P AC voltage and dB measurement capability . . . precision 4½", 200 uA meter for extra sensitivity. In addition, the new IM-18 has 120 V. or 240 V. AC wiring options, new Heathkit styling and a 3-wire line cord for safety. 5 lbs.



kit IM-13
$36.50
wired IMW-28
$56.95

HEATHKIT IM-13 "Service Bench" VTVM

The Heathkit IM-13 has the same performance specifications as the new IM-18 above, but it also incorporates other features that put it in a class by itself, such as a large, easy-to-read 6" meter . . . extra 1.5 and 5 volt AC ranges for additional accuracy . . . convenient gimbal mounting that allows attachment to your most convenient surface . . . "Set and Forget" calibration — all controls are adjustable from the front panel with a screwdriver . . . smooth ten-turn vernier control of Zero and Ohms adjust for greater accuracy and easier setting . . . clean, open parts layout and a readily accessible "ohms" battery. Assembly is easy, thanks to the famous Heathkit manual, and operating convenience and versatility are tops. For maximum value in a general service VTVM, you just can't beat the Heathkit IM-13. 7 lbs.

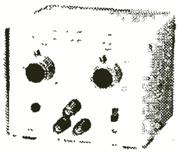


kit IM-38
$39.50
wired IMW-38
$54.95

HEATHKIT IM-38 Laboratory AC VTVM

For all around general service work, audio design or laboratory analysis, there isn't a better value than the new Heathkit IM-38 AC VTVM. Here's why — 10 voltage ranges measure from 0.01 to 300 volts RMS full scale . . . extended frequency response of 10 Hz to 500 kHz at ± 1 dB . . . 10 megohm input on all ranges for higher accuracy . . . . wide —52 to +52 dB range . . . VU-type ballistic meter damping . . . very low AC noise . . . 120 or 240 VAC wiring options and new Heathkit styling in sharp beige & brown with an easy-to-grasp, easy-to-read knob. 5 lbs.

kit IP-18
$19.95



HEATHKIT IP-18 1-15 VDC Power Supply

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

kit IT-18
$24.95

HEATHKIT IT-18 In-Circuit Transistor Tester

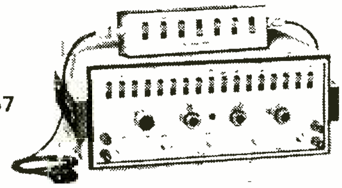
In-Circuit transistor testers don't have to be expensive, and the IT-18 is proof of that . . . . tests DC Beta 2-1000, in or out-of-circuit . . . leakage Icbo and Iceo current 0-5000 uA out-of-circuit . . . identifies NPN or PNP devices . . . tests diodes in or out-of-circuit for opens & shorts . . .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

kit IM-17
$21.95

HEATHKIT IM-17 Solid-State Volt-Ohm Meter

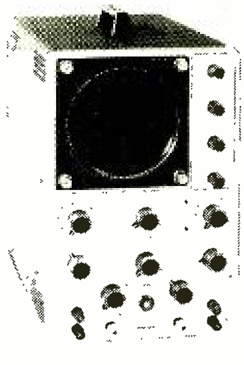
Another very popular volt-ohmmeter from Heathkit engineering and it's easy to see why — all solid-state circuitry . . . high impedance FET input, 11 megohms on DC, 1 megohm on AC . . . 4 AC voltage ranges . . . 4 DC voltage ranges . . . 4 ohm ranges . . . 4½" 200 uA meter . . . 3 built-in test leads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

kit IG-57
$135.00
wired IGW-57
$199.00



HEATHKIT IG-57 Solid-State Post Marker/Sweep Generator

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



kit IO-18
$84.95
wired IOW-18
$139.95

HEATHKIT IO-18 Wide-Band 5" 'Scope

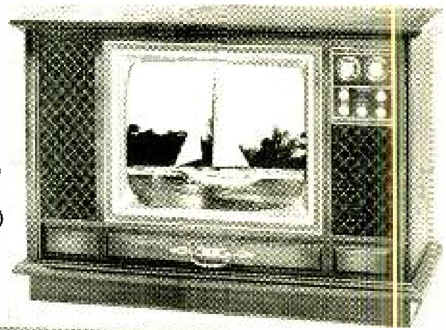
The New Heathkit IO-18 is destined to be the world's most popular 'scope, just as its predecessor, the IO-12 was. Features 5 MHz bandwidth, the famous Heath patented sweep circuit — 10 Hz to 500 kHz in 5 ranges, two extra sweep positions which can be preset to often-used rates, frequency compensated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

Home . . . From The Leader

HEATHKIT

Now There are 4 Heathkit Color TV's . . . All With 2-Year Picture Tube Warranty

NEW Deluxe "681" Color TV With Automatic Fine Tuning



kit GR-681

$499^{95}

(less cabinet)

The new Heathkit GR-681 is the most advanced color TV on the market. A strong claim, but easy to prove. Compare the "681" against every other TV — there isn't one available for any price that has all these features. Automatic Fine Tuning on all 83 channels . . . just push a button and the factory assembled solid-state circuit takes over to automatically tune the best color picture in the industry. Push another front-panel button and the VHF channel selector rotates until you reach the desired station, automatically. Built-in cable-type remote control that allows you to turn the "681" on and off and change VHF channels without moving from your chair. Or add the optional GRA-681-6 Wireless Remote Control described below. A bridge-type low voltage power supply for superior regulation; high & low AC taps are provided to insure that the picture transmitted exactly fits the "681" screen. Automatic degaussing, 2-speed transistor UHF tuner, hi-fi sound output, two VHF antenna inputs . . . plus the built-in self-servicing aids that are standard on all Heathkit color TV's but can't be bought on any other set for any price . . . plus all the features of the famous "295" below. Compare the "681" against the others . . . and be convinced.

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

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

kit GR-295
now only

$449^{95}

(less cabinet)

Big, Bold, Beautiful . . . and packed with features. Top quality American brand color tube with 295 sq. in. viewing area . . . new improved phosphors and low voltage supply with boosted B + for brighter, livelier color . . . automatic degaussing . . . exclusive Heath Magna-Shield . . . Automatic Color Control & Automatic Gain Control for color purity, and flutter-free pictures under all conditions . . . preassembled IF strip with 3 stages instead of the usual two . . . deluxe VHF tuner with "memory" fine tuning . . . three-way installation — wall, custom or any of the beautiful Heath factory assembled cabinets. Add to that the unique Heathkit self-servicing features like the built-in dot generator and full color photos in the comprehensive manual that let you set-up, converge and maintain the best color picture at all times, and can save you up to $200 over the life of your set in service calls. For the best color picture around, order your "295" now.

GRA-295-1, Walnut cabinet shown **$62.95**
Other cabinets from $99.95

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

kit GR-227
now only

$399^{95}

(less cabinet)

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

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

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

kit GR-180
now only

$349^{95}

(less cabinet)

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

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

Now, Wireless Remote Control For Heathkit Color TV's

New Wireless
TV Remote Control
For GR-295, GR-227 & GR-180

$69^{95}

New Wireless
TV Remote Control
For GR-681

$59^{95}

Control your Heathkit Color TV from your easy chair, turn it on and off, change VHF channels, volume, color and tint, all by sonic remote control. No cables cluttering the room . . . the handheld transmitter is all electronic, powered by a small 9 v. battery, housed in a small, smartly styled beige plastic case. The receiver contains an integrated circuit and a meter for adjustment ease. Installation is easy even in older Heathkit color TV's thanks to circuit board wiring harness construction. For greater TV enjoyment, order yours now.

kit GRA-681-6, 7 lbs., for Heathkit GR-681 Color TV's **$59.95**
kit GRA-295-6, 9 lbs., for Heathkit GR-295 & GR-25 TV's **$69.95**
kit GRA-227-6, 9 lbs., for Heathkit GR-227 & GR-180 TV's **$69.95**

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FREE 1969 CATALOG!

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☐ Enclosed is $____________, plus shipping.

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Prices & specifications subject to change without notice. CL-353

Circle 114 on reader service card

Service Clinic

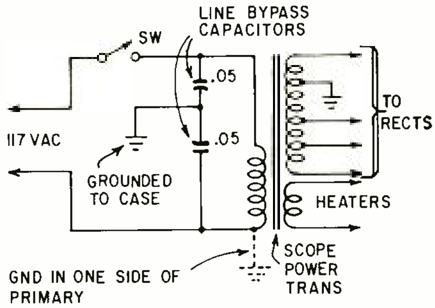
By JACK DARR
SERVICE EDITOR

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

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

Hot Scope Case

The case of my scope is "hot" unless I ground it to an ac outlet. But then I get a terrific spark if I try to hook the ground to a hot-chassis set.—P. L., Roxbury Crossing, Mass.



Chances are you have a shorted or leaky ac-line bypass capacitor on the power-transformer primary. Unsolder one end of each capacitor and recheck for sparks. Most scopes have these capacitors, but if yours doesn't you may have a ground in the primary wiring.

Broken VTVM Function Switch

I've got a Philco 6110 vtvm with a broken function switch. I can't get any information on it from the distributor, and the factory says that parts or a schematic are no longer available. Can I use another type of switch in this instrument?—W. R. E., Skowhegan, Me.

Yes. Centralab, Switchcraft and many others are making switches now that will do anything! Look through the catalogs at your distributor's. You ought to be able to find quite a few that will do the work.

PRECAUTION: *before* you disconnect *any* of the wiring from the old switch, draw a *very* complete diagram! Better yet, draw two diagrams: a schematic, and a pictorial or rough sketch of wire colors and where each goes. If you do this, you'll have a lot more fun when it comes time to put the pieces back. The best thing, of course, is to leave the old switch in there until you get the new one.

Trace out each circuit, and label each deck of the switch. Be sure to show whether a contact is on the front or back of the deck. By checking up on similar switches on other makes of vtvm's, you can get a rough idea of about how they work. Like TV chassis, vtvm's are much the same *functionally*.

Loss of Height, 24-inch Zenith

I have a 24-inch Zenith with not enough height. It uses a 6BX7 tube in the vertical output. Voltages, etc., on the oscillator seem to be normal. Yoke, output transformer, etc., have all been checked. Any ideas?—G.B., Silver Bay, N.Y.

This used to be a common problem, especially in sets with 6BX7 tubes! The 6BX7 is a "special selected" 6BL7, which in turn is a specially selected 6SN7! Pushing a 24-inch tube to fill height is a job; so, you can't stand too much of a drop in tube output.

Try substituting several 6BX7 tubes, and you may find one that will fill the screen: this was our most frequent way of fixing such troubles! Also, measure the peak-to-peak drive signal on the 6BX7 input grid. This is important.

Warmup Misconvergence On CTC7

I notice that the convergence is pretty bad on a CTC7AA chassis until it's been on for about 10 minutes. I have reconverged it, but I tried it the other day with the set cold, and it looks awful. After it's on for a while, the convergence floats back in and then it runs fine. What's causing this?—B. G., Gallup, N. M.

This is probably due to a slow-heating vertical output tube, or to a resistor somewhere in the vertical circuits that isn't up to par. You're actually getting enough distortion of the vertical sweep waveform to change the shape of your dynamic convergence parabolic waveforms. I think, if you'll look closely, you'll see that most of it is vertical misconvergence—red or blue showing on the sides of vertical lines.

Try replacing the vertical output tube, and check out all resistors in and around the vertical oscillator circuit. Most especially, check the big resistors (3.3 meg, 6–8 meg, and so on) in the vertical linearity control circuit. This is a feedback type of linearity control, and if you have a thermal-sensitive resistor in there anywhere, it could cause just this kind of distortion. **R-E**

NEW TUBES AND SEMICONDUCTORS

TWELVE NEW HEP IC'S

Eight new digital and four new linear IC's have been added to Motorola's HEP line of semiconductors for hobbyist, experimenter and service technician. Three of the RTL digital IC's are in 14-pin plastic dual in-line packages. They are the HEP-570 quad 2-input gate, HEP571 dual buffer and HEP572 dual J-K fiip-flop.

The other five digital units are the metal-cased HEP580 dual 2-input gate, HEP581 four-input gate, HEP-582 dual buffer, HEP583 J-K flip-flop and HEP584 dual two-input gate (equivalent to the popular μL914).

The four new linear IC's are the HEP590 high-frequency amplifier for rf and i.f. applications, HEP591 wideband amplifier/discriminator for use as a FM i.f. amplifier and detector, HEP592 dual preamplifier for stereo phonos and recorders and the HEP-593 1-watt audio amplifier. These four units are in 10-pin cans similar to the TO-5.

Additional information is contained in catalog No. HMA27-4 and the booklet *Tips on Using IC's* (HMA-32) available from HEP distributors or from Technical Information Center, Motorola Semiconductor Products, Box 20924, Phoenix, Ariz. 85036.

INDICATOR TUBE FOR LOGIC READOUT

The 6977 subminiature logic indicator tube has been rerated for operation with either npn (positive) or pnp (negative) logic circuits. Its new rating permits grid potentials as high as 12 volts with proper biasing. When the 6977 is on, it produces a brilliant blue-green bar of light visible even in a brightly lighted room. A hard-vacuum tube, its response is virtually instantaneous.

Arrays of 6977's mounted on circuit boards are used to monitor flip-flop circuits in computer registers, input/output devices and other logic circuits. The 0.217" tubes can be mounted in direct contact with each other.

For a new data sheet and applications data showing how to use this tube to indicate logic 1's and 0's at either positive or negative logic levels, write to Amperex Electronic Corp., Semiconductor and Microcircuits Div., Slatersville, R.I. 02876.

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The IC-10 is a monolithic IC power amplifier and preamp measuring only 1" x 0.4" x 0.2" and delivering 10 watts peak (5 watts rms) continuous with less than 1% distortion at full output. Frequency response is flat within ±1 dB from 5 Hz to 100 kHz. The circuit is complete within itself and requires only tone and volume controls and a power supply for operation.

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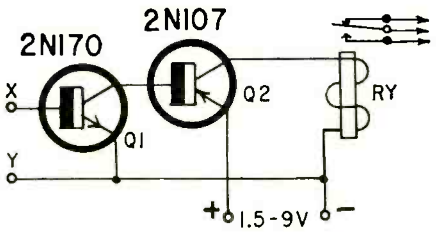
The IC-10 is guaranteed for 5 years and costs 59s. 6d, complete with a comprehensive instruction manual. Available from Sinclair Radionics Ltd., 22 Newmarket Road, Cambridge, England. **R-E**

NOTE-WORTHY CIRCUIT

THE TRANS-RELAY

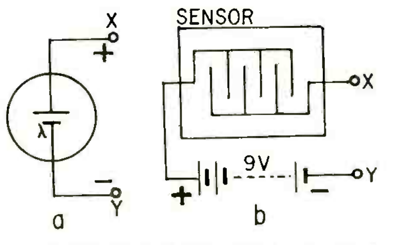
This simple two-transistor device is a photoelectric relay, touch-control switch or rain alarm, just as you want. Cost is nominal, and the device fits in the palm of your hand.

The basic circuit (Fig. 1) is a direct-coupled amplifier driving a dc relay. As long as one is n-p-n and the other p-n-p, any two transistors can be used, though high-gain units will pep up performance. The relay can be any sensitive low-voltage dc type such as one of the Sigma 11F series. I used an inexpensive surplus relay that I got from a mail-order house, a 60-ohm unit that pulled in well on low voltages.



Mount the relay and the two transistor sockets on a piece of bakelite or Vector board, wire it up, plug in the transistors and connect the battery (that turns the unit on!). I use a 9-volt battery; the relay resistance will affect the optimum voltage. I have used from 1.5 to 12 volts.

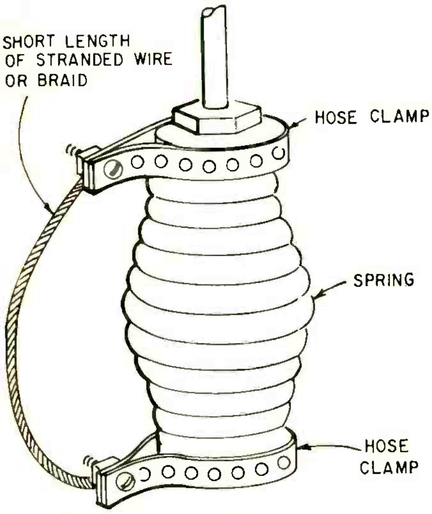
To make a photoelectric relay (Fig. 2-a) just attach the photocell, positive lead to the base of Q1, negative end to the emitter. For the rain alarm, make a moisture sensor as shown in Fig. 2-b. Cut two sheets of aluminum in the shape of combs, cement them to a piece of plastic, and attach a paper clip to each as a contact. Be sure the combs do not touch. Hook it up as shown, with a 9-volt battery. Moisture between the teeth will bridge the gaps and conduct current, operating the relay. Touching the moisture sensor and bridging a gap also actuates the relay. You can vary the design for a touch switch.—*Albert Koehler* **R-E**



TRY THIS ONE

MOBIILE ANTENNA HINT

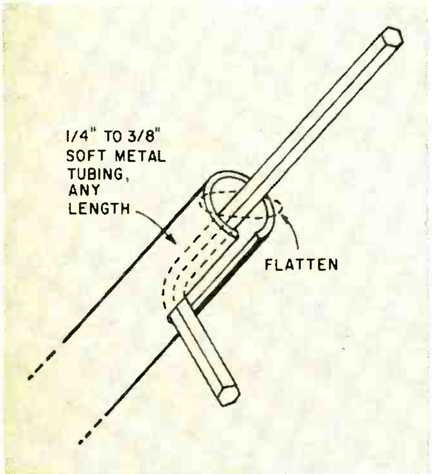
Many CB, ham and other two-way radio mobile whip antennas have a spring base. Inside the spring is a piece of braid or heavy stranded wire that connects its ends and prevents it from acting as an unwanted loading coil.



To insure reliable two-way contacts, add a second shorting braid or wire on the outside of the coil. Use rust-proof hose clamps to fasten the braid to the ends of the base.—*Richard Mollentine—WAØKKC*

EXTENSION FOR SETSCREW WRENCH

Is that setscrew (Allen, Bristol, etc.) way back in the works, hard to



get to? Make an extension by sawing a slot in one edge of a soft metal tube about as large as a pencil. Squeeze the tube so the wrench is locked in the slot.—*Paul F. Brown*

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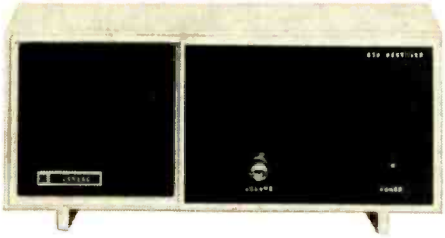

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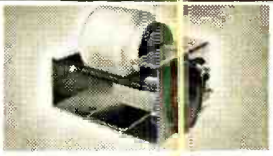

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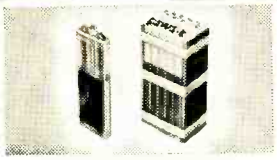

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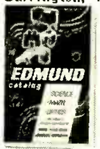

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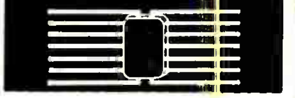

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6SK7	6AC7	6C4	25L6
6SL7	6AF4	6C6	25Z6
6SN7	6AG5	6CB6	35W4
6SQ7	6AK5	6CD6	84/6Z4
6U7	6AL5	6CG7	5687
6U8	6AN8	6CG8	6350
6V6	6AQ5	6CM7	6463
6W4	6AT6	6CZ5	7044
6W6	6AT8		

Tubes are New or Used and So Marked. Lab Tested, Ind. Boxed. Branded & Code Dated

Special! With Every $10 Order **25¢ PER TUBE** Your Choice Of These Sizes
6AG5 6W4 6AU6 6CB6 6J6 6SN7 6S4

Prestige & Success as an

ELECTRONICS EXPERT!

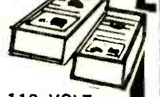
HOME STUDY COURSES

TV SERVICING **$3.50**

RADIO SERVICING **$3.00**

BOTH COURSES $6.00

2 STATION INTERCOM



12⁹⁵

A.C. 110 VOLT TRANSISTORIZED INTERCOM!

ONE YEAR GUARANTEE! DUMONT TUBES!

Brand New Except Glass!

TUBE TYPE	DUD DEP.	TUBE PRICE
19XP4	3.00	21.95
21AMP4	1.00	14.95
21CBP4	1.00	14.95
21CEP4	3.00	18.95
23FP4	5.00	24.95
21FJP22	20.00	79.95
23EGP22	35.00	119.95
25AP22	27.50	99.95
23AHP4	5.00	24.95
24AEP4	1.00	22.95

Please remit full tube price plus dud deposit with order. Dud deposit will be returned immediately upon postpaid return of dud. No C.O.D.'s on picture tubes. All duds returned for refund must be under full vacuum.

FREE! CORNELL'S NEW CATALOG! WRITE FOR YOUR COPY TODAY!

RED & BLACK TUBE CARTONS

High Gloss, Clay Coated, Built in Diag. Partitions

SIZE	TUBE SIZE	10 CARTONS	100 CARTONS
MIN.	6AU6	.29	2.59
GT.	6SN7	.39	3.49
LG.GT	5U4GB	.59	5.29
G.	5U4G	.89	7.99

NO SUBSTITUTIONS WITHOUT YOUR PERMISSION!
YOUR ORDER FREE IF NOT SHIPPED WITHIN 24 HRS.

CORNELL

DEPT. RE 2 4217 UNIVERSITY
SAN DIEGO, CALIFORNIA 92105

Terms: Orders over $5.00: Add 3¢ per tube shipping. Prepay in full and avoid C.O.D. charges. Send $3.00 deposit on C.O.D. orders. **Orders under $5.00:** Add 3¢ per tube plus 50¢ handling. **Canadian and Foreign Orders:** add approx. postage. No C.O.D. orders. **Combine varied orders to bring order over $5.00.**

Circle 134 on reader service card

CLASSIFIED COMMERCIAL RATE (for firms or individuals offering commercial products or services). 70¢ per word . . . minimum 10 words.

NON-COMMERCIAL RATE (for individuals who want to buy or sell personal items) 30¢ per word . . . no minimum.

Payment must accompany all ads except those placed by accredited advertising agencies. 10% discount on 12 consecutive insertions, if paid in advance. Misleading or objectionable ads not accepted. Copy for April issue must reach us before February 14.

WORD COUNT: Include name and address. Name of city (Des Moines), or state (New York) counts as one word each. Zone or Zip Code numbers not counted. (We reserve the right to omit Zip Code if space does not permit.) Count each abbreviation, initial, single figure or group of figures or letters as a word. Symbols or groups such as 8-10, COD, AC, etc., count as one word. Hyphenated words count as two words. Minor over-wordage will be edited to match advance payment.

CLASSIFIED ADVERTISING ORDER FORM

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35

No. of Words { @ .30 Non-Commercial Rates / @ .70 Commercial Rate } =$_____

Total Enclosed $_____

Insert_____time(s)

Starting with_____issue

Payment must accompany order unless placed through accredited advertising agency 28

NAME_____

ADDRESS_____

CITY_____STATE_____ZIP_____

SIGNATURE_____

MAIL TO: RADIO-ELECTRONICS, CLASSIFIED AD DEPT., 200 PARK AVE. SOUTH, NEW YORK, N.Y. 10003

For The Experimenter!

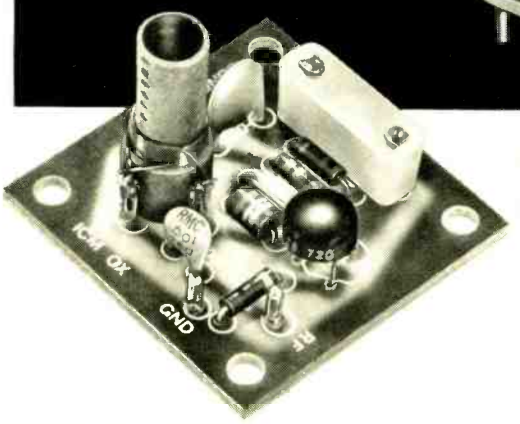
International EX Crystal & EX Kits

OSCILLATOR / RF MIXER / RF AMPLIFIER / POWER AMPLIFIER

Type EX Crystal

Available from 3,000 KHz to 60,000 KHz. Supplied only in HC 6/U holder. Calibration is ±.02% when operated in International OX circuit or its equivalent. (Specify frequency)

$3.95



OX OSCILLATOR

Crystal controlled transistor type.
Lo Kit 3,000 to 19,999 KHz
Hi Kit 20,000 to 60,000 KHz
(Specify when ordering)

$2.95

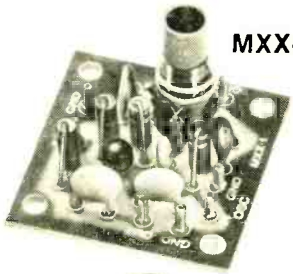
MXX-1 Transistor RF Mixer **$3.50**
A single tuned circuit intended for signal conversion in the 3 to 170 MHz range. Harmonics of the OX oscillator are used for injection in the 60 to 170 MHz range.
Lo Kit 3 to 20 MHz Hi Kit 20 to 170 MHz
(Specify when ordering)

SAX-1 Transistor RF Amplifier **$3.50**
A small signal amplifier to drive MXX-1 mixer. Single tuned input and link output.
Lo Kit 3 to 20 MHz
Hi Kit 20 to 170 MHz
(Specify when ordering)

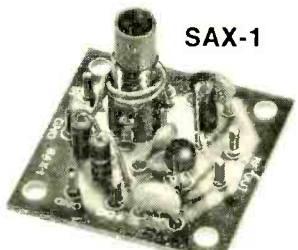
PAX-1 Transistor RF Power Amplifier **$3.75**
A single tuned output amplifier designed to follow the OX oscillator. Outputs up to 200 mw can be obtained depending on the frequency and voltage. Amplifier can be amplitude modulated for low power communication. Frequency range 3,000 to 30,000 KHz.

BAX-1 Broadband Amplifier **$3.75**
General purpose unit which may be used as a tuned or untuned amplifier in RF and audio applications 20 Hz to 150 MHz. Provides 6 to 30 db gain. Ideal for SWL, Experimenter or Amateur.

Write for complete catalog.



MXX-1



SAX-1

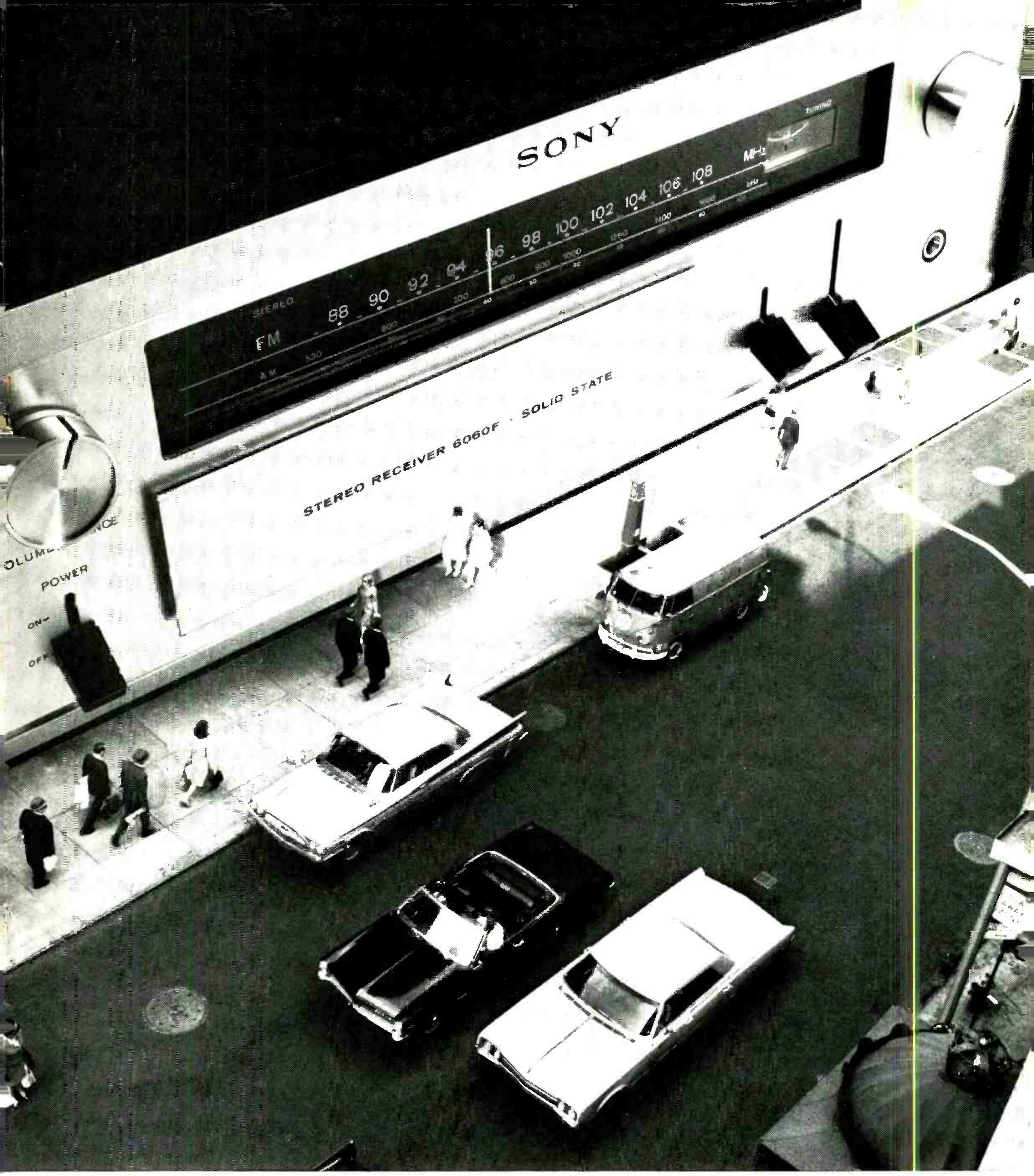
PAX-1

BAX-1

INTERNATIONAL

CRYSTAL MFG. CO., INC.
10 NO. LEE • OKLA. CITY, OKLA. 73102

Circle 148 on reader's service card



The Sony Side of the Street

(it's any place they're showing the new 6060 receiver)

The Sony®6060 receiver is the brightest thing that's happened to stereo hi-fi in a long while. A superb performer on FM stereo; FM and AM broadcasts; records and tapes. It will brighten up the music in your life.

Here's what Sony built: *Amplifier* — 110 watts IHF power into 8 ohms. Distortion less than 0.2% at rated output. *The tuner*— sensitivity 1.8uV. Exclusive solid-state i.f. filters never need alignment, provide razor-sharp selectivity, 80 dB; superb capture ratio, 1.5 dB. Spurious signal rejection, 90 dB. *Abundant control facilities:* automatic stereo reception; zero-center tuning meter; front panel headphone jack; switches for tape monitoring, muting, speaker selection, tape or Aux, input, loudness — the works.

At $399.50 (suggested list) the 6060 outshines receivers costing up to $500. Get a Sony disposition.

Sony Corporation of America, 47-47 Van Dam St. L.I.C. N.Y. 11101

Circle 149 on reader's service card

Because we beat the heat you can play it cool with the 6LQ6/6JE6C...

Yes, you play it cool when you replace a 6JE6A, B or C tube in the demanding horizontal-deflection-amplifier socket of your customer's color TV set. RCA's 6LQ6/6JE6C Novar beam power tube beats the overheating problem common to the other tubes.

As a matter of fact, it can actually withstand 200 W plate dissipation for 40 seconds because of design improvements that include repositioned getters, cavity plate designed for better plate dissipation, and larger diameter screen grid wire which reduces screen grid temperature and improves the high voltage cutoff characteristic.

So play it cool. Replace with the RCA 6LQ6/6JE6C. And watch your customers warm up. More confidence from them . . . fewer call-backs for you.

Innovations and improvements that make your service operation more reliable, efficient and profitable are our constant aim. See your Authorized RCA Tube Distributor for quality RCA receiving tubes.

RCA Electronic Components, Harrison, N.J. 07029

RCA