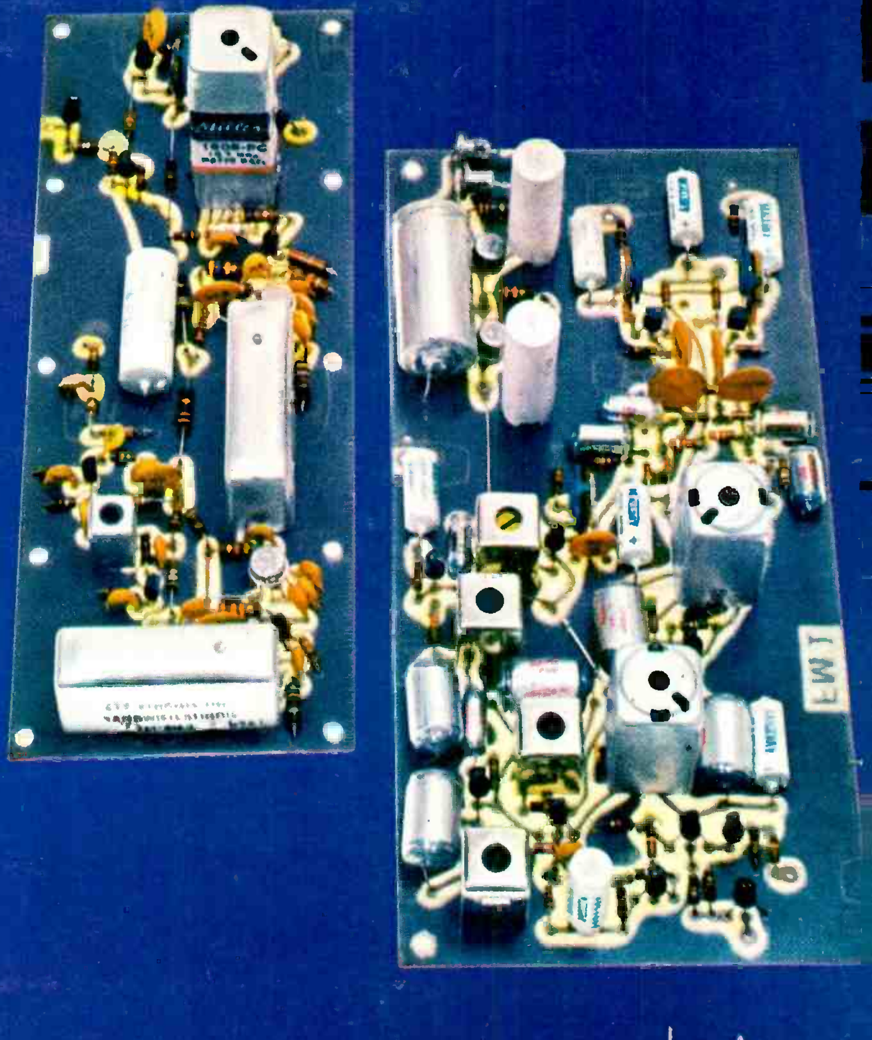
60c ■ MAY 1970

Radio-Electronics

BUILD "The Ultimate"

R-E's NEW STEREO FM TUNER



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Computer logic circuits

10 Emitter-follower circuits

BONUS FEATURES

Kwik-Fix™ transistor agc

Photography 1970

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Electronic flash tester

Pulsed darkroom timer

Horizontal efficiency tester

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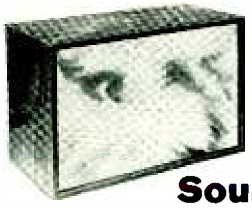
Dazzle your friends with lightworks.



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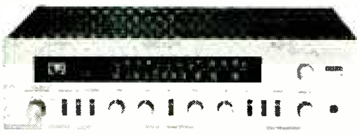
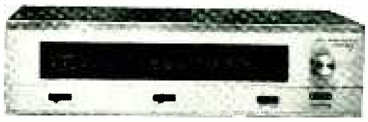


70-Watt AM/FM Stereo Receiver including cabinet. Cortina 3770, $189.95 kit, $279.95 wired.

70-Watt FM Stereo Receiver including cabinet. Cortina 3570, $169.95 kit, $259.95 wired.

150-Watt Silicon Solid-State Stereo Amplifier, including cabinet. For the audio perfectionist. Cortina 3150, $149.95 kit, $225 wired.

70-Watt Silicon Solid-State Stereo Amplifier, including cabinet. Cortina 3070, $99.95 kit, $139.95 wired.



FM Stereo Tuner including cabinet. Cortina 3200, $99.95 kit, $139.95 wired.

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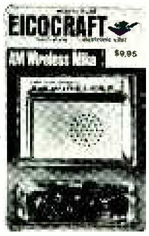

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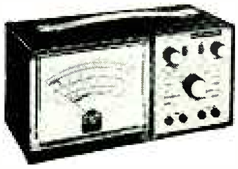

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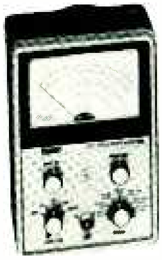

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NEW & TIMELY

Volume 41 Number 5 RADIO-ELECTRONICS May 1970

ON THE ROAD: RADAR BRAKING, ELECTRONIC SHIFT

IC- and radar-controlled shifting and braking units for cars are in the news.

An automatic braking system may appear next year in trucks, buses and cars that uses an Impatt-diode microwave oscillator to beam a 10.525-GHz signal at obstacles on the road. The radar signal can be beamed from a horn antenna concealed near a headlight; another antenna near the other headlight receives reflections. A phase-sensitive detector senses Doppler frequency shift, feeding the signal eventually to accelerator and braking controls. Manufactured by Bentley Associates of Chelmsford, Mass., the units will cost $800.

In Japan, an electronically controlled automatic transmission is being included in Toyota's Corona models. The electronic computer used in the car replaces almost 50% of the hydraulic parts needed in regular automatic transmissions with 12 hybrid and monolithic IC's. The electronic controls enable the shift range in second gear to be varied for conventional or sport-type driving. Cost is about $60 over conventional automatic.

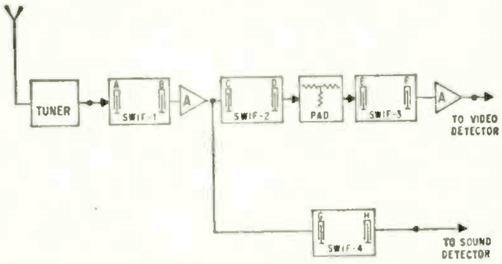
UHF FOR 'GHOSTS'

NEW YORK—When the twin 110-story towers of the World Trade Center rise above lower Manhatten in 1973, TV transmitters located in the Empire State Building will be moved to the trade center. Meanwhile, to prepare for possible ghosts from the partially completed towers, TV stations here are planning to operate secondary uhf transmitters to cover a pie-shaped wedge North of the city.

LOOKING AHEAD

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

ACOUSTIC SURFACE WAVE FILTERS FOR COLOR TV



Three SWIF combs are combined into single unit shown in photo. Center comb, with about 20 fingers, serves as transmitter; two outer combs are series or parallel connected. Diagram above is of SWIF i.f. unit formed on a 2 x 1-inch substrate with IC amplifiers.

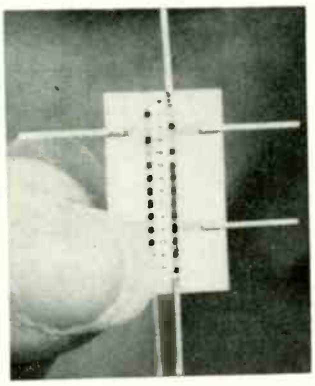
CHICAGO—Transistors for tubes, IC's for discrete transistors, varactor and computer diodes for mechanical tuners . . . what's next on the replacement list in TV receivers? Zenith has their sights on the bulky, drift-prone LC filters needed for the i.f.

The exotic fixed-bandpass replacements are called SWIFs (Surface Wave Integrable Filters) by their developer, and are made with lead zirconate, a piezoelectric ceramic. The rf input to one comb on an interdigital transducer pair (see drawing) exerts stress near the substrate. The transmitter comb propagates acoustic surface waves to the receiver comb, which detects electric fields generated by the waves. Spacing between comb fingers determines bandpass frequency.

To obtain the 40-MHz bandpass response for color TV, Zenith can cascade four SWIFs on a 2 x 1-inch thick-film substrate, along with IC amplifiers to boost losses between SWIFs. One of the devices substituted for a standard i.f. produced a good color picture.

In the experimental SWIF, section 1 provides out-of-band rejection and attenuates the sound carrier; filters 2 and 3 provide a notch at 41.25 MHz, and with section 1, the proper bandpass with a notch at 47.25 MHz. Section 4, with part 1, provides the correct level between sound and picture carriers. The SWIFs are still under development.

COMPOSITE TRANSISTORS



MURRAY HILL, N.J.—By combining a score of tiny transistor chips into a single power transistor, Bell Labs has greatly boosted the amount of information it can handle in comparison with other 17-watt devices.

A new technique used for the experimental transistors eliminates emitter circuit parasitic inductance, which has limited the power output/gain-bandwidth combination from power transistors. The devices have produced linear power gains of 15 dB from dc to 500 MHz with 60-70% efficiencies.

CBS OFFERS STATIONS NEW COLOR CORRECTOR

NEW YORK—If CBS Television network performers have been less colorful in recent months, it's the fault of CBS Labs. R. H. McMann, Jr. of CBS Labs developed a color corrector that keeps color variations between live, film and videotape programs to a minimum. The network has been using a computer-regulated prototype, and a $3000 version was made available to individual stations last month by CBS Labs.

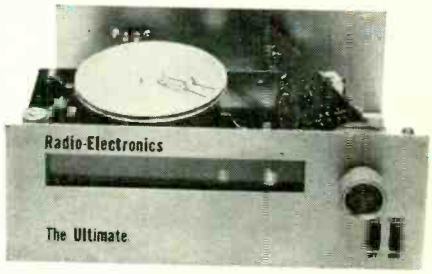
Engineers can now adjust color variations after encoding or at any point during transmission. Color differences can be balanced by adjusting all three primary colors instead of one, which might upset the balance.

The source signal is split into two parts, and a correction vector added to the red, blue and green signals in one decoded signal. After remodulation, the combined signals produce an error voltage which is summed with the original signal to cancel the error. ■

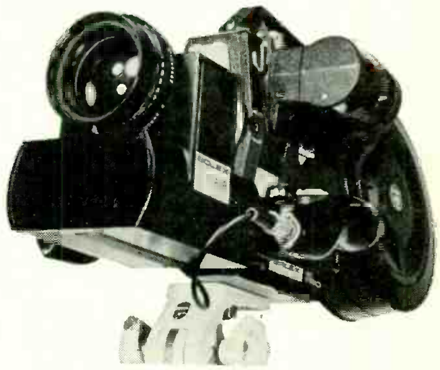
(N & T continued on page 6)

Radio-Electronics

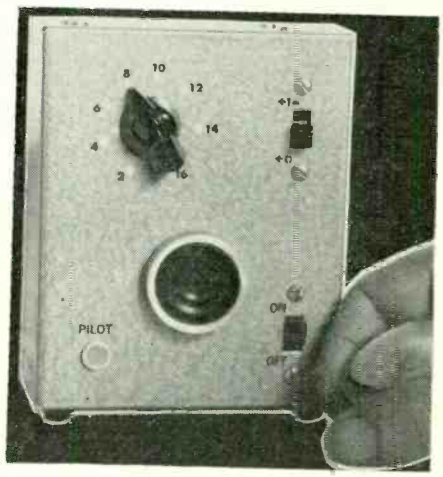
May 1970 • Over 60 Years of Electronics Publishing



Stereo FM tuner you'll be proud to own. Unbeatable performance . . . use the three PC patterns and instructions.
. . . see page 36



Sophisticated electro-optical system added to this movie camera uses modulated light beam to focus it.
. . see page 41



Half-hour interval timer can be used in the darkroom for accurate exposures —or anywhere in the house.
. . . see page 57

RADIO-ELECTRONICS, MAY 1970. Vol. 41, No. 5
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LOOKING AHEAD

Volume 41 Number 5 RADIO-ELECTRONICS May 1970

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

Standardizing VTR's

Standards adopted in Japan for video tape recorders using ½-inch tape may become worldwide standards—mainly because hardly any country outside Japan produces any quantity of ½-inch vtr's, and certainly no other country has given any thought to standardizing.

At the time the standards were adopted in Japan last August, no two makes of machine had compatibility or tape interchangeability. Now Sony, by far the biggest manufacturer of ½-inch vtr's, has announced that all of its new models will be "standard," giving virtual assurance that all future Japanese recorders will meet the same specifications. Earlier, Matsushita (Panasonic) had announced "standard" machines, and versions were understood to have been designed by seven other manufacturers—General, Hitachi, Mitsubishi, Sanyo, Sharp, Toshiba and Japan Victor.

Compact vtr by Panasonic uses standard ½-inch tape, and can record NTSC color. Automatic-control circuit corrects phase and frequency flucuations. It will be available this year.

Highlights of the Japanese specs: (1) Full-field, 2-head, diagonal-scan video recording (FM); single-track fixed-head audio recording. (2) 7.5-ips tape speed. (3) Maximum recording time of more than 60 minutes on 7-inch reels. (4) Video frequency bandwidth of 2.5 MHz. (5) Video signal-to-noise ratio of more than 40 dB. (6) Cylinder diameter of 115.92 mm. (7) Video pitch of 173 microns. (8) Video track angle of 311°. (9) Control track width at 0.8 mm. (10) Audio track at 1 mm.

TV sets and fires

Completing its investigation of fire and smoke incidents in television receivers, the National Commission on Product Safety issued a widely publicized (and widely assailed) report on 13 TV manufacturers and their "problem" models which attempted to "rate" brands and models for fire safety on the basis of information submitted by the manufacturers themselves. There were immediate charges that manufacturers were penalized for their cooperation, and that those set makers with the best record-keeping procedures (particularly those with their own service companies) were charged with the greatest incidence of fires.

On the basis of records said to cover nearly 22 million color sets produced from 1965 through 1969, the Commission found that reported fire and smoke incidents worked out to 120 cases per million sets. It also determined that the large majority of identified part failures connected with these incidents involved transformers (mostly flybacks). Other parts responsible, to a considerably lesser degree, in diminishing order of importance—high-voltage components, yoke, ac switch.

The Commission requested that set makers undertake a nationwide inspection and free parts replacement campaign covering so-called "problem models"—those models involved in two or more reported fire or smoke incidents. Some manufacturers—notably RCA and Olympic—announced immediate programs to locate, inspect and repair, if necessary, all cited models. Others, including Magnavox and Sears Roebuck, said they had already located and repaired most or all sets with potentially defective components.

The Commission's report concentrated on color sets because its study showed that they were 40 times more likely to have fire or smoke problems than black-and-white sets. Arithmetically, this would indicate only three fire or smoke incidents per million monochrome sets (based on the Commission's figures of 120 incidents per million color sets).

'Comparable' vhf-uhf tuning

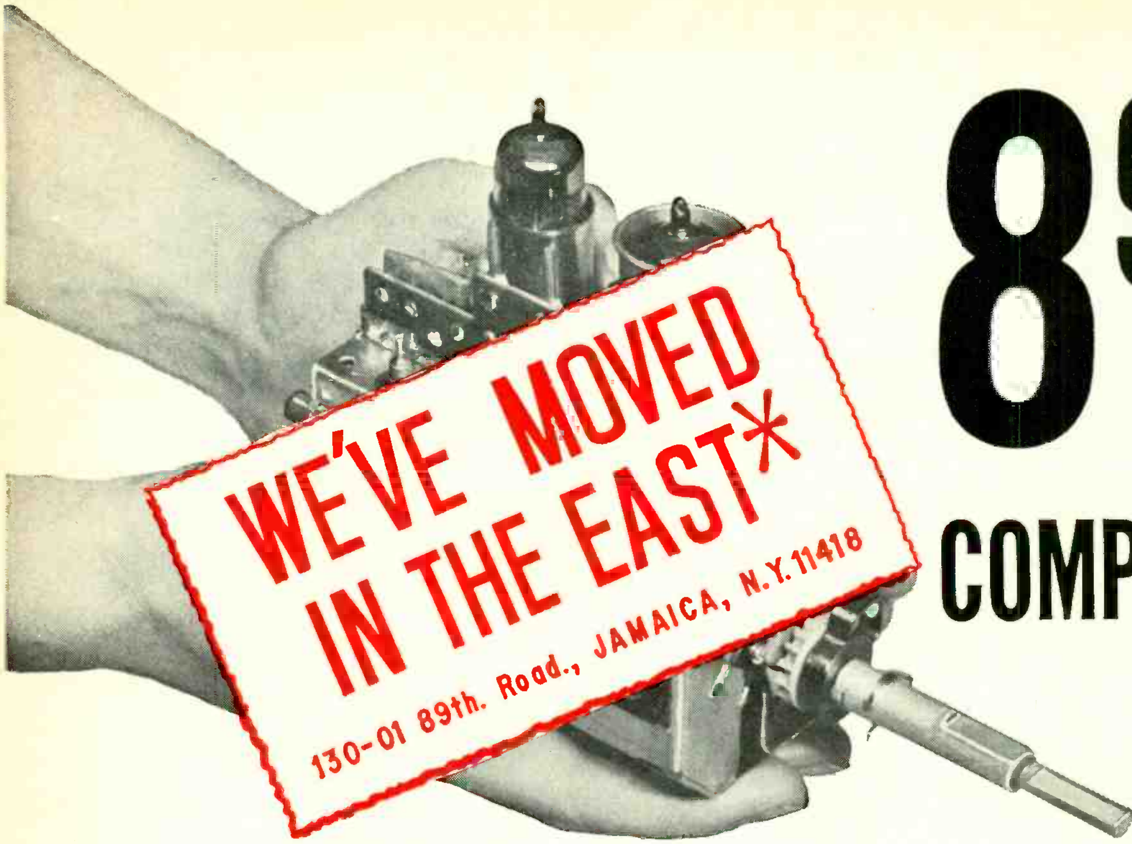
Television set manufacturers were completely unprepared when the FCC issued its ruling requiring that uhf and vhf tuners in any receiver be mechanically and electronically "comparable." In fact, among set manufacturers there was the virtually unanimous view that the Commission had acted without knowledge of the true facts and that if the order were allowed to stand it would seriously hamper television production.

The controversial rule, adopted on the basis of petitions by uhf broadcasters who felt that tuning difficulties was costing them audiences, provides that all TV sets manufactured or imported into the U.S. after April 30, 1971 must have "comparable" tuning systems. An exception is made for sets with screens smaller than nine inches in diagonal measurement; these must be brought into compliance by May 1, 1973. The FCC made clear what it meant by "comparability": If the vhf tuner has detents to make it click into position, the uhf tuner must have them. If vhf tuning is done by pushbutton, uhf tuning must be accomplished the same way. If an electronic tuning system is used, it must be used on both bands.

The FCC did make a few qualifications. It said that uhf tuners need have only six detent positions or pushbuttons, provided that these can easily be set to any uhf channels by the set owner.

Set makers, who normally plan their new models three or more years in advance, said the target dates just couldn't be met. Some tuners may be available, but there was the feeling that the supply would be nowhere near the number needed. More importantly, the new types of uhf tuners won't fit, physically, the majority of cabinets already designed, requiring complete redesign and retooling. And even if target dates could be met, manufacturers were worried about the hefty cost increases involved—some put the retail price hike at $12 to $25 to cover the added costs of new tuners.

Though basically happy with the rule, some uhf broadcasters felt it didn't go far enough. They objected to the FCC's willingness to accept six uhf detents or pushbuttons as "comparable" when, in fact, some areas can receive more than six uhf channels. Some felt that 12 uhf positions would be truly comparable with a 12-position vhf tuner. **R-E**



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Overhaul includes parts, except tubes and transistors.

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UV combination tuner must be single chassis type; dismantle tandem UHF and VHF tuners and send in the defective unit only.

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Exact replacements are available for tuners that our inspection reveals are unfit for overhaul. As low as $12.95 exchange. (Replacements are new or rebuilt.)

● UNIVERSAL REPLACEMENTS

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CR7S	Series 600mA	1¾″	3″	41.25	45.75	9.50
CR9S	Series 450mA	1¾″	3″	41.25	45.75	9.50
CR6XL	Parallel 6.3v	2½″	12″	41.25	45.75	10.45
CR7XL	Series 600mA	2½″	12″	41.25	45.75	11.00
CR9XL	Series 450mA	2½″	12″	41.25	45.75	11.00

*Selector shaft length measured from tuner front apron to extreme tip of shaft.

These Castle replacement tuners are all equipped with memory fine tuning, UHF position with plug input for UHF tuner, rear shaft extension and switch for remote control motor drive . . . they come complete with hardware and component kit to adapt for use in thousands of popular TV receivers.

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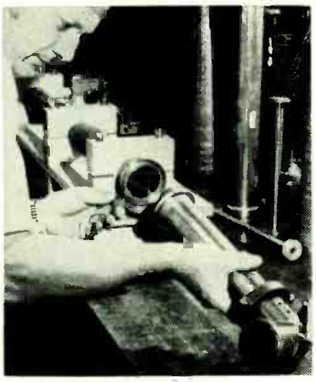
Circle 10 on reader service card

BELL SETS TRIALS FOR WAVEGUIDE TUBES

Test "word" similar to PCM pulses to be beamed at high frequencies through waveguides is displayed on oscilloscope.



A length of copper-lined steel pipe is readied for tests at Bell Labs. When buried, conduit protects pipe.

MURRAY HILL, N.J.—By the late 1970's, your telephone conversation may be beamed at 40–110 GHz through 2-inch circular waveguides throughout the country. 1974 field trials for northern New Jersey are being planned by Bell Labs.

One of the wrist-size copper waveguides is capable of carrying a quarter of a million telephone conversations. Bell will use PCM (pulse code modulation) since it is relatively unaffected by energy-mode variations that would be produced from slight bends in the copper tubes. PCM would cause only one error per billion pulses from one repeater to the next, and conversations and data transmission could be easily mixed with Picture-phone service.

Devices such as Impatt diodes, which generate millimeter waves (between microwaves and infrared in frequency), will be used as transmission sources, according to Bell.

At 20-mile intervals, repeater filters will divide the mm waves into 120 component channels, which will deliver 282 million-pulse-per-sec streams to separate repeaters. After amplification and regeneration, the pulse streams will be recombined by additional filters and beamed the next repeater station along the pipe line.

RCA TO ORGANIZE NEW SERVICE CHAIN

NEW YORK—RCA is establishing a new servicing company, independent from the RCA Service Co., to repair all makes of TV sets and home-entertainment products. The first centers will open in Philadelphia and San Francisco by October.

The subsidiary is being established, according to an RCA executive, because of "an expanding need for service in the entire consumer products industry."

TV REPAIR BILL CALLS FOR BONDING

ALBANY, N.Y.—A bill that would require licensing of television repairmen has been introduced in the state legislature.

New York City, meanwhile, is preparing a similar bill with additional requirements. Repairers would be required to post $2500 bonds to guarantee payment of customer judgments against them. Technician license fees would be $25 annually, and dealers would be required to have at least one licensed technician unless the dealer was licensed.

The city bill would cover some 1100 TV, radio and phonograph repair shops.

International wiring: Engineers from British Aircraft Corp. help prepare a test panel rack, part of a complete system of test equipment, that will check out the Intelsat 4 series of communications satellites. BAC is one of 12 foreign firms participating with Hughes Aircraft Co., builder of the satellites, under a $72 million contract from Comsat Corp. as agent for the 68-nation Intelsat organization. The test center, one of three to be built, is used to test satellites at the California factory, then shipped to Cape Kennedy to again test the satellites.

(N & T continued on page 12)

IN THIS ISSUE

"The Ultimate" stereo FM tuner described on page 36 has crystal filters and IC's in its i.f. section for a clean, steep-skirted bandpass. The rf front end uses forward-agc transistors for excellent performance on weak signals.

Radio-Electronics

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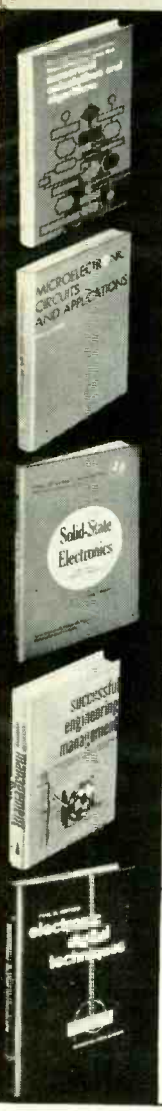

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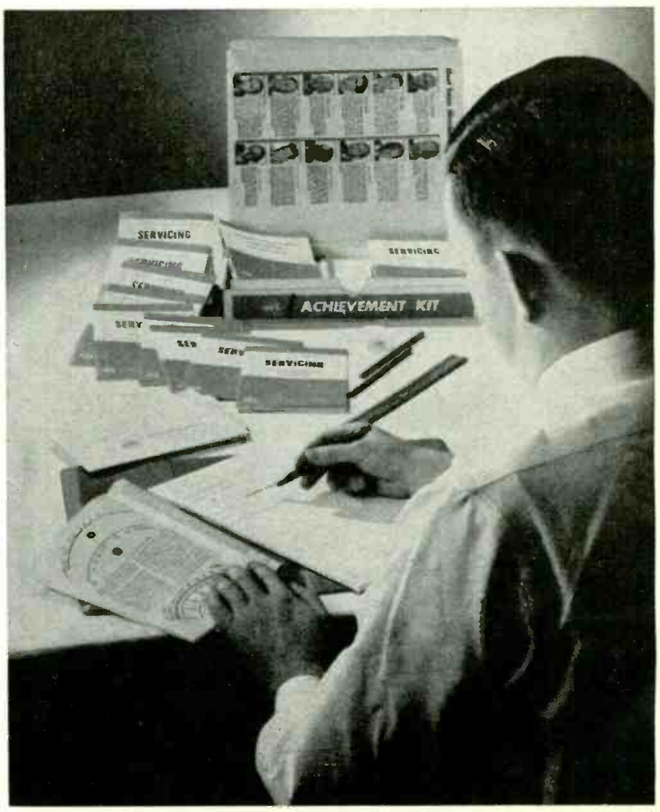

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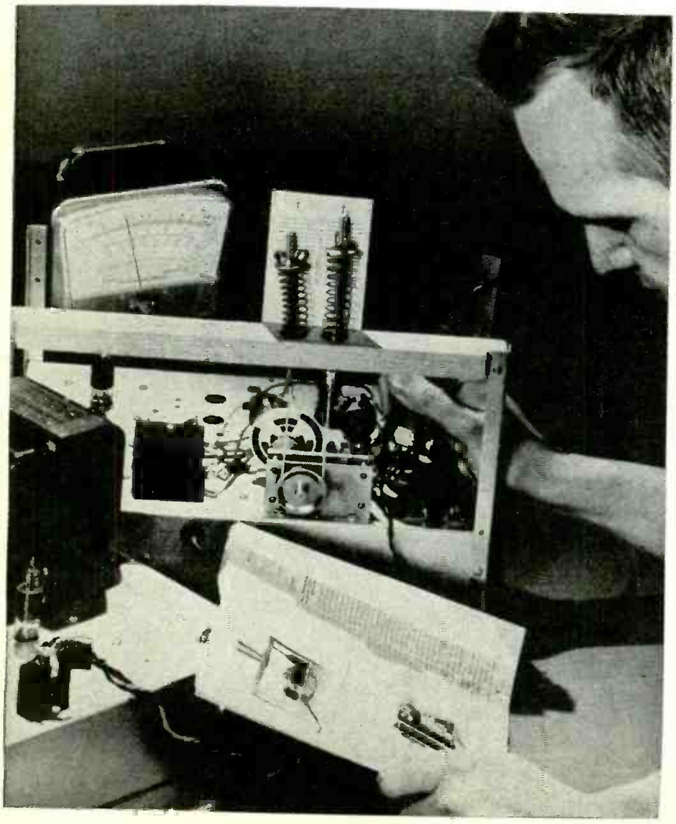
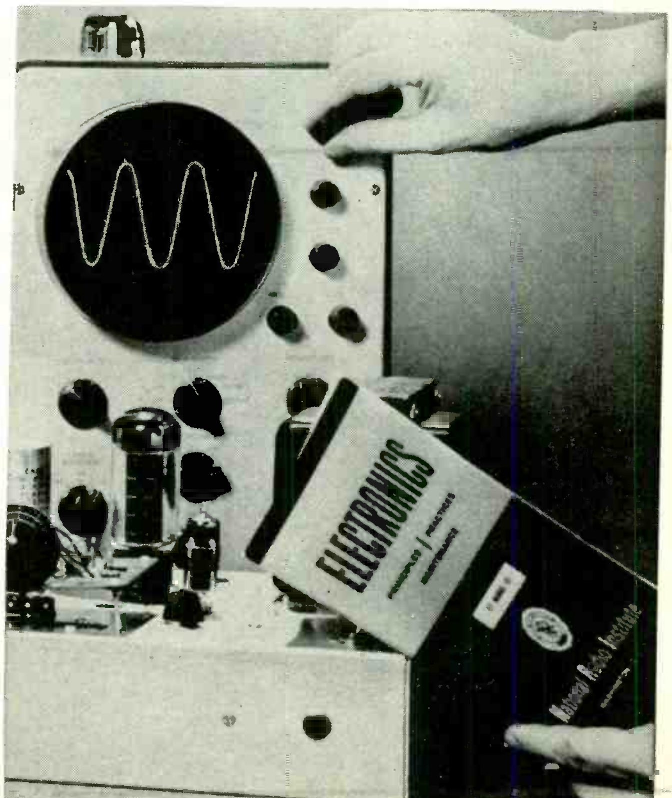




New & Timely

(continued from page 6)

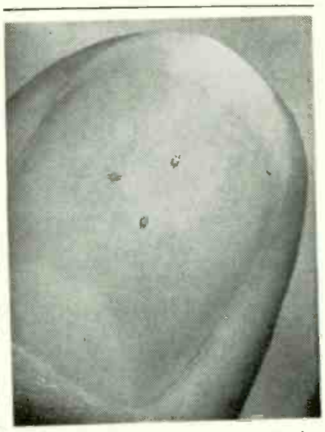
POLICE CARS LINKED TO COMPUTER CENTER

SAN FRANCISCO—Twenty police patrol cars here have been linked to a computer through data transmission techniques. In addition, a computerized dispatcher communication system is now undergoing tests.

A command and control unit (above) displays the location and priority of incidents, also showing the status of patrol cars in the area. Magnetic tape stores all events for later analysis.

An important feature of the mobile transmission equipment will be "unjamming" crowded police frequencies. The car units can handle 100 data transmissions in the time required for one voice transmission. Pushing a button on his radio lets an officer instantly request assistance or an ambulance, for example.

Requests for license verification can be cranked into a control panel (photo) and digitally transmitted by pressing the transmit button. A central computer can instantly acknowledge the signal on an illuminated dashboard display. The system is built by Sylvania.



Microminiature package made by Western Electric for Bell telephones contains four diodes for controlling the volume of signals for Touch-Tone calling. The 4-pin devices are part of an IC used in new tone generators, and replace larger diodes.

NEXT MONTH

If you've been worried about burglars, don't miss R-E's "radar" intruder alarm in June. The device will protect your home or shop.

Also coming is a detailed look at careers in aviation electronics.

Triacs are being used widely these days. Learn how they work next month.

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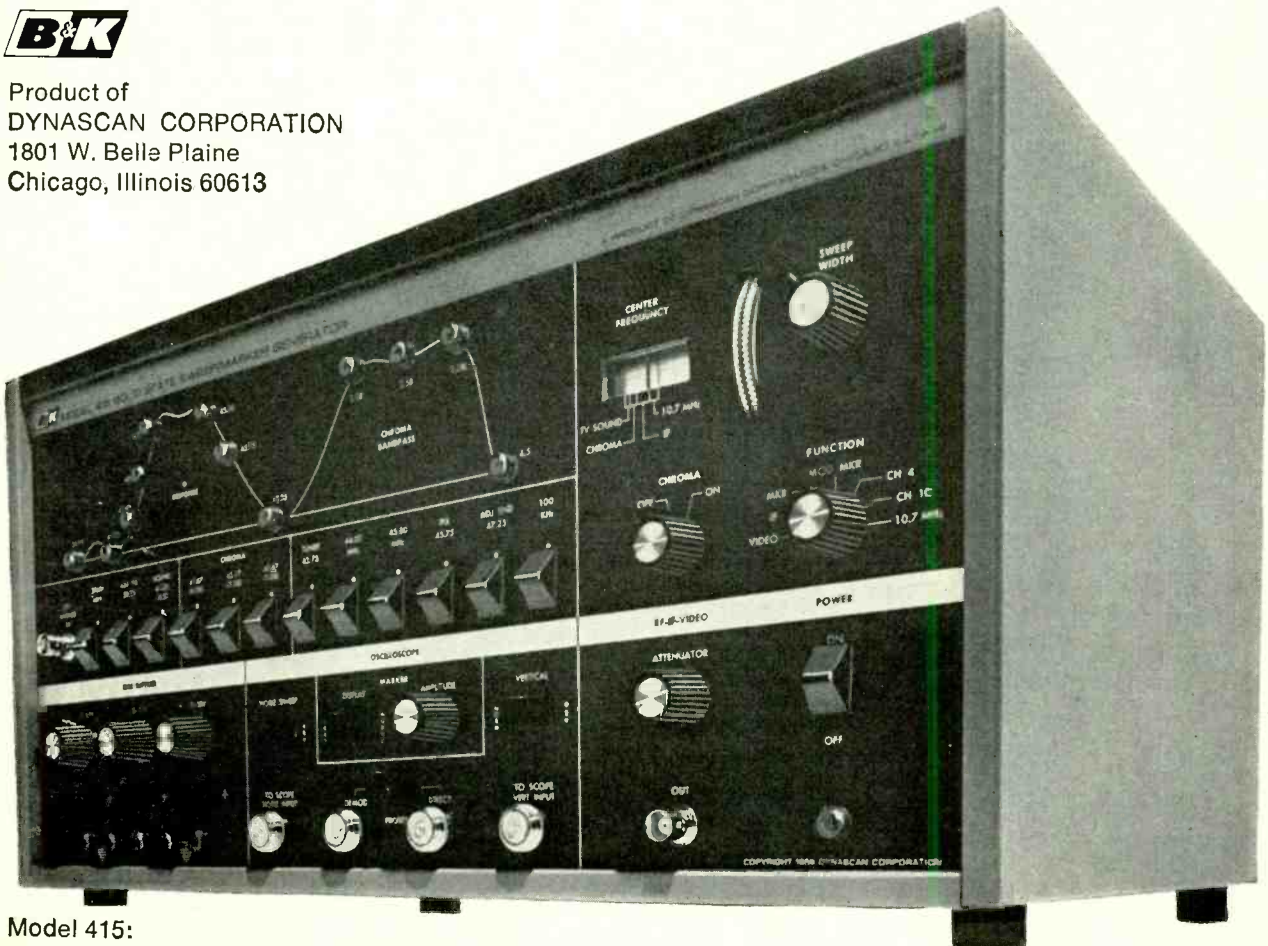

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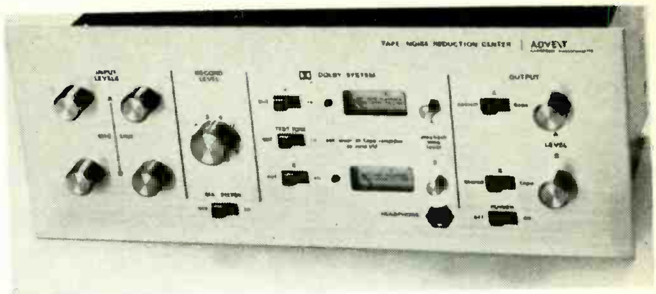
New & Timely

WILL DOLBY + CASSETTES = HI-FI?



NEW YORK—A demonstration of a simplified version of the Dolby noise reduction system here indicates the audio quality of cassettes can approach that of records.

The noise-reduction unit, made by Advent Corp., was demonstrated as a separate unit (photo) for use with any open-reel, cartridge or cassette recorder, and in a cassette deck. The Dolbyized cassette machine will be available soon for $250 and the separate tape unit is already on the market at the same price.

Both units use the "B-type" noise-reduction circuitry from the four-band professional system. The consumer version has a range from about 2 kHz upward, and provides a 10-dB noise reduction above about 4 kHz.

The Dolby system does not reduce noise already in the source material. Instead it boosts low-level signals above the background tape hiss level and compresses the recorded signal during playback. This returns the signal to its original level, pushing tape hiss down at the same time.

In addition to input- and master-level controls, the tape-center unit has calibration facilities to optimize the system to recorders, a test-tone oscillator and multiplex filter switch.

The Dolby units do not work with prerecorded tapes. currently on the market.

CONSUMER DOLBY— HOW DOES IT SOUND?

Advent conducted a series of A-B tests with and without Dolby. The basic cassette player used was a Wollensak. The only modification to the tape player was a readjustment of the bias for chromium dioxide tape (bias was turned up about 25% higher than in the original unit.

Sampler tape that came with the machine produced pronounced hiss. Dolby in—hiss almost completely gone.

High-density tape (Bell & Howell UHD and TDK) had lower hiss than standard tape. With Dolby hiss was absent.

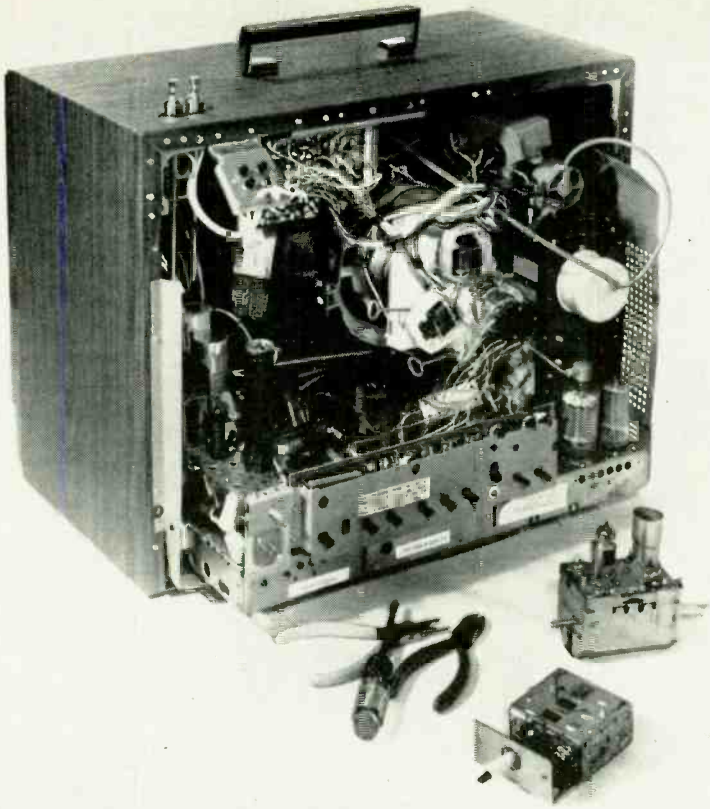
Chromium dioxide tape had lower hiss to start. With Dolby in, no audible hiss remained.

Opinion? Dolby can take the hiss out of low tape speeds. Fidelity is another matter.

MODULE EXCHANGE

Plug-in modules in new H. H. Scott gear can be exchanged for $10 if they become defective. Scott's regular parts & labor 2-year warranty remains in effect. Regular module cost is $30–$50.

Regular cost of the 342C's quartz crystal FM i.f. amplifier, for example, is now listed at $48.88. **R-E**



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Correspondence

IS NEW, NEW?

I am an electronics technician and have been a reader of your magazine for 20 years. Many times I have read of the discovery of a new device or principle. Some have been genuinely new or unique, others have been those "why didn't I think of that before" kind. Recently, I have been seeing a high percentage of the latter.

Remember when Acoustic Research caused a sensation with their "new" principle? Does anyone remember that, long before, Bell (or Westrex) sold a speaker with very low natural resonance to be used in a closed box? It seems to me that there was also an English speaker.

Why is everyone so snowed and awed by the Dolby system of recording? If you do research (i.e., the Radiotron Designer's Handbook), you find that the principles have been known for a long time. Combine well known compression/expansion techniques with something like the Scott Dynaural and the Olson Noise Suppressor and you have Dolby. There are differences, but the Dolby circuit is an obvious conclusion.

The Scheiber 4-channel recording method is also an obvious conclusion. I have known how to do this for years. In fact, I once tried to get a local company interested. The details have not yet been released for legal reasons, but if Schreiber's method is what I think it is . . . a great many people are going to be upset. Schreiber's use of such phrases as "Analog Computer Techniques" is designed to snow everybody until he gets his patent.

There is a theory in psychology that such discoveries will frequently occur to a great many people at approximately the same time. These people have no knowledge of each other. It is not ESP (as some have suggested), but is simply a logical conclusion to be drawn from available facts in time of need. Whoever makes money is whoever gets to the Patent Office first!

CLYDE E. WADE, JR.
6200 Asher #143
Little Rock, Ark. 72114

(continued on page 22)

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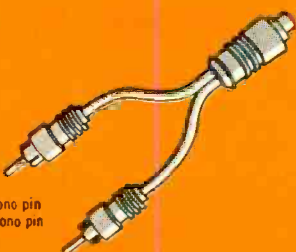

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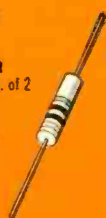

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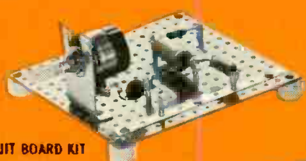

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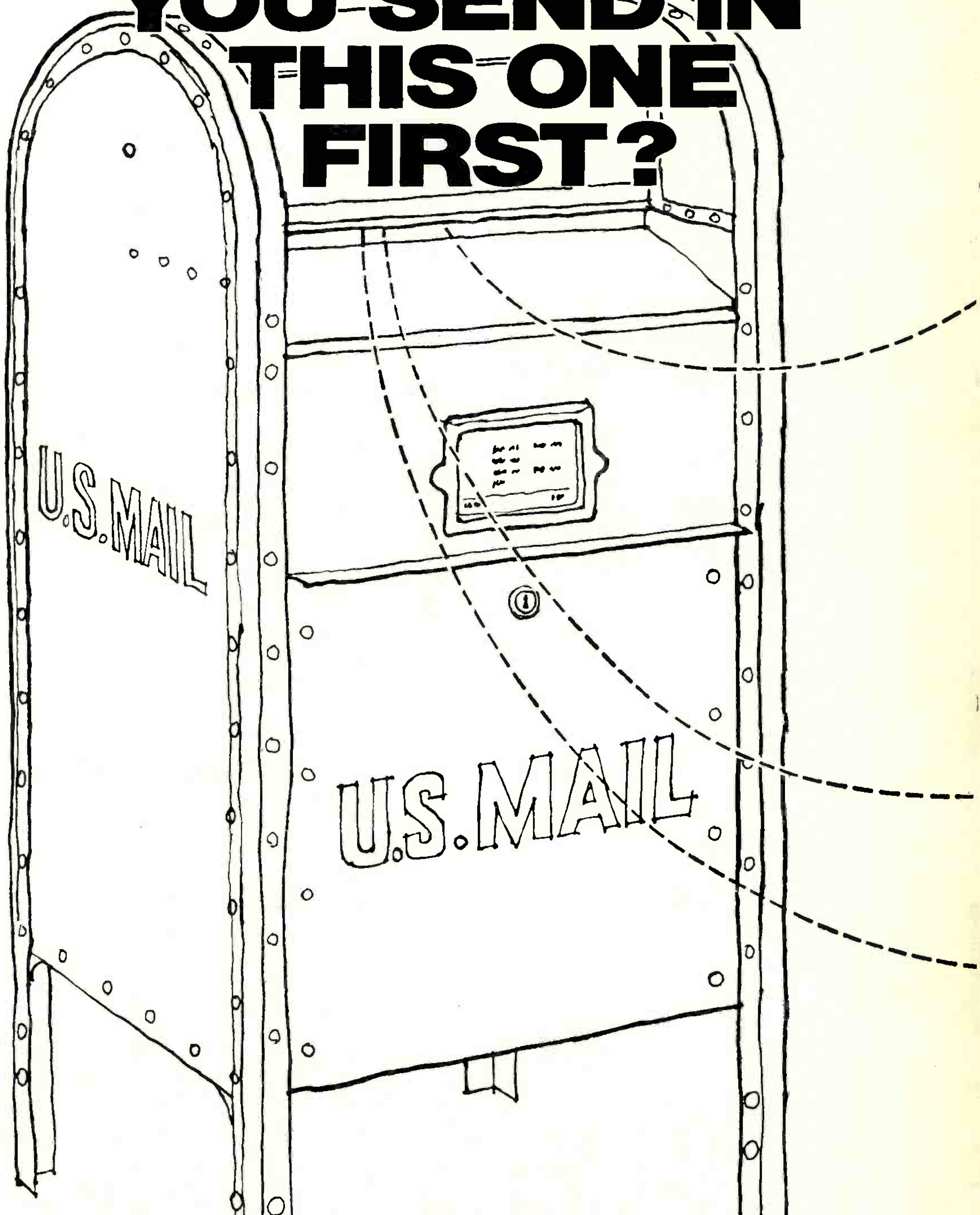

CORRESPONDENCE
(continued from page 16)

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.

KWIK-FIX™ WORKS!

I recently repaired a Zenith 20X1C38 chassis that had color stripes and turned to the March issue of Kwik-Fix™ for help.

It was a particularly difficult case because I had multiple troubles—the control voltage was inadequate and the 3.58 mHz oscillator was unstable, with the result that sometimes there were stripes and sometimes not.

Although the Kwik-Fix™ guide did not point to the defective parts, I found the circuit description and the troubleshooting guide in the text to be invaluable in isolating the intermittent components.

Although schematics are generally available, there is a real need for brief descriptions of their operation and I appreciate the thoroughness and tersity of Forest Belt's articles.

MONTY HUCKLE
Tahoe City TV Service
Tahoe City, Calif. 95730

PULSE-GENERATOR FOLLOW-UP

The author reports that if you use PC boards to construct the pulse generator (February 1970, page 37) you will do OK. But, if you wire directly from the main schematic (Fig. 2) or try to compare it with the PC pattern on page 38, you'll run into a little trouble. On the schematic, there should be a dot indicating a connection between the top end of R33 and the lead from R32 and the emitter of Q3. Resistor R33 is the common emitter resistor for Q12 and Q13.

Too, there should be a connection between the collector of Q5 and the top end of R18 in the base circuit of Q6. **R-E**

In the Shop . . . With Jack

By JACK DARR
SERVICE EDITOR

DIVIDE UP FOR EFFICIENCY

WHILE I WAS WORKING ON A TV SET the other day, I noticed that I did a lot of getting up and running back and forth. Not that the exercise wasn't good for me; I just seemed to spend most of my time "on the road." This might be healthy, but it isn't too darn *efficient*. This started me thinking about our shops, and their *efficiency*. In other words, what can we do to get more done in less time, and with less trouble?

I remembered a discussion I'd had with a friend about his shop layout. I took a long hard look at my own indoor pig pen, and decided that it fell a good deal short of being 100% efficient! Out came the scratchpad, and I started to see if I could work up some ideas.

I believe that for maximum efficiency we should divide the shop into three "primary areas," each one set up for a certain *type* of work—instruments, tools, etc. The first one would be the "starting point"; this should have the measuring test equipment—voltmeters, ohmmeters, high-voltage voltmeter, scope, etc. These are the test instruments you use *first* on every job to read "quantities": dc voltages, resistance, and so on.

A good percentage of service jobs will be finished right in this primary area. As you know, most jobs call for replacement of bad resistors, dead tubes, broken wires and that kind of thing. So, this position should have test equipment for making basic tests within easy reach.

Next to this position should be No. 2 area. This should have parts testers for capacitors, transistors, tubes, flybacks, and the parts-substitute boxes—resistors, electrolytic capacitors, etc. This area should *adjoin* No. 1 so you'll have to move only a short distance to get any of these instruments.

Next to No. 2 should be No. 3, with the equipment that we use least often. This would include color-bar and TV pattern generators, rf signal generators and the sweep and marker generators for alignment work. This area should be accessible, but out of the "main stream" of traffic flow to areas 1 and 2. When this isn't being used for alignment, it can be used as a "cooking area," with the signal generators, bar-dots, etc. to provide steady test signals.

There's one more question, and this depends entirely on how *you* like to work. Might say that the question is "fixed or mobile?" In other words, should the test equipment be set on the bench, on a shelf above it, or on carts so that it can be rolled up to the job? The best way to find is to try it and see.

For example, I use a combination: scope under the shelf on the bench, small transistorized voltmeter on the bench, and a big capacitor tester, flyback tester and transistor tester on a roll-around cart.

Run an experiment for yourself. Make a tentative instrument setup, and try it out on a few actual service jobs. See how many times you have to get up and go get an instrument that's not within easy reach; also, see if your *most-used* instruments can be reached without moving too far. With me, this is the tvm and the scope; yours may be different.

So, step back and take a long, hard, honest look at the operation and layout of YOUR shop. Then, see if you can't find some way to shuffle things around so that it will be much more efficient. As another example, I put a new transistor tester on the shelf at the far end of the bench from my favorite working position. I found myself jumping up and running the length of the shop to get the transistor tester. So, onto the cart it went with the rest of the parts testers, where it belonged.

I think you'll be surprised at the results. If you can make only a 10% saving of time on most jobs, it will amount to a tidy bundle of bread at the end of a month! If you have a fixed minimum bench charge, as most of us do, the quicker you can get a job out, the more you make per day. And, that's the name of the game! **R-E**

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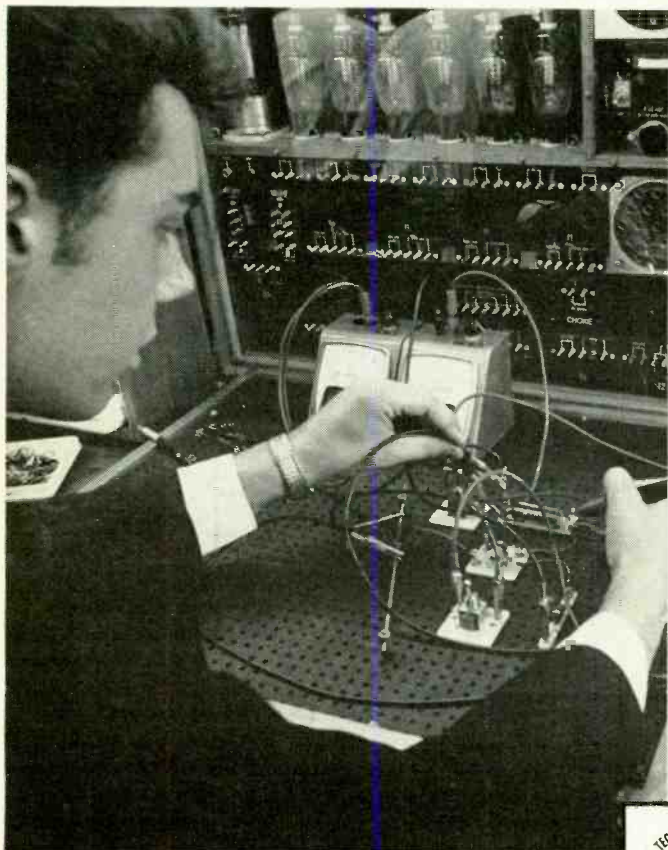

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EQUIPMENT REPORT

Hickok DMS-3200

For manufacturer's literature, circle No. 67 on Reader Service Card.

HICKOK'S NEW DIGITAL MEASURING System, the DMS-3200 Main-Frame, is the mother-unit of what promises to be a pretty large family. There are 12 plug-in units which can make the main-frame display unit into an ac or dc voltmeter, ohmmeter, capacity meter, event counter, current meter, frequency meter, and even a multimeter. Hickok will add new plug-in units from time to time, as the need arises.

The main frame includes the sequential counting and display circuits, their control circuitry, and an extremely well regulated power supply for main-frame circuitry and the plug-ins as well. The digital readouts are Burroughs Corp. Nixie tubes—special neon tubes which light up actual figures over an inch high. Three digits are displayed, but the system has a very wide coverage. This is made possible by range-switching of the plug-ins. The decimal point moves automatically.

The main-frame circuitry is basically a pulse counter. This is done by three cascaded decade scalers; five RTL JK flip-flops, interconnected as switch-tail-ring counters. These are computer circuits designed to count up to 10, then pass along one pulse for every 10 pulses fed in. If there are any odd pulses left over, it saves them up and displays them on its own Nixie tube. (Each decade scaler stage controls one of the tubes).

For example, if 467 pulses are fed in, the first counter will save the odd "7," and pass on 46 pulses to the next stage. This stage will pass on four pulses and save the "6." The final stage gets only four pulses; each stage will display the figure it has left over, and the display then reads "467." The "first" stage, by the way, is the "units" or *right* hand digit; this works from right to left. This is actually a "mini-computer." "Mini" only in physical size; it uses a total of 18 integrated circuits and 43 transistors. The pulses that it counts come from the plug-in unit.

In the ac voltmeter plug-in, for example, an ac voltage of any frequency up to 1 MHz is fed to the input. It reads rms values, at a rated accuracy of ± 0.1% of the indicated reading plus or minus *one count*. It will also read square or sawtooth waveforms with the same degree of accuracy. Correction tables are provided for use with other waveforms, if needed.

To get the pulses which are actually counted, the ac voltmeter takes the input ac voltage, passes it through a very closely calibrated attenuator network, and feeds it to an ac preamplifier.

From this stage, it goes to an ac/dc converter, where it is rectified to a dc voltage directly proportional to the rms value of the input. This is compared to a closely regulated reference voltage from a Zener diode. The differences voltage is split, and gated through a control flip-flop, with pulse shapers in its outputs. Our ac voltage has now become a squared-off and carefully calibrated pulse; this pulse triggers and *times* a gated oscillator circuit, working at about 10 kHz.

So, for a given value of ac input voltage, a very accurate "burst" of oscillator signal is generated and fed to the pulse counters in the main frame. These actually count the number of cycles, and display them on the Nixie tubes. In the example given before, the input voltage pulse "chops out" 467 cycles of oscillator signal and sends it along to be counted.

It's very interesting to watch this thing at work! The Nixies light up

(continued on page 80)

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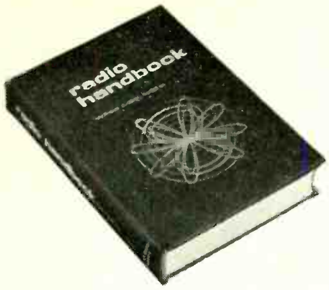

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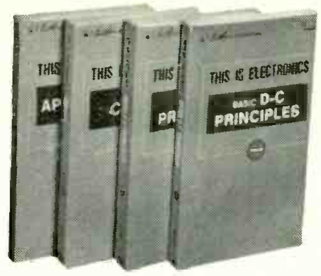

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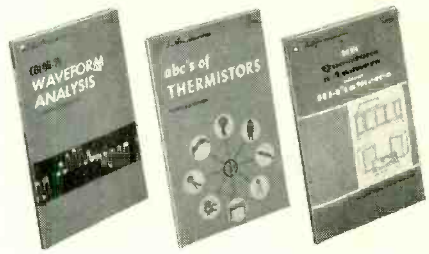

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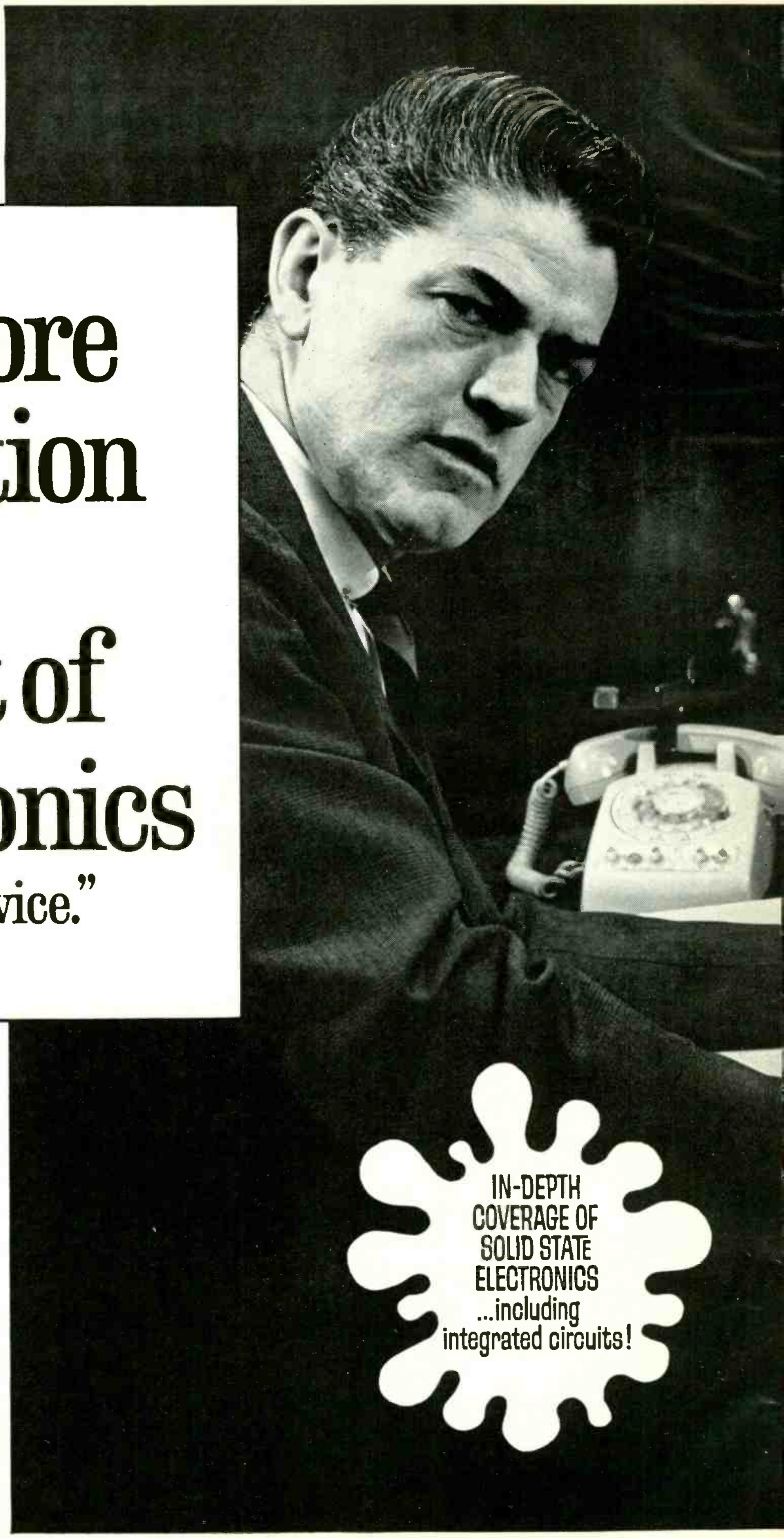

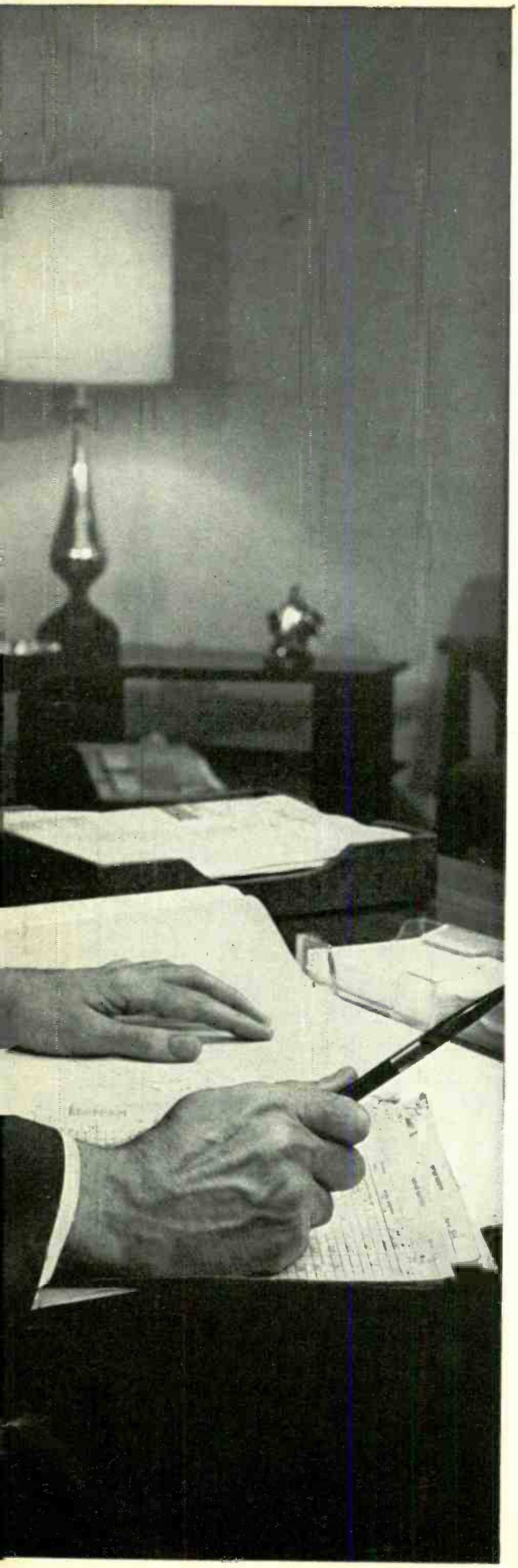

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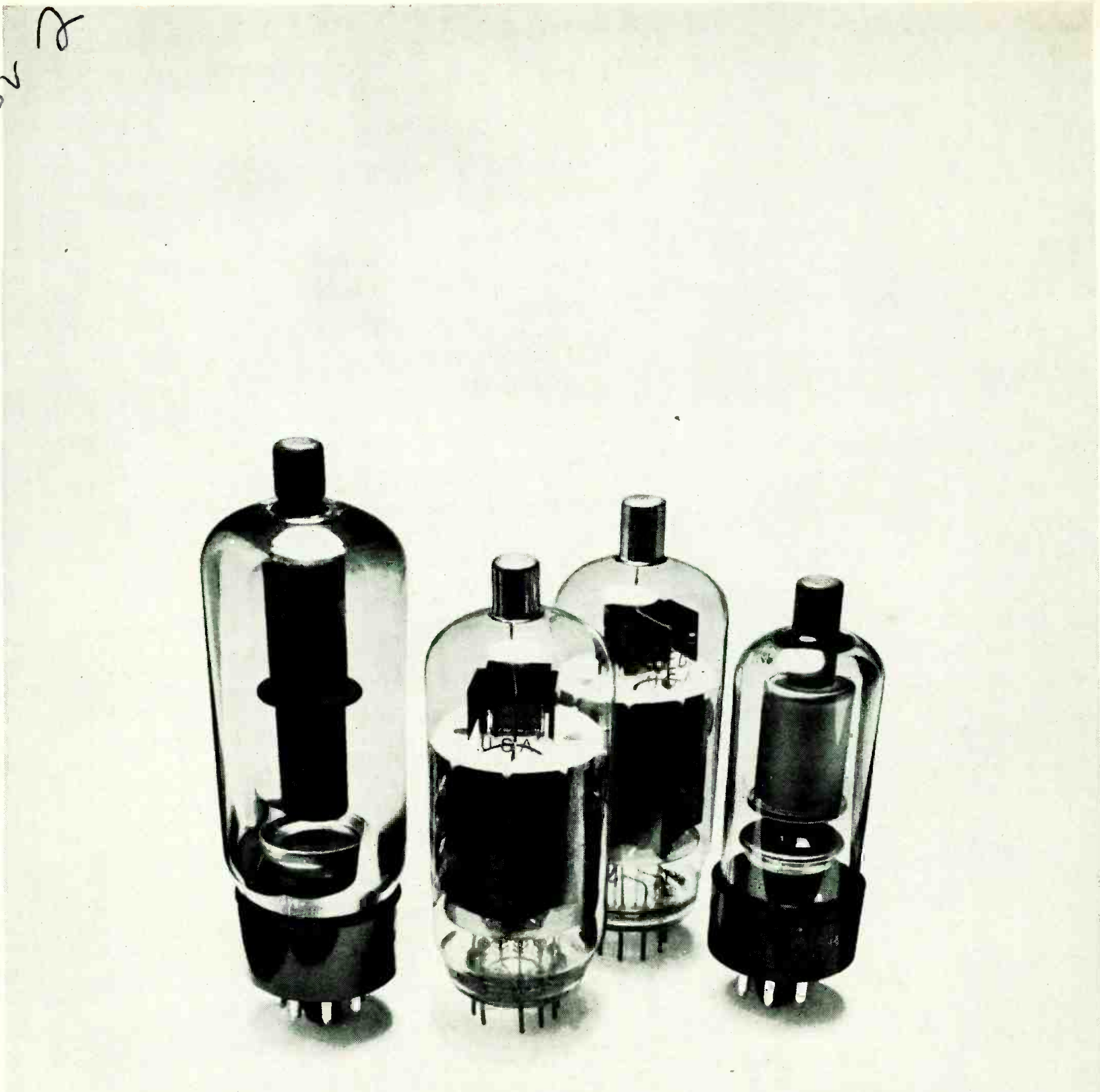

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For the experimenter

10 EMITTER-COUPLED OSCILLATOR CIRCUITS

1 Basic emitter-coupled circuit
2 Basic R-C oscillator
3 R-C oscillator to 30 kHz
4 Simple musical instrument
5 R-C oscillator with feedback
6 L-C oscillator variations
7 Capacitive feedback circuit
8 Carrier insertion oscillator
9 Intruder detector
10 Emitter-coupled amplifier

by FRED MAYNARD

THE EMITTER-COUPLED AMPLIFIER IS a most useful configuration in logic, switching and vhf circuits. It can also be used in a series of very simple and interesting oscillators. Eight such circuits are shown here.

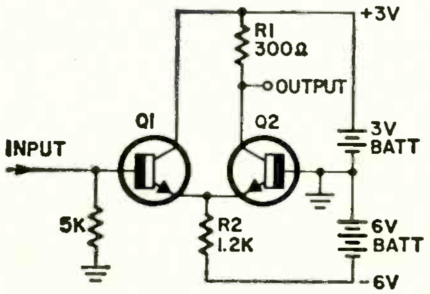
The basic E-C amplifier

The basic emitter-coupled amplifier consists of the two-transistor, three-resistor configurations shown in Fig. 1. The base of Q1 is the input, and the collector of Q2 is the output. Transistor Q1 is an emitter follower, and Q2 a grounded (common)-base voltage amplifier. The emitters of Q1 and Q2 are tied together and connected to a common, unbypassed emitter resistor, R2. Resistor R1 is a normal load resistor.

In the circuit in Fig. 1-a, the bases of both transistors are at ground potential, and a split supply of +3 volts and −6 volts is required. A more convenient circuit requiring a single 6- to 9-volt supply is shown in Fig. 1-b. Here the intermediate base bias level is obtained from voltage divider R3 and R4. Resistor R4 is bypassed to ground. In all the applications shown in this article, a version of Fig. 1-b is used, but the split-supply version of Fig. 1-a can also be used.

Gain and phase relationships

As a voltage amplifier, the E-C amplifier is not outstanding. The configuration in Fig. 1-b provides a voltage gain of about 4. A well-designed, common-emitter, single-transistor amplifier can provide voltage



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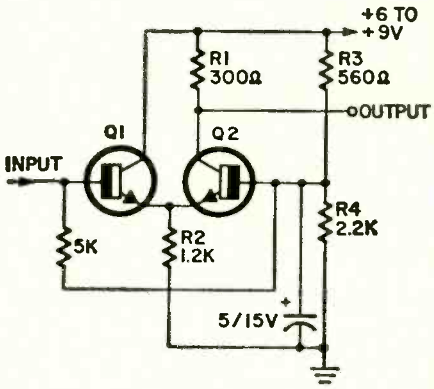

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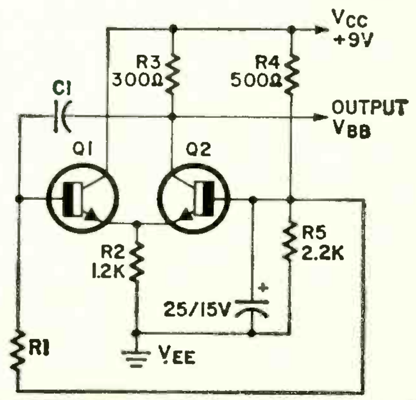


Fig. 1-a—(left) Emitter-coupled amplifier using split supply. *b*—Using a 6–9, volt supply.

Fig. 2 (above)—R-C oscillator has feedback from Q2's collector to the base of Q1.

Fig. 3 (below)—R-C oscillator circuit covers 15 Hz–30 kHz, and is useful as wave generator.

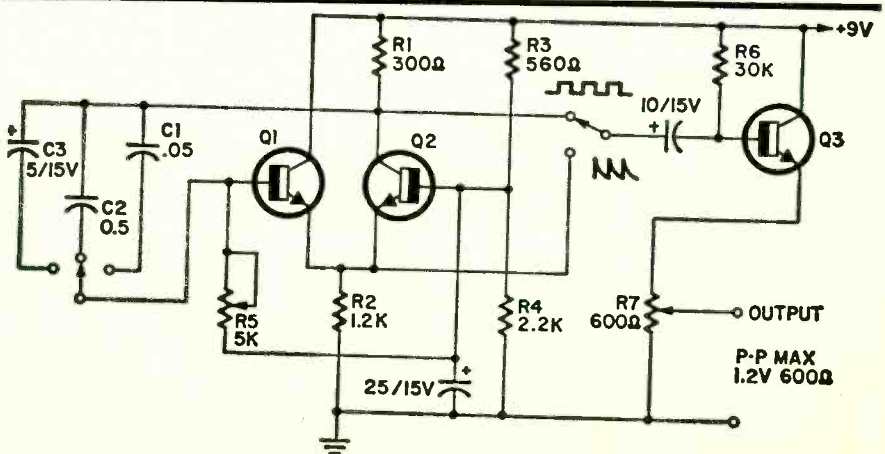
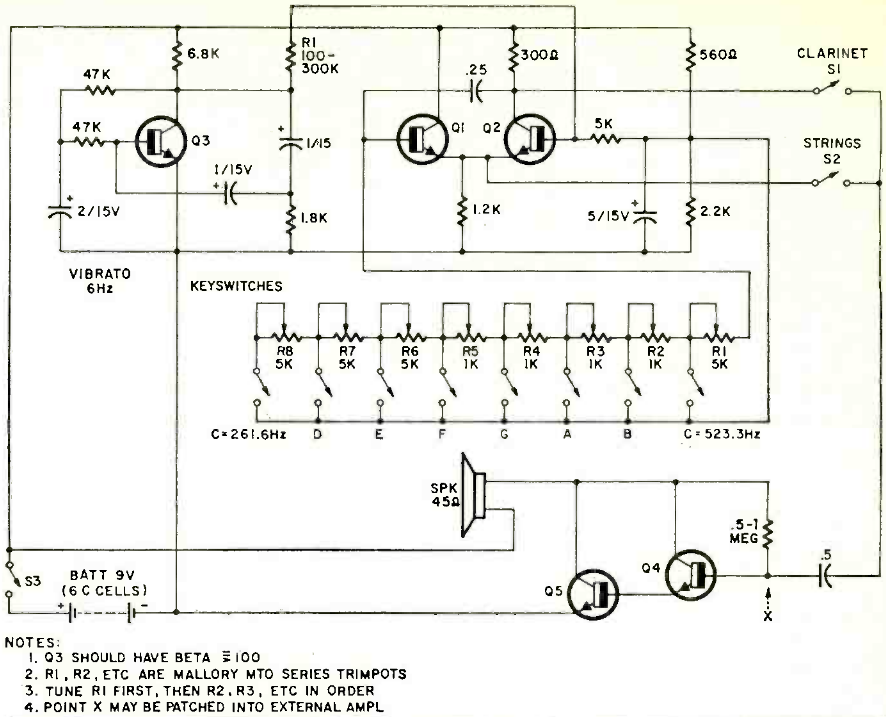
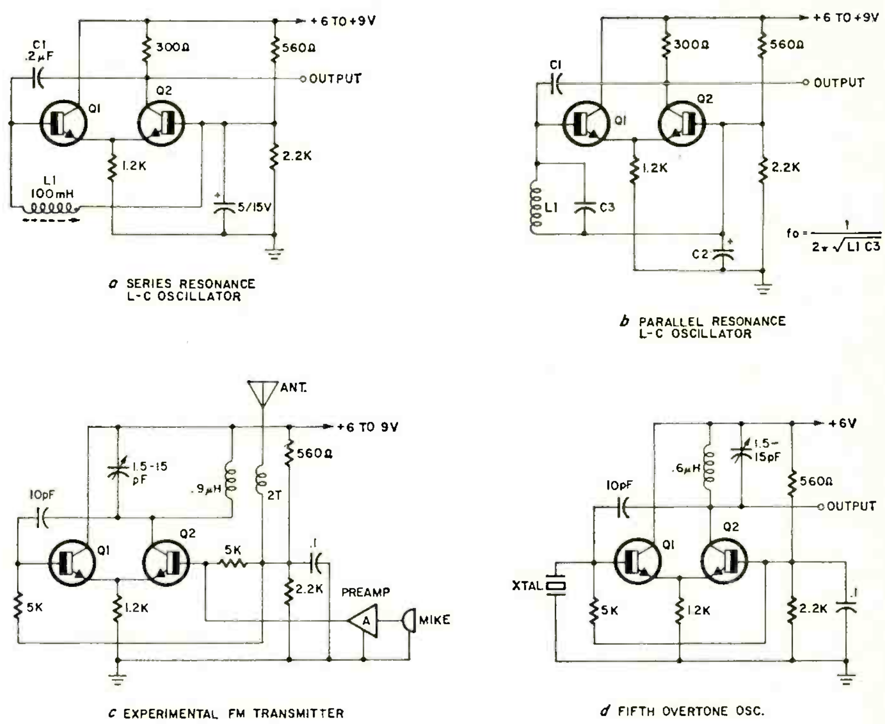


Fig. 4—Trim pot series can turn Fig. 3 circuit into a simple musical instrument covering C scale. R1 value varies vibrato.

Fig. 5—Variations of L-C oscillator can be used for useful R-C circuits.





gains of 10 to 20. On the other hand, the E-C amplifier has a much higher input impedance than the common-emitter version, and provides a much higher power gain.

The most interesting and useful thing about the E-C amplifier is that the input and output are in phase. Suppose a negative-going signal is applied to the input base of Q1. The emitter of Q1 will follow and go negative by the same amount. This pulls the emitter of Q2 negative, causing Q2 to conduct harder. Hence, the collector of Q2 is also pulled negative.

This in-phase relationship provides for the implementation of several very simple oscillators.

Basic oscillator circuit

A basic R-C oscillator is shown in Fig. 2. In this circuit the V_{BB} bias is obtained from voltage divider R4, R5, or may be from a split power supply, as described earlier. Feedback is provided from the collector of Q2 to the base of Q1, and the base bias (to Q1) from the V_{BB} bias through R1. The oscillator frequency depends basically on the R1C1 time constant, as well as other shunting or capacitive effects in the oscillator circuit.

This circuit will oscillate over a range of nearly two decades. Over a substantial part of this range, an approximate formula for frequency in terms of the values of C1 and R1 may be written as:

$$f_o = 0.32 \frac{1}{R1C1}$$

where f_o is in kHz, R1 in kΩ, and C1 in μF.

The measured deviation from this relation may be as much as ±10%, depending on circuit conditions, transistor parameters, etc.

Simple wide-range R-C oscillator

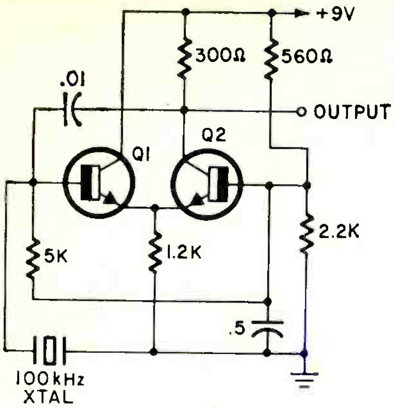
A wide-range R-C oscillator is shown in Fig. 3. This oscillator is implemented with feedback capacitors C1, C2 or C3 from the collector of Q2 to the base of Q1, and variable resistor R5, which returns to the base point on the divider. With the constants shown the circuit will oscillate from about 15 Hz to 30kHz in three decade ranges.

The output of this oscillator at the collector of Q2 is a square wave with fast rise and fall times. It may, however, be quite asymmetrical over part of the tuning range. A rather good sawtooth wave appears at the common-emitter junction. The follower, Q3, prevents loading.

I have used this circuit as a calibrated test generator and as a simple musical instrument. The latter is shown in Fig. 4. The oscillator is tuned to a musical scale with series-connected resistors, preferably adjustable low-cost trimming potentiometers. These resistors are adjusted to tune the oscillator to notes in a musical scale, such as the scale in C shown. If desired, a much longer scale can be used, and the half tones (sharps and flats) can be inserted. Simple keyswitch contacts on the keys make contact to a bus that goes to the divider. The 5,000-ohm resistor between the base of Q2 and the divider allows the injection of a 6-Hz vibrato circuit (Q3). The instrument may be played with any external amplifier or the simple Darlington amplifier shown can be used to obtain moderate room volume. The vibrato depth can be adjusted to the most pleasing level by varying the value of resistor R1.

L-C oscillators

Four L-C oscillator forms based on the emitter-coupled amplifier are in Fig. 5. The version shown in Fig. 5-a



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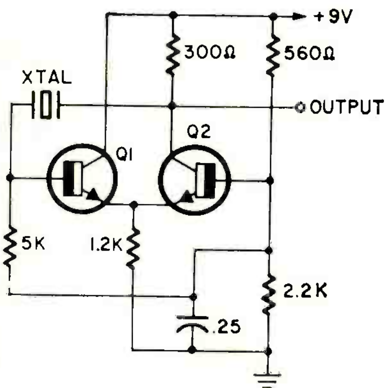

b

Fig. 6-a—Capacitive-feedback crystal oscillator. b—Using crystal for feedback.

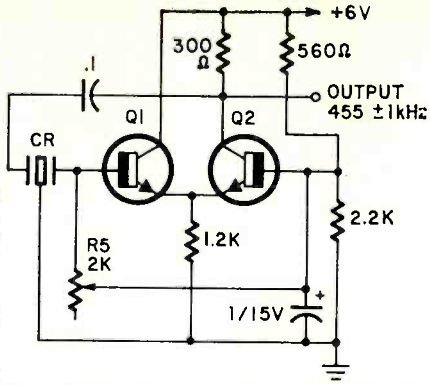

Fig. 7—Carrier insertion oscillator is one use for this ceramic-filter circuit.

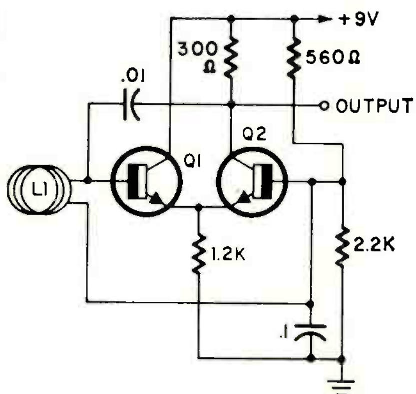

Fig. 8—Coil L1 varies 7–30-MHz oscillation when someone approaches the loop.

is almost identical to the R-C version described earlier, with inductor L1 substituted for the resistor. This circuit has a series resonance between L1 and C1, but not at exactly the theoretical resonance.

In Fig. 5-b, a capacitor is added to the same circuit to form a tank circuit. Here the formula for series resonance for a good approximation is

$$f_o = \frac{1}{2\pi\sqrt{LC}}$$

Feedback capacitor C1 should be about a tenth the value of C3.

In Fig. 5-c, the L-C tank circuit is placed in the collector leg of Q2. In this position the circuit develops substantially more power than in the version shown in Fig. 5-b. I used this circuit in an experimental FM transmitter at about 96 MHz. The FM is obtained by driving the base of Q2 with a microphone preamplifier signal. The voice quality obtained is quite good.

A crystal-controlled version of Fig. 5-c is shown in Fig. 5-d. This circuit was used as the local oscillator in a fixed-tuned vhf receiver with good results. The oscillator tank was locked in on the fifth crystal overtone.

Crystal-controlled oscillators

One overtone crystal oscillator was described above because it fits in with the L-C circuit versions. Two fundamental-mode crystal oscillators are in Fig. 6. In Fig. 6-a, capacitance feedback is used with the crystal across the base load of Q1. In Fig. 6-b, the crystal itself forms the feedback element.

An interesting oscillator is shown in Fig. 7. The part labeled CR is a 455-kHz ceramic filter used instead of a transformer in some transistor receivers. By varying R5, the crystal frequency can be "pulled" about ±1 kHz from its center resonance frequency. This oscillator serves very effectively as a carrier-reinsertion oscillator in a solid-state single-sideband receiver. It provides excellent stability in the reinsertion stage, where very good stability is needed.

A "big loop" oscillator

During the experimental work with the E-C amplifier, when it appeared that the circuit would oscillate under almost any conditions, a "fun" circuit was set up. It may have an element of usefulness. In Fig. 8, L1 is a loop of 10 to 20 turns of insulated wire.

Several loops were tried, varying in diameter from about 4 inches to 4 feet. In all cases oscillation was obtained at some fairly high frequency (7 to 30 MHz). It was noted that the frequency shifted substantially when a person came near or into the loop. This oscillator together with a resonant detector might make a very good antipersonnel alarm.

Transistor requirements

Transistor gain does not appear to be critical in the E-C amplifier and the oscillator circuits. This is probably due to the fact that the critical gain in an emitter-coupled amplifier gain is alpha, rather than beta. Low-cost (40¢ each) Motorola MPS2926 units work satisfactorily. **R-E**

CONVENIENT TAPE-REEL STORAGE

A good way to hold tape reels in pairs is to use spring-type garment-holding clamps. These clamps are in pairs with a center pivoting rod. Large manila envelopes make excellent holders for single reels of tape with incomplete programs if you cut off the top of the envelope or fold it over to make it the proper size for the reel of tape. Jot the contents of the reel on the outside of the envelope, noting starting and stopping point of a particular program. There is plenty of space for making all required entries, and erasures can be made easily. Discarded envelopes will serve this purpose as well as unused ones.—*Glen F. Stillwell*

COAX CONNECTOR HINT

When installing rf connectors on coaxial cable, excess heat can warp, melt or disfigure the polyethylene insulation covering the center conductor. You can prevent this and minimize the possibility of shorts by slipping a short piece of shrinkable tubing between the braid and the dielectric. The heat from the soldering operation shrinks the tubing uniformly so the insulation holds its shape and does not melt.—*Richard Mollentine, WA0KKC*

MORE HEAT AT THE TIP

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All tube designs, all the older transistor designs, and the present FET designs use an agc technique known as reverse bias in which a negative bias is applied to either a grid or base to reduce the output current (and gain) of the device. While reverse bias works well with devices such as tubes and certain FET's, which can operate at zero or negative bias, it fails when used with ordinary transistors which must always have some forward bias to maintain operation.

Strictly speaking, the forward bias on the transistor was only reduced until the gain decreased at some very low collector current. Unfortunately, this meant that the base-emitter junction could be a very good rectifier for the same strong signal that was producing the bias. Thus this biasing technique was a failure in operation and the setting was ripe for the introduction of FET's.

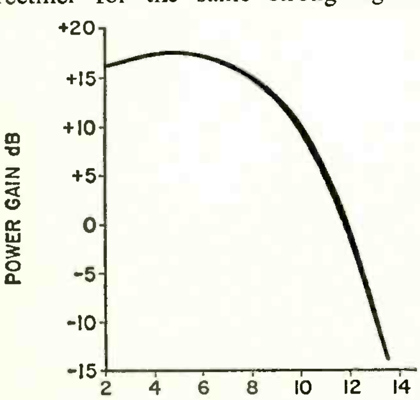


Fig. 1—Curve of foward-agc transistor. Low collector currents yield high gain.

The use of a different type of transistor, however, solves the overload problem. This transistor is known as the "forward agc" type—one in which gain reduction is caused by an *increase* in the forward bias applied to the transistor as shown by the curve of Fig. 1. Note that at collector currents of only 2-3 mA the power gain of the device is maximum, but when the current has increased to a higher value the power gain may even become negative, with less output than input.

Of course, since the base-emitter junction is heavily biased, a strong signal cannot be rectified at this point. Thus, in the FM-1 tuner described here, we can apply a signal of 0.2V rms to the antenna terminals without degrading performance.

Although forward-agc transistors can successfully compete with FET's under extremely strong signal conditions, they deliver superior performance when handling very weak signals. We get this kind of performance by close impedance matching between the coupled circuits, which implies maximum power transfer. With an antenna impedance of 300 ohms it is simply not possible to transform this upwards to the higher values required for field-effect transistors. Circuit configurations capable of this transformation such as transmission lines and tuned cavities are bulky and of prohibitive size.

The transistors used in this design present a much lower input impedence and consequently more useful power is transferred. The result is a tuner with high sensitivity and an extremely important side benefit—no shielding is required in the rf section. Whereas a stray coupling capacitance as low as 0.1 pF (16,000 ohms @ 100 MHz) can couple a considerable amount of power between two high-impedance circuits, the same stray capacitance effects little power transfer between impedances nearer 1200 ohms.

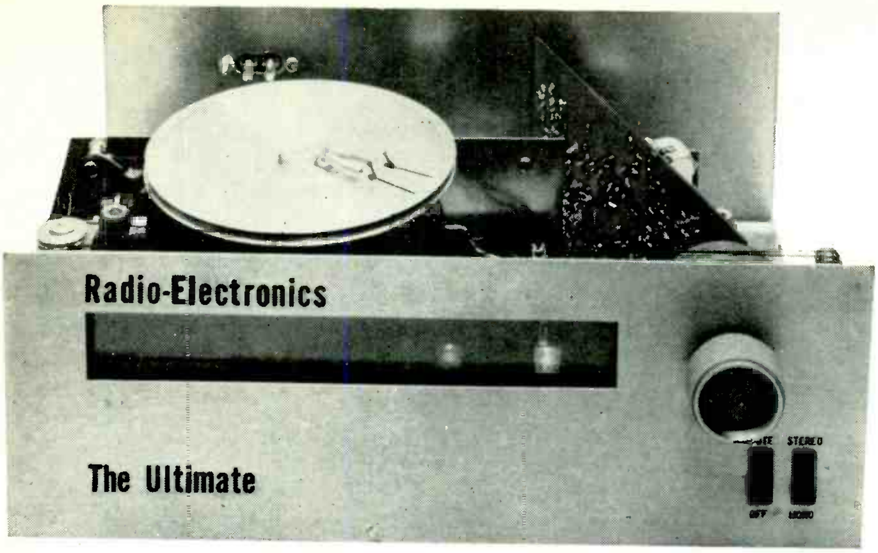
Remember also that any electrostatic shield placed over an inductance must be much larger than the coil diameter to prevent drastic reduction of Q values and inductance since the shield acts as a single shorted turn coupled to the inductor.

The crystal filter impedances in the FM-1 are closely matched to reduce phase non-linearity and preserve good stereo separation.

FM-1

Using the detailed alignment procedure that appears on these pages, the reader should be able to achieve or improve the

20 db Quieting Sensitivity	1 μV
30 db Quieting Sensitivity	1.4 μV
50 db Quieting Sensitivity	3.9 μV
Capture Ratio	1 dB
AM Suppression	60 dB
Harmonic Distortion	0.5% (measured at detector output)
Hum and Noise	less than −70dB
Spurious Response	less than −90dB
Image Rejection	less than −90dB
Half i.f. Response	less than −80dB
Adjacent Channel Selectivity	−70 dB
Overload Sensitivity (for 1% distortion)	0.2V rms



The Ultimate STEREO TUNER

On weak signal reception, forward bias to Q1 and Q2 (Fig. 2) is supplied through R22 and R24 from the junction of R21 and R25. Adjusting R25 sets the bias for highest sensitivity. As signal strength increases, the base voltage on Q5 becomes more positive until, at a higher signal level, Q5 is providing bias to Q1 and Q2.

The resistance in the collector circuits of Q1 and Q2 is low to prevent saturation at these higher collector currents. The base connections to L2 and L3 provide maximum power transfer from the tuned circuits. Q3 is a dual-gate FET mixer with the rf signal applied to gate 1 and the local oscillator signal to gate 2.

Transistor Q6 is arranged to provide a low distortion oscillator signal to the mixer. An additional Zener regulator prevents frequency variation while the R28-C24 combination removes any Zener noise. The base of Q4 is matched to the mixer output by a tap point formed by the capacitive division of C14 and C15.

Transistor Q4 provides the 500-ohm output impedance for the first crystal filter. Each filter requires about 5 pF at the IN terminals to give the specified bandpass. For F101 (Fig. 3) this capacitance is the length of shielded cable connected to Q4. For the second filter it is the output capacitance of IC101.

Transistor Q101 amplifies the signal and applies it to Q103 and IC101. The gain of Q103 and Q104 is just enough so that the i.f. voltage rectified by D101-D102 will provide further bias to the transistors only when the signal is well past the point of maximum noise reduction, but long before the signal level reaches the overload level. The design gain of the Q103 and Q104 stages is centered within this range.

All i.f. transistors are of a special type with the emitter lead placed between the base and collector leads. This lead arrangement prevents unwanted coupling (and phase shift) between output and input of each stage.

The ratio detector, T102, has a linear bandwidth of 500 kHz and contains the diodes within the housing. Because of T102's bandwidth, alignment is simple, and can be done almost as well with off-the-air signals as with a signal generator.

The tune indicator lights when the signal is tuned correctly. The voltage at R125 will be about 1.1 V positive without a signal and rises to nearly 1.3 volts when even a weak signal is tuned in. R126 provides an adjustment for this voltage discrimination. When the voltage at R125 rises in the presence of a signal, Q105 is turned on, in turn saturating Q106 and Q107. LM101 in the collector circuit of Q107 lights to indicate correct tuning. A S202 contact (Fig. 4) is wired to the turn-on bias for Q107. If S202 is set to the stereo position this bias will be clamped to ground by Q207 unless the 19-kHz pilot signal has resulted in turning on the stereo indicator, LM201. Thus if the MUTE switch is on, and S202 is set to the stereo position, only stereo signals will be heard.

Since Q107 saturates at this time, a contact on S201 may return source resistors of Q210 and Q211 to ground, allowing the audio to appear at the output jacks.

The collector voltage at Q106 also saturates Q208 in the stereo indicator circuit, allowing an indication only when stereo is tuned in.

The detected composite signal feeds the high-impedance input of Q201. T201 and C203 present a high impedance in the emitter circuit of Q201. The output voltage appearing across R201 is low in 19-kHz components. T202 and C202 are tuned to 67-kHz to eliminate SCA interference at the stereo outputs. The 19-kHz pilot signal appearing across T201 is amplified by Q203. T203 and T204 are tuned to the 19-kHz signal. The input to emitter follower Q204 is a very pure 19-kHz signal which provides superior lock-in of the oscillator even on extremely weak signals. Since the voltage at the emitter of Q204 is a low impedance it is used to drive the pilot detectors, D201 and D202, as well as synchronizing Q209.

The rectified pilot signal satur-

Specifications

following figures. The specifications will be explained further next month.

Multiplex Separation	.45 db mid-frequency 35 dB @ 50 Hz 30 dB @ 10 kHz
Output Level	adjustable up to 1Vrms
Output Impedance	approx. 20,000 ohms
Distortion	1%, 1000 Hz, 75 kHz deviation
SCA Suppression	48 dB
Hum and Noise	45 dB —60 dB (below reference IV output with 19 and 38 kHz components notched out)

ates Q205, which in turn provides a turn-on bias to Q206, the stereo lamp driver. The emitter of Q206 is in series with Q208. Therefore, the indicator will not light unless Q208 is also turned on. Q208 is driven by the voltage appearing at the collector of Q106, and this voltage will bias Q208 only when a signal is received. The stereo indicator lights only when a stereo signal is received. There are no false indications between stations.

Locked oscillator Q209 can only operate when pin 6 of T205 is returned to ground by the saturation of Q206. T206 in the collector circuit is tuned to 38kHz and drives the balanced detectors D203-D205 and D204-D206. Balanced detection reduces the 38-kHz components which can appear across the de-emphasis networks, R224-R225-C219 and R226-R227-C220.

The gates of output amplifiers Q210 and Q211 are returned to ground potential. Source resistors R230 and R231 are switched to ground to turn on and to +12 volts to mute. In muting, the audio output is reduced over 50 db. This switching voltage is taken from the collector of Q107, the TUNE lamp driver. The output of each channel may be adjusted to any voltage up to 1V rms by the output controls in the drain circuits of Q210 and Q211.

Resistor R204 selects the amount of composite signal, minus 19-kHz and 67-kHz components, applied to the switched detectors. This composite output contains the L + R signal at 50-Hz to 15-kHz, as well as the L − R sidebands at 23-kHz to 53-kHz. These sidebands may be attenuated by multi-path reception as well as phase distortion in the i.f. strip. The detector transformer used in the FM-1 has a linear bandwidth of 500-kHz to minimize this distortion. However the tuner alone is not able to compensate for all possible causes of L − R sideband attenuation. Therefore C204 should be installed on the following basis: use the .02-μF unit if this multiplex board is *not* used with the remainder of the FM-1, or if all your useable signals originate more than 30 air miles from your receiving location. Use the .05-μF capacitor when the multiplex is used with the FM-1 and the stations are both local and distant.

The power supply provides +14.6V for LM101 and LM201 and regulated 12V for all other circuits. Q212 functions as a capacitance multiplier; the +14.6V has less than 5 mV p-p ripple. D210 provides a regulated output from Q213. If there is excessive Zener noise you can add a simple R-C network to eliminate it.

Diode D209 serves only one function; to prevent destruction of Q213 in case of a wiring error or accidental short during testing. Without D209 any short would cause the charge in C232 to be placed directly across the base-emitter junction of Q213. The resulting current flow would destroy this transistor. With D209 in place any short drains C232 of its charge at the cost of only a momentarily increased dissipation in Q213.

Three circuit boards are used in the tuner. These boards are the rf head, i.f. strip, and multiplex and power supply boards. Each board is completed according to the sequence shown. When all boards are wired,

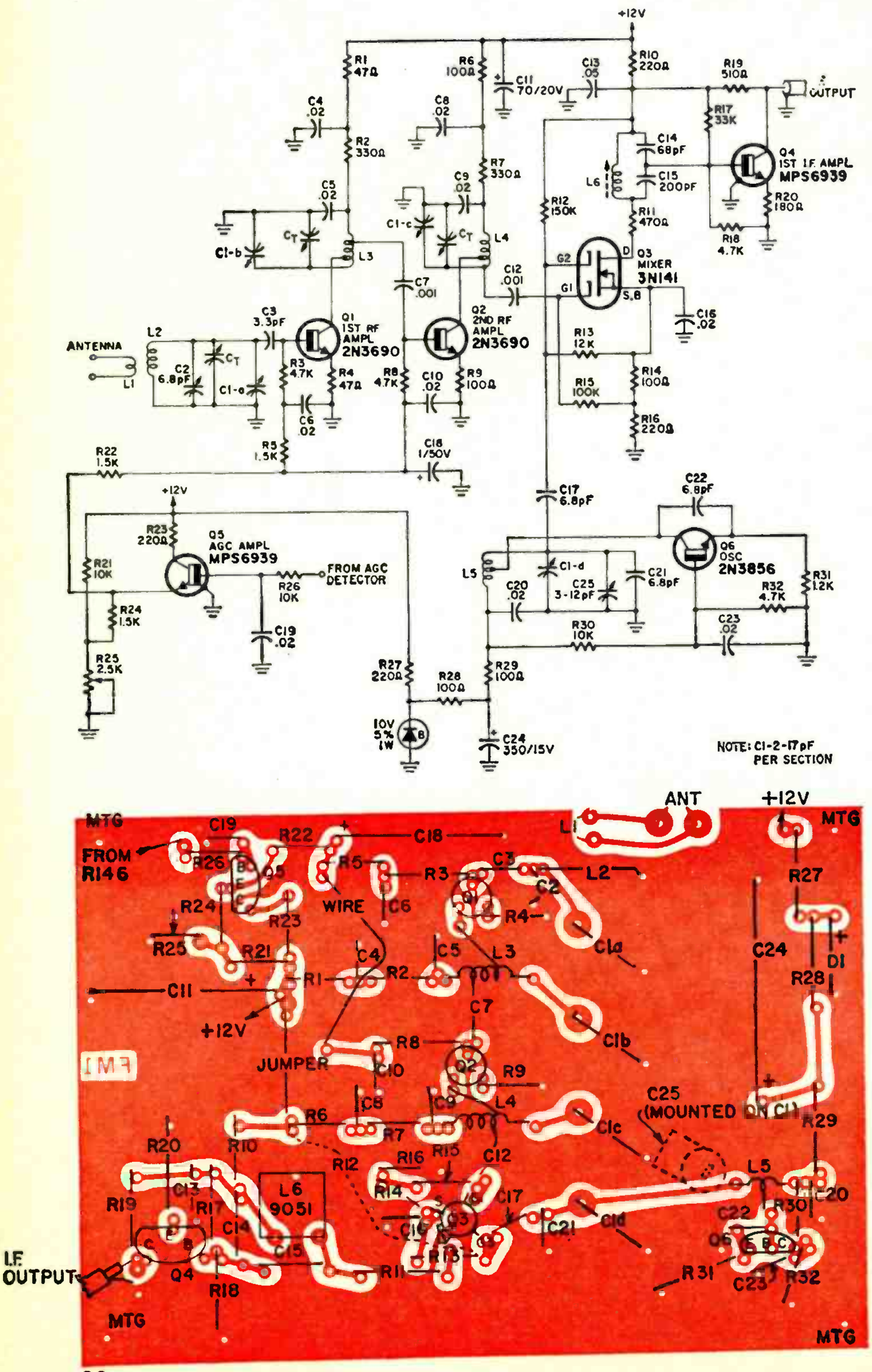


Fig. 2—**Rf-head schematic** is above, and the component placement for its PC board in on the left. Notice trimmer C25 is mounted on the "d" section of the four-part tuning capacitor which is mounted on the board. Parts list for the tuner begins on page 72.

they are temporarily mounted in the chassis for alignment. After alignment is complete, the dial panels are mounted and the unit is ready for final wiring and assembly.

Alignment procedure

Set dial to 88 MHz. Loosen the dial drum set screws and slide the drum off the shaft. Using small pieces of masking tape, tape the dial cable in place so it cannot become tangled.

I.F. STRIP

1. Set generator for a sweep width of about 300 kHz, centered about the 10.7 MHz. If possible, use post marker adding to set two markers; one at 10.6 and the other at 10.8 MHz. Set the generator output level to about 200 μV. Connect the output cable ground to the edge of the i.f. strip near the input to F101. Clip the "hot" lead to the insulated cable jacket leading to F101; DO NOT tie the hot lead directly to the input pin of F101.

2. Set the bottom (primary) slug of T102 for a symmetrical response with the top slug tuned off resonance. The scope vertical input should be connected to the output lead from R121, and the horizontal input should be fed from the sweep voltage in the generator. Follow the generator instructions for connections and phasing procedures.

3. Next adjust the top slug (secondary) of T102 for best linearity between the 10.6 and 10.8 MHz markers. Do not retune the bottom slug.

4. Connect a dc vtvm set on the lowest range between ground and the top end of R119. Slowly adjust the

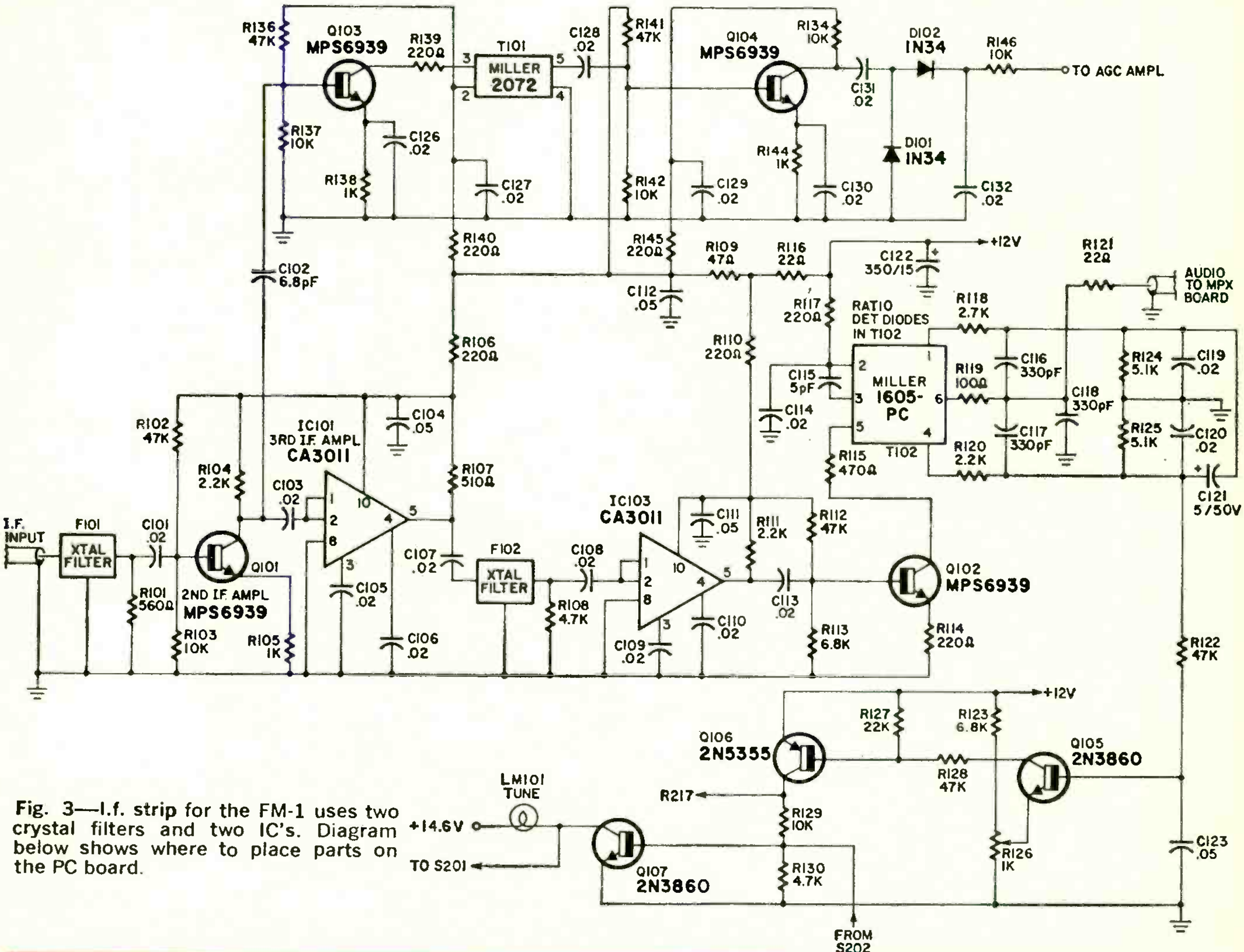
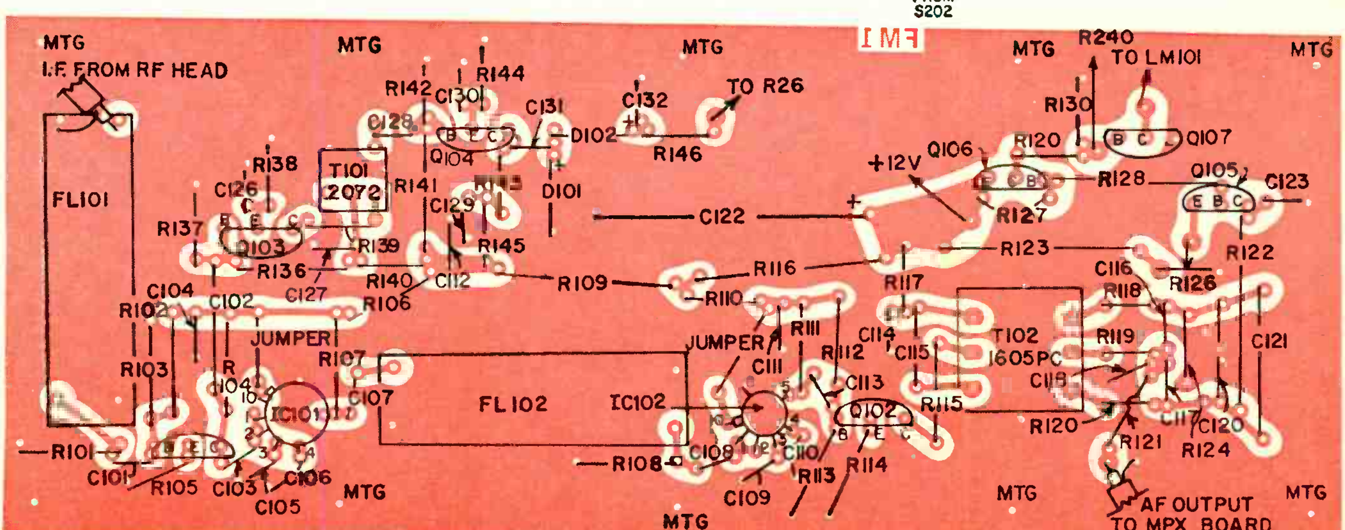


Fig. 3—I.f. strip for the FM-1 uses two crystal filters and two IC's. Diagram below shows where to place parts on the PC board.



top slug of T102 for exactly zero volts. This should be a very small part of a turn.

5. Connect the vtvm to the output lead from R146 and increase the generator output until you can read some voltage above zero. Tune T101 for a maximum reading. Reduce the generator output and repeak T101.

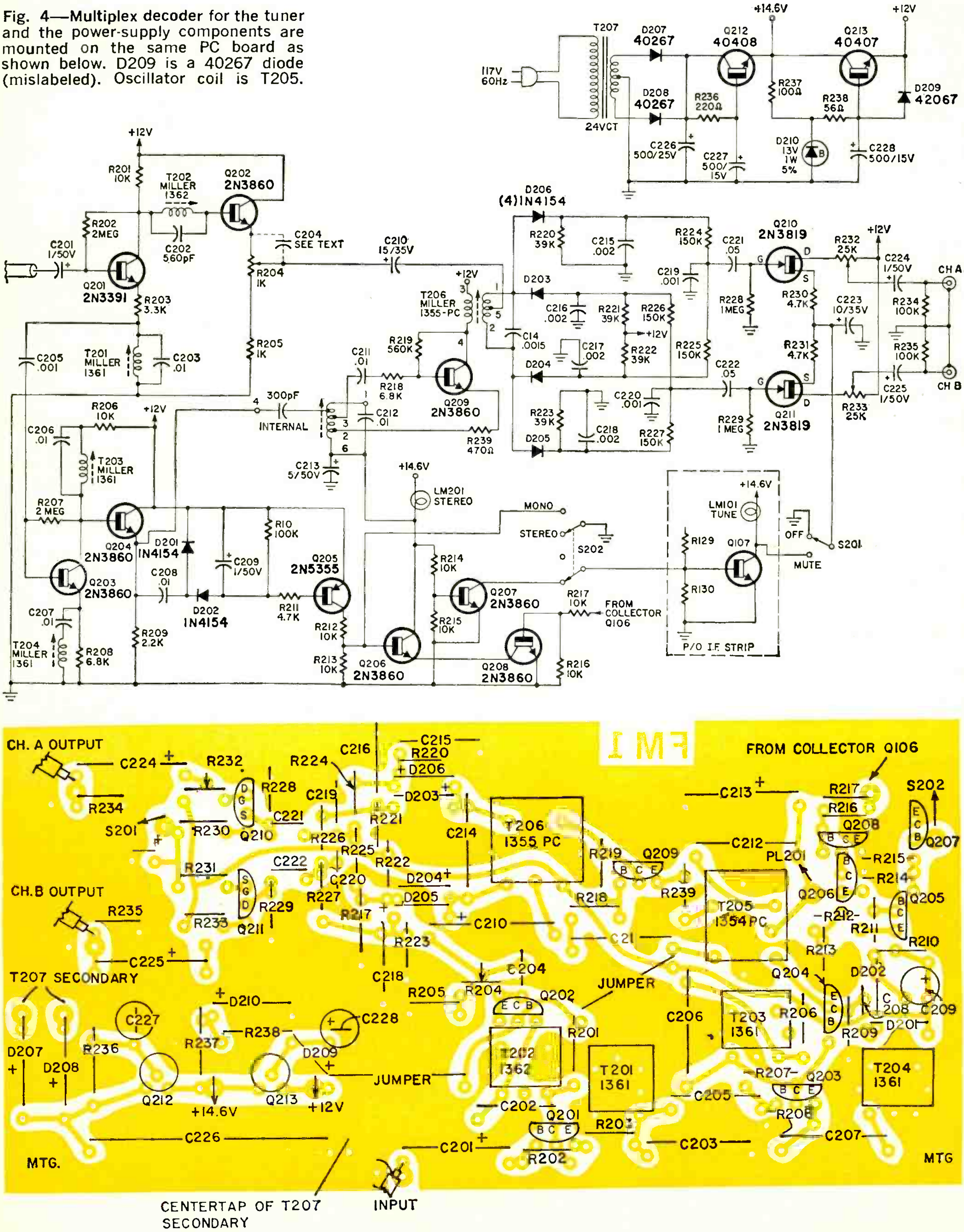
6. Place a small ceramic-disc capacitor in series with the output lead of the generator and connect the capacitor to L4. Leave the vtvm on R146. Increase the generator output and tune L6 for a maximum reading. Reduce the output and repeak L6 This completes the i.f. alignment.

RF HEAD

1. Set R25 to mid-position; connect a small amplifier and speaker to the output lead from R121. Set the generator output to 88 MHz with enough deviation so that an audio sig-

(continued on page 70)

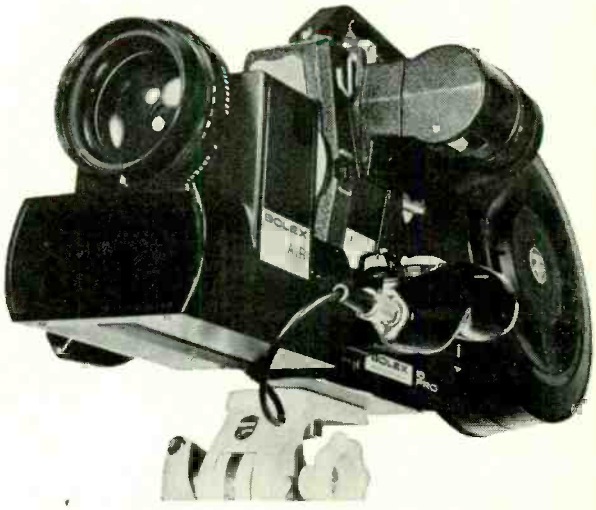
Fig. 4—Multiplex decoder for the tuner and the power-supply components are mounted on the same PC board as shown below. D209 is a 40267 diode (mislabeled). Oscillator coil is T205.

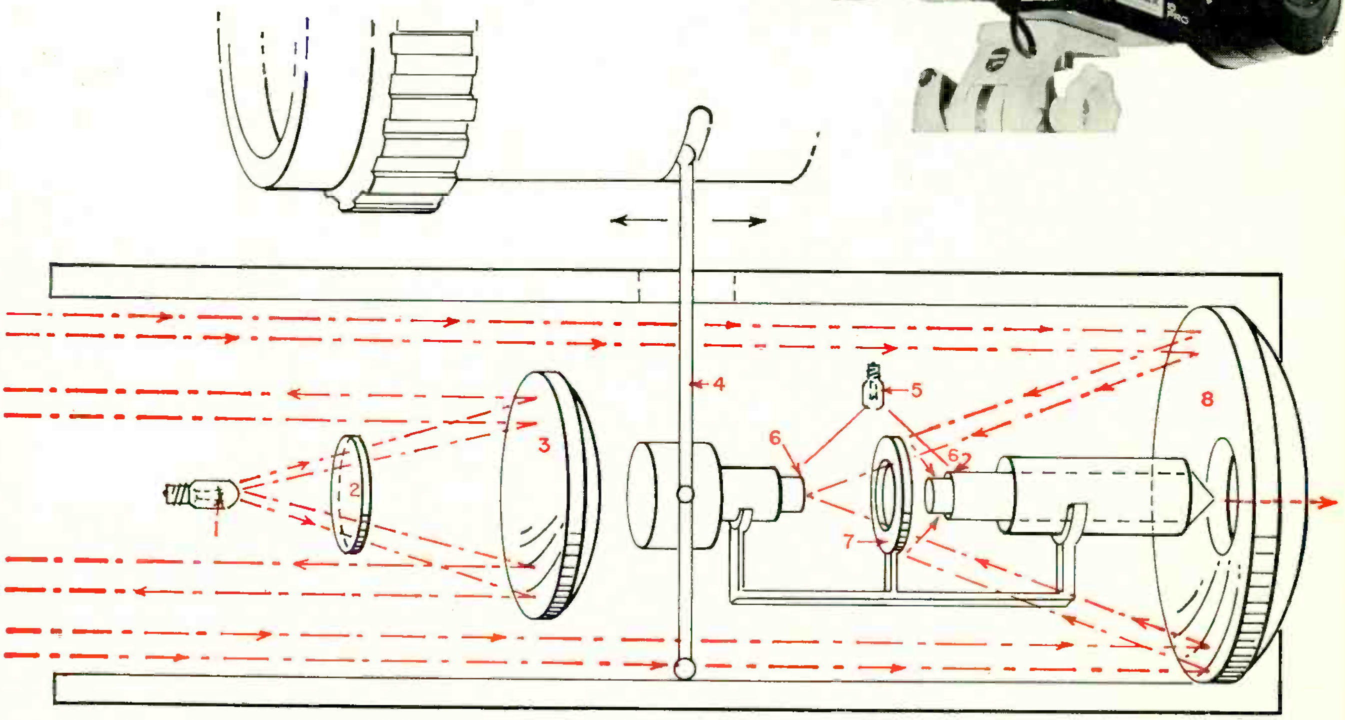


PHOTOGRAPHIC ELECTRONICS-'70

by **JOHN R. FREE**
Associate Editor

A narrow, invisible beam of modulated light penetrated the twilight near the United Nations building. Aimed through a group of reporters clustered around the ambassador's limousine, the beam caught him squarely in the chest as he stepped to the sidewalk. He paused; then, dodging questions, strode rapidly toward the UN. Now the beam was fixed on his back. Inside the small AIR unit pointed at him, computer circuits hummed . . . a servomotor whirred faintly, tracking him. . . .





SOUND LIKE THE SCENARIO FOR A Hollywood science/spy thriller? Within a year, VIP's around the world may be "zapped" with invisible beams. The source of this international intrigue is Yverdon, Switzerland, where the Bolex AIR (Automatic Infrared Rangefinder) is being made.

The harmless beam comes from a 2-watt, 12-volt bulb in the AIR, whose function is to help newsreel cameramen keep their subjects in focus automatically. Variations of the AIR system may eventually be used for non-professional cameras.

The Bolex-made system, previewed at several photographic shows, will cost about $700 when it reaches the market. The AIR shown in the photo is fitted to the Bolex 16 Pro, a newsreel camera with built-in power focusing. The 4 x 4 x 8-inch electronic and optical package guarantees accurate focusing between 5 and 80 feet. A 12-volt battery powers both the camera and AIR.

Projector and detector

To hit the camera subject with a narrow beam of modulated infrared light and receive the reflected radiation, the optical system shown in the diagram is used. A Schott glass infrared filter (2) absorbs most of the visible light from the projector lamp (1), which is positioned at the focal point of a Mangin mirror (3). (This is a concave lens with a reflective coating on its rear surface.) The mirror curvature is designed so the infrared spot on a target 30 feet away is only 3 inches in diameter.

Part of the infrared light reflected from the subject strikes the larger receiving Mangin mirror (8). This light may be an extremely faint 10^{-14} watt, and of course is mixed with other light wavelengths—unwanted for AIR operation, but necessary to expose ordinary film. The

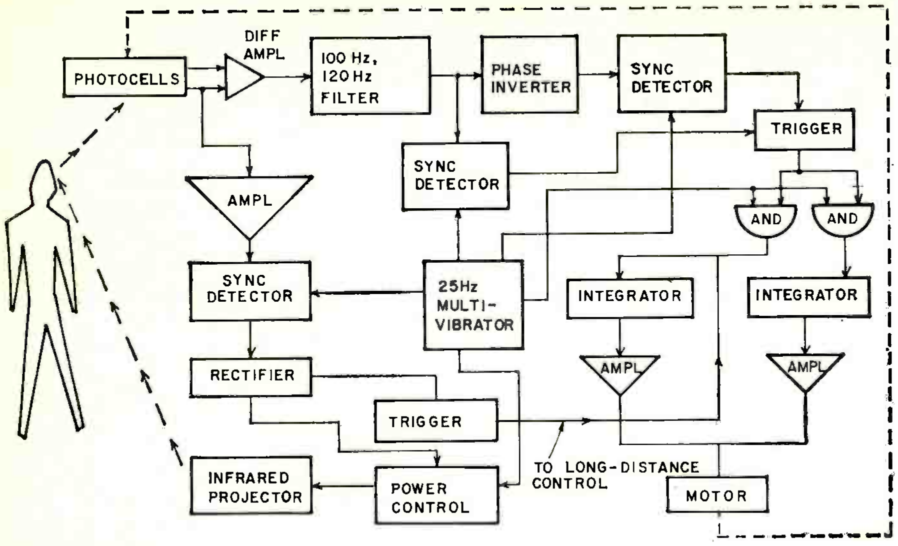


Fig. 1—Servoloop is formed by subject, mirror/photocell assembly and the circuit. Long-distance control sets lens to infinity when signal disappears.

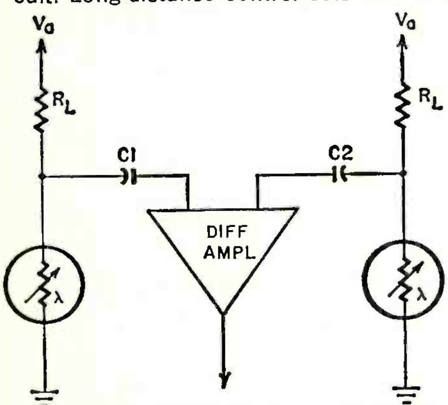


Fig. 2—Dc voltage in photocell circuit from sunlight is blocked by C1 and C2.

larger Mangin mirror focuses light from the camera subject into a ring-shaped image that shifts along the mirror axis slightly as the subject moves away from or toward the AIR.

This image is directed toward a ring-shaped separator mirror (7) positioned between two infrared-sensitive photocells (6). The separator mirror/photocell assembly can move along the receiving mirror's axis, tracking the moving image.

When a camera-shy ambassador hurries away from the AIR, his image moves down the mirror axis, passing *through* the hole in the separator mirror and falling *only* on the left photoresistor. This unbalances the photoresistor/servo circuit (described later), which sends a signal to a servomotor telling it to move the mirror/photocell assembly down the mirror axis and "hunt" for the image missing on the right photoresistor. Simultaneously, the motor moves the camera lens into focus (4).

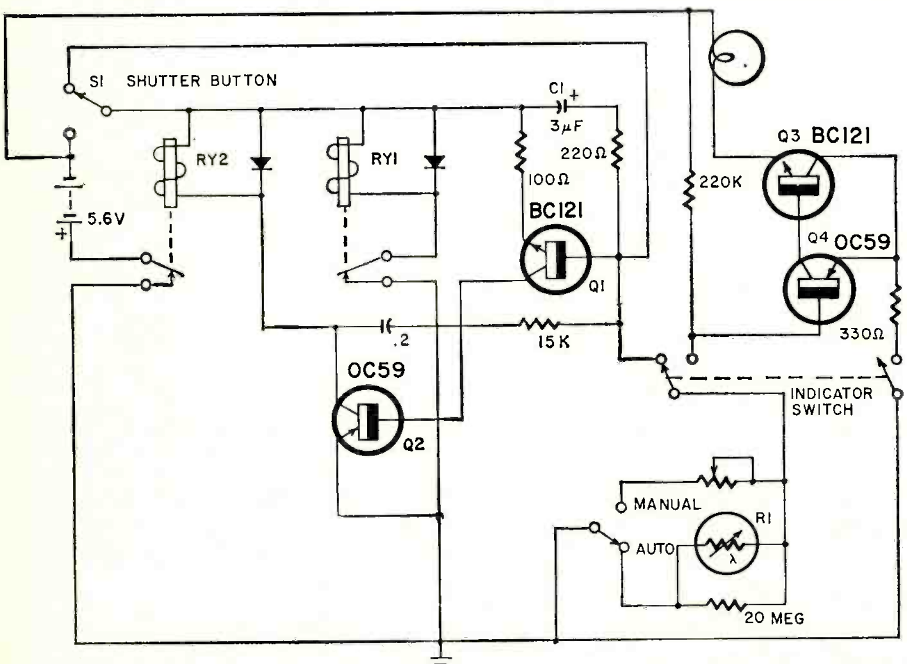


Fig. 3—Minox C works when S1 energizes RY1, opening shutter. C1 charges through photoresistor R1 until Q1 conducts, turning on Q2, which activates RY2.

When the separator mirror moves into the correct plane with the image, some light passes through the separator mirror to the left photoresistor and some is reflected to the right photoresistor. With both photocells illuminated, the servomotor does not receive a drive signal. If the cameraman moves closer to the ambassador, or vice versa, only the right photoresistor will be illuminated, and the mirror/photocell assembly will move toward the receiving mirror until equilibrium is achieved again.

Electronic servo circuit

Everything a cameraman points the AIR at emits infrared light, so the advantage of modulating the infrared projector is obvious: it makes the AIR's radar-like beam stand out from the infrared "chaff." Bolex selected 25 Hz as the central multivibrator frequency (Fig. 1) since at higher frequencies the lamp filament would not dim enough between pulses to provide a well-modulated beam.

Voltage generated in the photoresistor circuits due to continuous light (sunlight, car headlights, etc.) is eliminated by capacitors C1 and C2 between the differential amplifier and photoresistor voltage divider (Fig. 2). Interfering illumination of 120 Hz (100 Hz in Europe) is filtered after the signal voltage is amplified. To operate the photoresistors in a fixed region of their response curve, a small "bias" lamp (5) shines on them. This lowers sensitivity, but improves accuracy.

Depending on which photoresistor is illuminated, the differential amplifier output will be in or out-of-phase with the multivibrator. A phase inverter insures the sync detectors receive out-of-phase signals, so only one conducts when it receives in-phase 25-Hz pulses from the multivibrator.

After shaping in the trigger circuit, the signal turns on the proper AND gate. The pulses are then integrated, the voltage is amplified and, depending on its polarity, operates the servomotor to drive the mirror/photocell assembly forward or backward.

Incoming light to the photoresistors may vary at a ratio greater than 1:1000. The reflected 25-Hz signal, as we've mentioned, is a very small portion of the light reaching the photoresistors. But to keep this 25-Hz signal fairly constant, an automatic gain control circuit is used.

Bolex hasn't described this part of the AIR, but it appears that part of the return signal from the right photocell is fed to this circuit when the subject is near and highly reflective. After detection and rectification, it is used to control the light output of the projector lamp.

The servoloop formed by the mirror/photocell assembly, circuit and dc motor may look familiar if you've read about or used the autofocus slide projectors on the market. They usually use a mirror/lens arrangement to reflect a beam of light from the front of the slide to a spot between two photocells. If heat "pops" the slide slightly out of focus, the beam is deflected onto one of the cells, whose output operates a servomotor to drive the projector lens or slide holder into proper focus.

Minox C exposure control

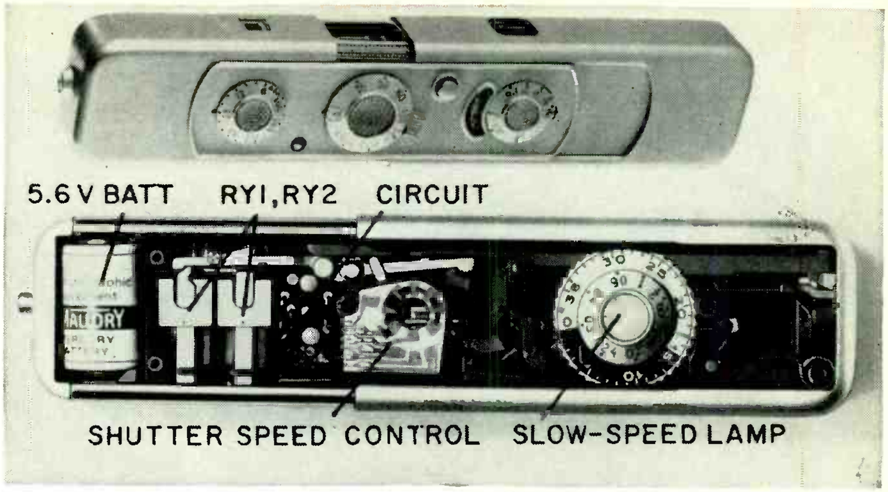
Automatic electronic exposure control for 35 mm and other cameras is now old hat, but packing all the gadgetry necessary for the job into a 4¾ x 1⅛ x ⅝-inch unltraminiature camera—without using IC's—is no simple task. To squeeze all the hardware into their model C, Minox had to extend its length about ¾ inch beyond the B model. The miniature PC board for the Minox C requires very little space, but the 5.6-volt battery and electromagnets to operate the sliding double-blade shutter occupy about one-quarter of the case (see photo). The shutter-control circuit works with a fixed f/3.5 lens to expose the film from 7 secs to 1/1000 sec.

Despite its miniaturization, the exposure-control circuit is conventional, charging a timing capacitor through a cadmium-sulphide photocell (Fig. 3). When the shutter button (S1) is closed, electromagnet RY1 is energized, opening the shutter. Power is removed from RY1 an instant later when its normally closed contact opens. The shutter remains open.

Light falling on photoresistor R1 then begins charging C1 until a voltage level is reached where Q1 begins to conduct. This turns on Q2, which energizes RY2 and closes the shutter. RY2's contact opens and resets the circuit.

Like most electronically operated cameras, the Minox C also has a circuit to indicate when lighting conditions are too poor for a hand-held shot. To get this reading, the indicator switch is pressed and the lamp lights (through Q3 and Q4) if the exposure time would be long enough to require camera support.

A special miniature cadmium-sulphide photocell was specially designed by Clairex for the Minox. The cell was the only type available with an adequate slope of the conductance-vs-light curve at low resistance to be used linearly. A center-weighting effect is achieved with the photocell by positioning it in a light well.



Miniaturized electronic shutter control for Minox C fits in 4¾ x 1⅛ x ⅝" case.

Oscillating shutter blades

A new circuit being used by Nikon in their movie cameras operates in conjunction with a photocell circuit to keep the diaphragm blades of a camera constantly in motion—although the motion does not register on the film.

Automatic exposure control for movie and TV cameras generally uses a photocell circuit that controls the current through the moving coil of a galvanometer. The diaphragm blades are mechanically linked to the moving coil. A problem with moving the diaphragm blades rapidly to compensate for changes in light has always been static friction between them. Also, since the galvanometer exerts little force, the blades can easily be jammed if foreign particles increase the friction between them.

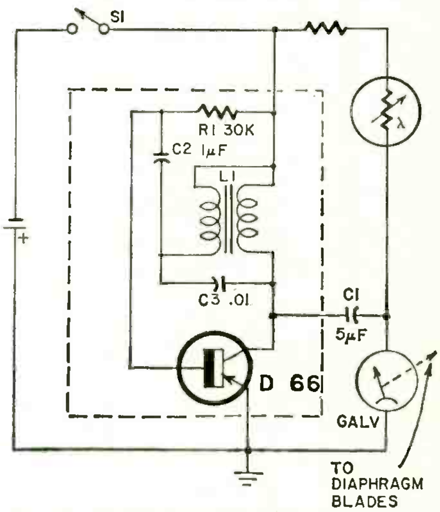
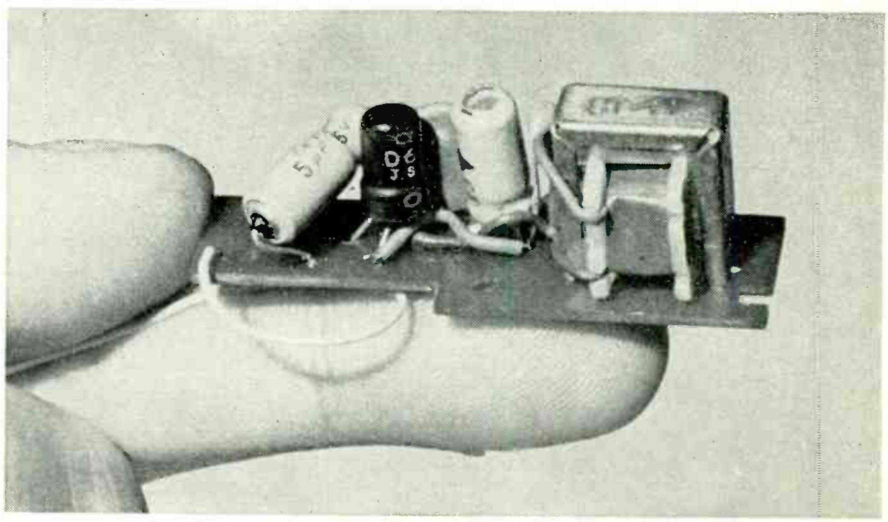


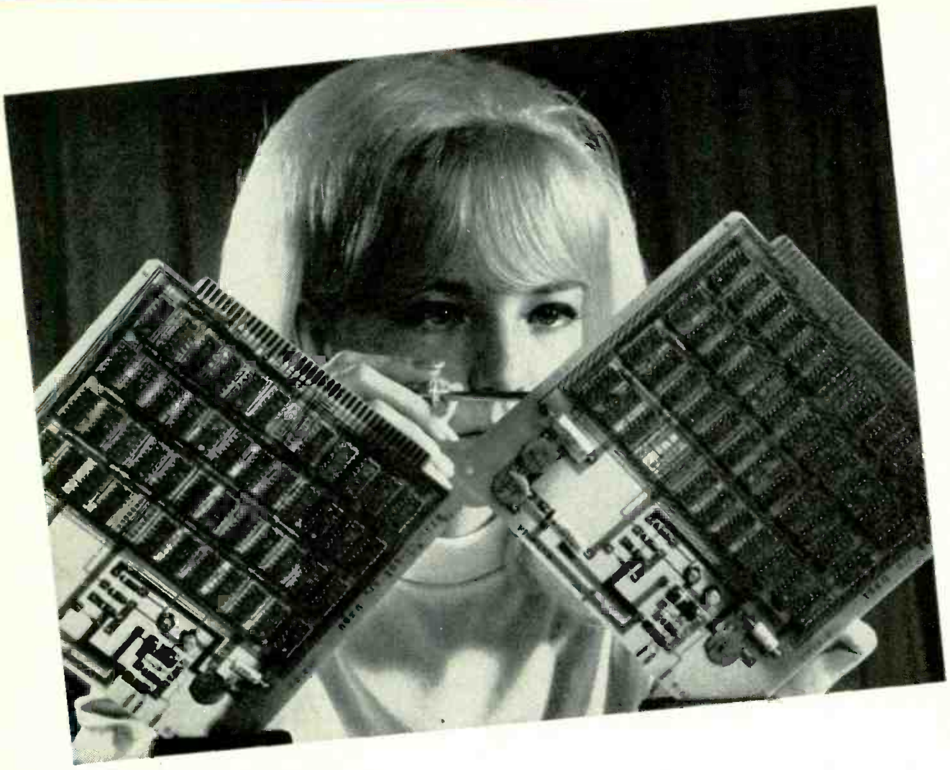
Fig. 4—Oscillator circuit puts ac current on galvanometer, vibrating blades.



Components shown in dashed-line portion of circuit above and C1 are on this small PC board.

The circuit used by Nikon (Fig. 4) provides an oscillating current that is superimposed on the direct current passing through the galvanometer. Component values in the circuit produce an oscillation frequency of about 200 Hz, and the circuit, minus the galvanometer and photoresistor, is mounted on a miniature PC board (see the photograph above).

At 200-Hz, the oscillation of the moving coil cannot register on the film, and the frequency is greater than the natural frequency of the diaphragm blades. As a result, jerky movement of the blades is eliminated and jamming is prevented. **R-E**



Easy-to-Build Computer Logic Circuits

by **MATTHEW MANDL**
CONTRIBUTING EDITOR

WHILE MODERN DIGITAL COMPUTERS use thousands of transistors, diodes and other components, the number of circuit *types* are few. Logic functions are performed by repeatedly using certain circuits, in series or parallel combinations, to perform the required tasks of counting, sorting and routing signals, and of modifying binary representations as needed.

Since logic circuits are not complex, they are easily assembled. Thus, if you build your own you not only learn the over-all circuit function, but get better acquainted with the function of individual components and the logic which applies to their use. With chips and modules it is almost impossible to acquire a true understanding of complete circuit makeup and its various functions.

Switches and gates

Most computer logic circuitry has switching functions. Signals are gated and routed to conform to preset conditions. Since a switch is either closed or open the two states are related to 0 and 1 (the binary system). Steady-state or pulse-type signals can be used to represent logic 0 or logic 1. If a positive voltage is selected as representing logic 1, then the absence of a voltage, or a negative voltage, represents logic 0. Similarly, if a negative voltage represents 1, logic 0 is either a positive voltage or no voltage. In the initial design of a computer, either a positive or negative signal is selected to represent logic 1.

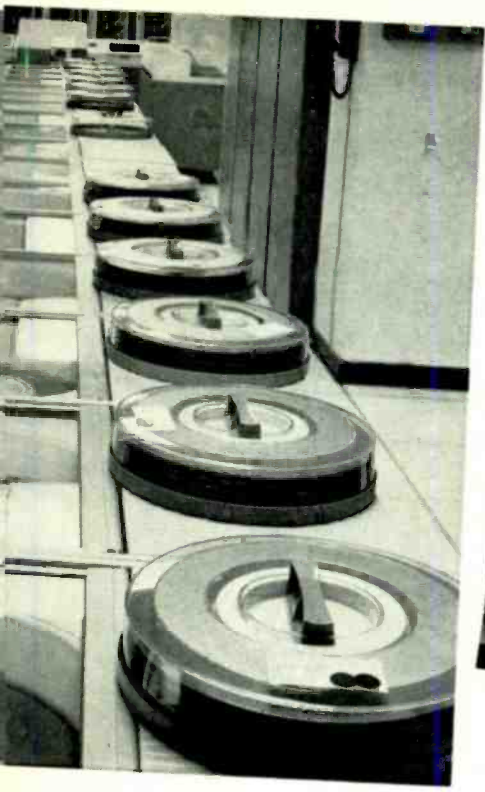
Diodes have the advantage of forming simple and inexpensive logic circuitry, though transistors provide signal gain where needed and can also alter logic by phase inversion, as shown later. If you construct the circuit shown in Fig. 1 you can observe the function of two basic, and important, logic gates. Diodes other than 1N34 types can be used as long as they have a good front-to-back ratio. Use a vtvm or a 20,000-ohms-per-volt meter for output signal observations.

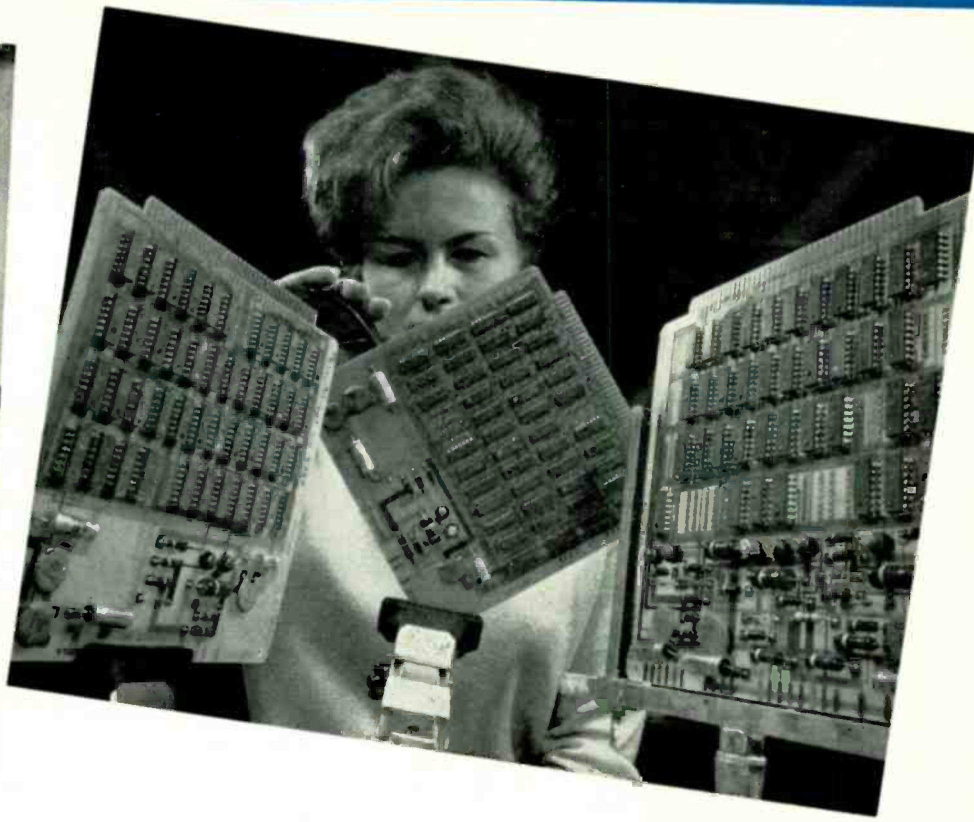
While pulse-type signals would normally be used for this circuit, its function can be readily observed with steady-state signals. The type logic obtained with this circuit depends on whether we select a negative or a positive signal to represent 1. Initially, let's assume that a positive signal is logic 1 and a negative signal (ground) is 0. Set both spdt switches so inputs A and B to the diodes are at ground-voltage level. This now represents 0 input at A and B.

Now throw the A input switch to the positive-signal input. Note that a reading is obtained at the output, representing a 1 output (positive voltage). Place the A switch at ground again and repeat the procedure for the B switch. Note that an output is obtained again. Note also that an output is obtained when *both* switches engage a positive input.

You have now observed the function of what is known as an OR gate (or switch). The logic is: If either A *or* B *or* both inputs are ap-

All photos on these pages are of the RCA Spectra 70 computer system. Courtesy of RCA.





Logic circuits are the basic elements of a computer. Discover how they work by making your own—it's easy!

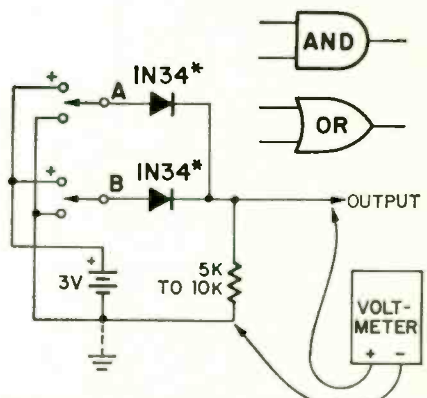
plied, an output is obtained. This OR circuit has a special symbol which is also shown in Fig. 1.

If we invert the logic 1 representation, we form an entirely different logic gate. Assume *negative* voltages represent logic 1 and place each spdt switch to the plus position for an initial logic 0 input at both A and B. The meter at the output reads a steady-state positive voltage, now representative of logic 0. Since a positive voltage appears at the input to each diode, both conduct.

If *either* the A or B input is changed for a logic 1 input (switching from positive- to negative-ground input), no appreciable voltage change is felt at the output, because one diode will still conduct. If, however, both A *and* B inputs have a negative voltage applied (logic 1's) both diodes stop conducting and the output voltage drops to the ground (negative) level, representing a logic 1 output of the circuit.

Thus, for this gate to produce an output when negative voltages represent logic 1, both the A *and* B inputs must be applied. Hence, this is called an AND gate or switch. Its special symbol is also shown in Fig. 1. This is sometimes also called a *coincidence* gate, because simultaneous inputs must be applied to obtain an output signal.

For more thorough understanding of the OR and AND functions reverse the diodes and the battery potential of Fig. 1. Now if you repeat the same test procedures you will find that an OR gate is formed when *negative* signals are used for logic 1's and



* OR EQUIVALENT

Fig. 1—OR function is shown when A or B or both inputs (switch to +) provide an output. AND function, or coincidence gate, requires both A and B switches in negative position for an output signal (negative voltages for a logic 1).

an AND gate function is obtained for conditions where *positive* signals are logic 1's.

In-depth analysis of factors relating to switching-circuit logic is done by using a special math known as Boolean algebra. In this system the OR and AND functions are indicated by using a plus sign (+) for the OR logic and a multiplication sign (·)

for the AND logic. These signs are called *logical connectives* and if the circuit shown in Fig. 1 is used as an OR gate, the Boolean expression is: A+B, where the plus sign is read as OR (A *or* B). For the AND function, we can show it as A·B, or use the algebraic method for displaying the multiplication, by placing the variables close together as AB.

More than two inputs can be used in the OR and AND gates of Fig. 1. If three inputs are used, for instance, the OR expression would be A+B+C (assuming our third input is designated as a C). Other designations can, of course, be used. If we have a three-input AND circuit, with X, Y, Z inputs, the expression that

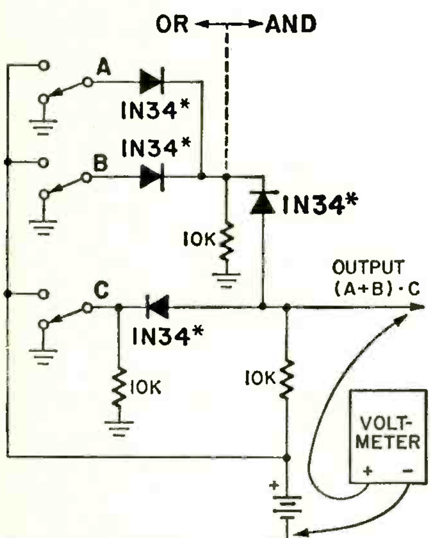


Fig. 2—Two- level circuit: two-input OR followed by two-input AND. Output requires A and B or both, plus the C input.

would be used is X·Y·Z, or XYZ.

Tables and levels

The logic of the OR and AND switches can be shown in "truth table" form, indicating the output obtained for given inputs:

OR gate		AND gate	
A+B+C	Output	A·B·C	Output
0 0 0	0	0 0 0	0
0 0 1	1	0 0 1	0
0 1 0	1	0 1 0	0
0 1 1	1	0 1 1	0
1 0 0	1	1 0 0	0
1 0 1	1	1 0 1	0
1 1 0	1	1 1 0	0
1 1 1	1	1 1 1	1

These tables show that an output is obtained for any one or more inputs to the OR switch, but an output is obtained from the AND gate only when all inputs are present.

One logic gating system can follow another to obtain specific functions, as shown in Fig. 2. This circuitry is a *two-level* type and could also consist of an AND circuit feeding an OR circuit. For the one shown we have a two-input OR gate followed by a two-input AND switch. Thus, since coincidence must occur at the AND gate inputs, we must have the C input *and* at least one or both of A and B. In this system we are using positive voltages for the logic 1's. Again, 1N34 diodes (or equivalent) are used.

Two-level logic in symbolic form is shown in Fig. 3. The OR-AND combination which produces an output of (A+B)C applies to Fig. 2, and a C input must be present with either A

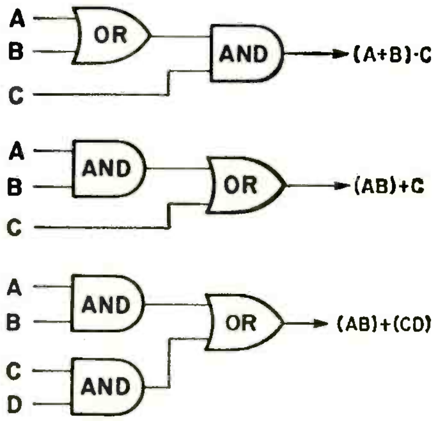


Fig. 3—OR-AND two-level logic symbol (top), AND-OR (middle) and the AND-AND-OR (bottom). Text shows (A+B)C truth table.

Fig. 4-*a*—(right) Emitter-follower circuit keeps input signal phase and has no voltage gain. *b*—NOT circuit inverts phase.

or B (or both) for an output. The single AND gate feeding the OR circuit with an output of (AB)+C is obtained if we reverse the diodes of Fig. 2 and also the battery potential, while still using positive voltages to represent logic 1. Now, C alone will produce an output, or A and B in coincidence, as well as all three inputs at the same time.

For Fig. 2 the C input could be replaced by another OR circuit to produce the logic (A+B)·(C+D), where at least one input from each OR circuit must be used to produce an output. With reversed logic we have the two AND gates feeding an OR circuit, as also shown in Fig. 3. Now the logic is (AB)+(CD). Now either A and B or C and D will give an output.

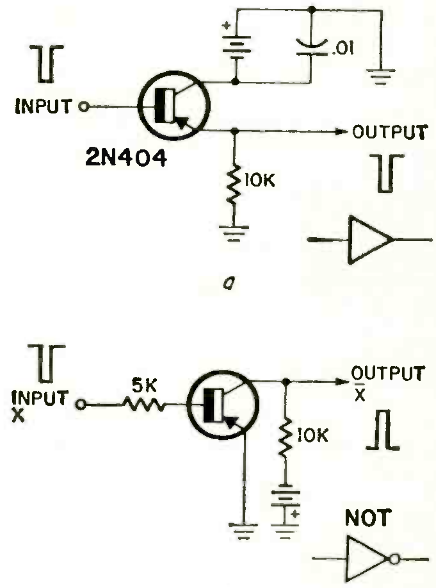
Truth tables can also be constructed for these circuits, showing the logic which applies. The following example applies to the (A+B)C system:

(A+B) C	Output
0 0 0	0
0 0 1	0
0 1 0	0
0 1 1	1
1 0 0	0
1 0 1	1
1 1 0	0
1 1 1	1

This table shows that only three input combinations produce an output: A and C, B and C, or all three inputs.

Transistor logic

Transistors, while more costly than diodes, provide amplification as well as additional logic functions not obtainable with diodes. For the circuit



in Fig. 4-a, the output is obtained from the emitter resistor, hence the circuit is called an *emitter follower* (and compares to the tube-type cathode follower). If a negative signal (pulse or dc voltage) is applied to the base input line, the necessary forward bias is applied to permit the transistor to conduct.

Now, electron flow is from the negative terminal of the battery to the collector and emitter and down through the output resistor. Thus, a negative signal is developed at the output. While such a circuit has no voltage gain, there is signal current amplification. Note that the phase of the output signal "follows" that of the input—hence the term "emitter follower." The triangular symbol for amplifier is used as shown.

For the circuit in Fig. 4-b the output is taken from across the collector resistor. Electron flow is up through this resistor, producing a positive-signal output as shown. When we have such a phase reversal of the signal between input and output, the logic which applies relates to **the output** signal *not* being in phase with the input signal. Hence this is known as a NOT circuit.

A line over a letter indicates the NOT function, as $\overline{A}$ for "NOT-A" and $\overline{X+Y}$ for NOT-X OR NOT-Y. A triangular symbol is used as with the amplifier, but a small circle denotes the NOT function. This logic function is useful when it is necessary to change a logic 1 to logic 0 or vice versa in computer circuitry design.

Diodes can be combined with transistors as shown in Fig. 5. Two diodes provide an OR gate input to an emitter follower in Fig. 5-a. Additional diodes could be included to provide more input lines. Such circuitry is known as diode–transistor logic and sometimes referred to as a DTL

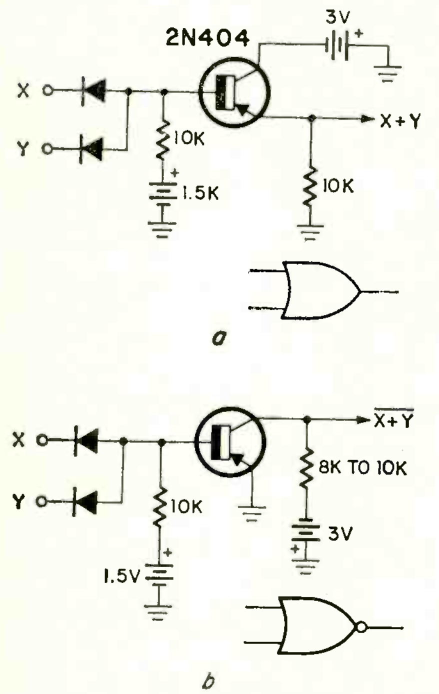


Fig. 5-*a*—DTL (diode-transistor logic) OR circuit. *b*—NOT-OR (NOR) circuit.

circuit. For the circuit in Fig. 5-b the output is from the collector and hence a NOT function is also obtained. Now we have the logic condition of NOT-OR, is commonly termed a NOR circuit. Note the OR-circuit symbol now has the small circle denoting the logic inversion function.

For the circuits in Fig. 5, a reverse bias is applied to the base circuit, thus cutting off transistor conduction. A negative signal above −1.5V applied at either (or both) the X and Y inputs overcomes the reverse bias and causes conduction. Electron flow up through the collector resistor (Fig. 5-b) develops a voltage drop across it, producing a positive-signal output. The diodes could be replaced with resistors for resistor–transistor logic (RTL) though diodes work better.

As with the diode logic gates discussed earlier, the AND function can also be obtained from these circuits. For Fig. 5-b the result is a NOT-AND logic function, known as a NAND circuit. The symbol for the NAND circuit is shown in Fig. 6, where others are also shown for comparison.

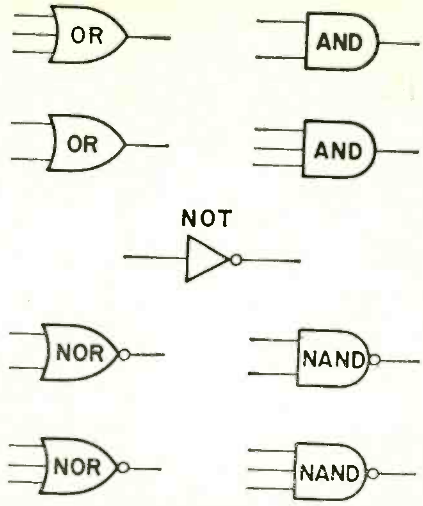
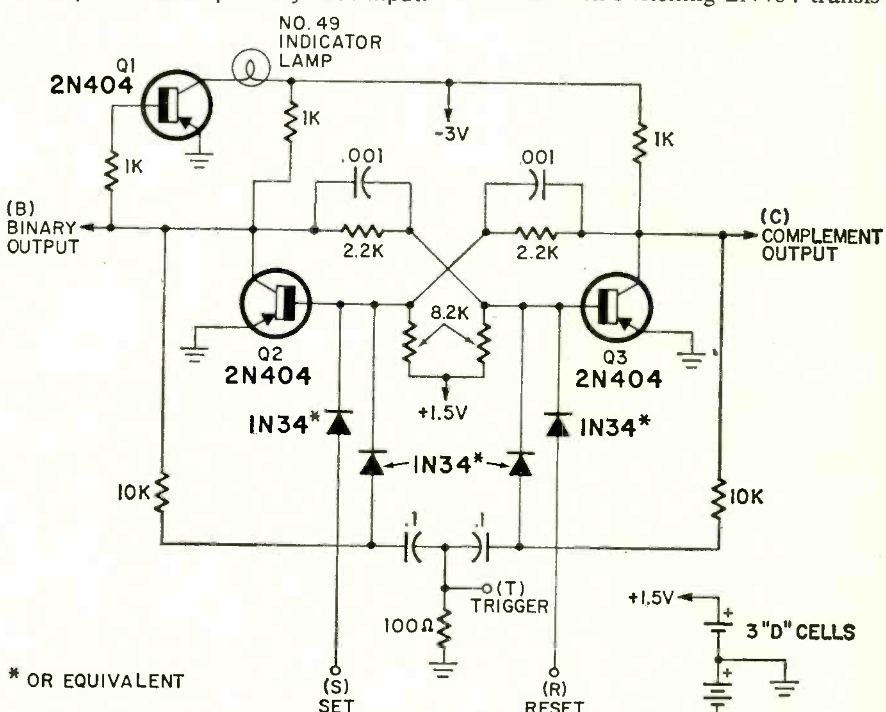


Fig. 6—Symbols for two- and three-input OR, NOR, AND, NAND gates.

Fig. 7—Below is a bistable flip-flop, which produces output only with input.



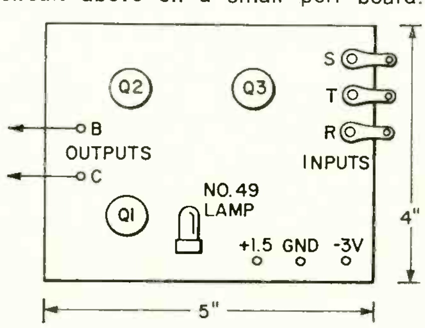
The flip-flop

The flip-flop circuit performs many functions in a digital computer. A string of flip-flop circuits forms counters, temporary storage registers, accumulators (accumulating counts as basic addition), scalers (a form of binary division), and switches (providing "on" and "off" conditions as needed).

The flip-flop is a *bistable* device with one state representing logic 0 and the other logic 1. It is not a free-running oscillator and produces an output signal change only when an input signal is applied.

The flip-flop shown in Fig. 7 uses medium-switching 2N404 transistors and operates with only three D-cells as shown. It has an extra transistor to drive the indicator lamp to show the logic 1 state of the flip-flop. The circuit can be built on a 4 x 5-inch panel as shown in Fig. 8. The output lines should be at the left so when several flip-flops are connected in series they will show binary magnitudes from right to left to conform to the arithmetic place system.

Fig. 8 (below)—Practical way to lay out circuit above on a small perf board.



Note the polarity of the base diodes. These restrict the signals to positive voltages for representing logic 1. When the flip-flop is in the logic 0 state, transistor Q2 conducts while Q3 does not. At this time the binary (B) output line is less negative than the complement (C) output line, hence it can be considered positive with respect to the other.

When power is first applied to a flip-flop it may assume either the 0 or 1 state, depending on which transistor conducts initially. Hence all computers reset all flip-flop stages to 0 immediately after power is applied. If your flip-flop indicator light goes on after you connect batteries you will have to reset it.

Use a jumper connected to the positive terminal of the battery and apply a voltage momentarily to the reset (R) input line. If the circuit has been assembled properly, the indicator light will go out. The positive voltage applies a reverse bias to the base of Q3 and causes it to stop conducting. Now the high negative potential at the *collector* of Q3 is felt at the *base* of Q2, permitting the latter to conduct.

Apply the positive voltage to the set (S) line and Q2 will stop conducting. Now the indicator light goes on, indicating the second state (logic 1) has been reached. Note that additional applications of positive signals to the set line have no effect.

Now apply the voltage to the reset line to change the stage to logic 0 again. Now note that additional voltages applied to the reset line have no effect. Voltages applied to the trigger (T) input should successively turn the flip-flop to the 1 and 0 states. (It may be necessary to apply the positive voltage quickly to imitate a pulse input for proper triggering.)

When two or more such flip-flop stages are connected so one feeds the other (Fig. 9-a) a counter is formed. Make sure the signal output from the B line is coupled to the T input of the next stage through a coupling capacitor as shown. (Ground connections must be common for each stage.)

Positive voltages applied to the trigger input of the first flip-flop (FF1) will cause the stages to count in ascending order in binary form. Thus, one signal entry into the first flip-flop will set the first stage to 1, with the indicator light on, represent-

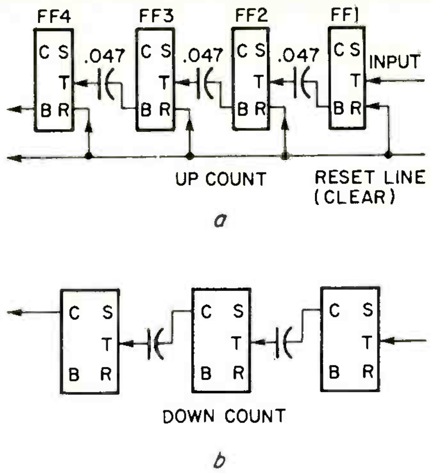


Fig. 9-*a*—Connecting flip-flop for count up. b—Count-down flip-flop circuit.

ing 0001. Another pulse entry at FF1 shuts off the indicator light of the first state and the second stage goes into the 1 state, representing number 2 in binary: 0010. The third entry into FF1 sets the counter to 0011 for 3. The fourth shows 0100, the fifth 0101, the sixth 0110, etc. up to the maximum count, which is limited by the number of stages used. Four flip-flops will count up to 15 (binary 1111).

A down counter is formed by taking the complement (C) outputs and feeding them to the T inputs of successive stages as shown in Fig. 9-b. If each flip-flop is set to 1, successive inputs to the first flip-flop will reduce the count progressively. (In some diagrams the C and B outputs are designated as 1 and 0.)

The use of AND and OR gates with a counter is shown in Fig. 10-a. This combination forms a *decade counter* that will count only up to 9 and will trigger to 0 at the count of 10. Also, at the count of 10 the next stage is triggered to its logic 1 state. Decade counters are useful in data processing and each counter accumulates counts in base-10 fashion but still operates in basic binary mode. At the count of 9 the stages hold 1001

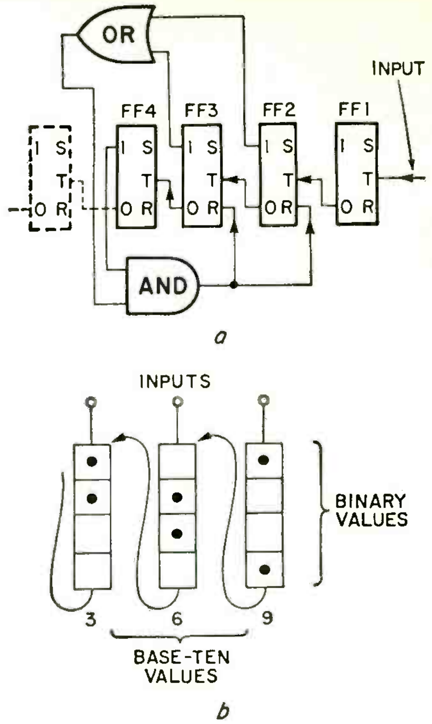


Fig. 10-a—Decade counter triggers at 10 count. b—Three decades set on 369.

(binary). Normally the entry of another logic 1 input to the counter would result in the binary number 1010 (10_{10}). The OR circuit, however, feeds the AND circuit and resets the second stage from the right to 0 and is also instrumental in clearing the fourth stage which, in turn, trips the next decade count to the 1 state.

In Fig. 10-b three decade counters are shown, holding the number 369. Note the first counter (at the right) holds binary 1001 which represents 9. The next counter holds binary 0110 (6) and the left counter contains 0011 (3). If another pulse were entered in the right-most counter, it would trip to 0 and send another pulse to the center counter, changing the latter to 7. Now the count would be 370 and the system would have added an additional 1 which was entered to the existing number. **R-E**

TOOLS FOR ELECTRONICS

by TOM HASKETT

This issue, starting on the facing page, concludes our series of articles on soldering tools for electronics. It is the third part of our description of soldering tools. This month we will also start a series on nutdrivers. We believe you will find all of this material a handy, practical addition to your R-E Reference Manual.

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

Iron and pencil accessories

You cannot simply lay an iron or pencil down on the work surface, for it can burn something or injure someone. Most people use a **holder** (also called a **stand** or **cradle**), as shown in Fig. 12. Some have a solder cup at the bottom, so the tip stays tinned.

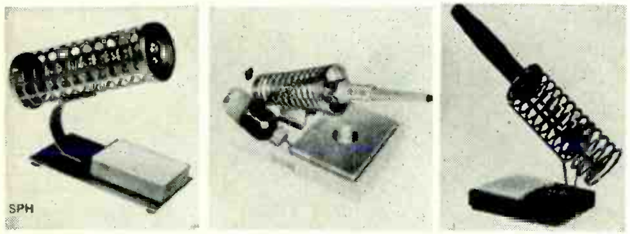


Fig. 12—Three soldering-iron holders that help make life a little easier. Left, Wall SPH. Center, Hexacon 890. Right General Electric 1197-879.

Keeping the tip of a pencil or iron clean is another continuing task. You can use a rag, but if you do a lot of soldering it's convenient to use a **tip cleaner,** shown in Fig. 13. It's merely a wet sponge in a water well, and requires only one hand to clean the tip.

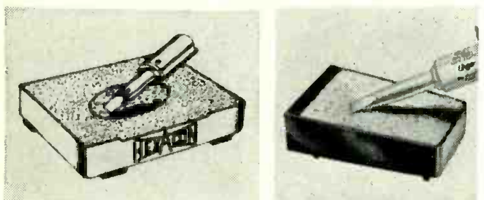


Fig. 13—Two ways to keep soldering iron tips clean. Left is Hexacon model 812. Right is Ungar 400, Kleen-Tip.

Other techniques

One very unusual soldering tool—a gun which contains a coil of solder which you can feed out into the joint—is very useful for one-hand jobs.

If you have to do some soldering in the field, away from an ac power line, you have a problem. The answer is a field iron, clamped across an auto battery. Models are available (Fig. 14) to work on 12 or 24 volts, and they come with battery clamps.

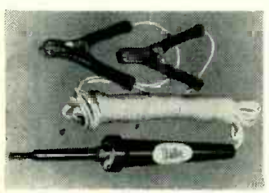


Fig. 14—When you have to solder away from any ac outlets try a battery powered iron. The Weller TCP-12 is shown.

current to the probes. Sometimes a single probe is used together with a ground return connection.

Other specialized soldering methods are used in production work: high-frequency induction soldering, dip soldering, oil-bath soldering, ultrasonic soldering and oven soldering. These highly specialized techniques are seldom used in the electronics fields covered here. **R-E**

NUTDRIVERS

The tool used for turning a hexagonal or square bolthead or nut is called a **wrench.** In electronics, many machine screws have hexagonal heads, and turning them with a right-angle wrench is tedious. Most people use a **nutdriver** (sometimes called a **socket wrench**) to turn hex-head screws and nuts up to about 3/4 inch in diameter. You can work a nutdriver much faster than a right-angle wrench. (Drivers for square nuts are made, but seldom used in electronics. This article will concentrate, then, on hex-socket nutdrivers.)

The common nutdriver is almost identical to the screwdriver; it consists of the **tip** (or **socket**), the **blade** (or **shaft**), and the **handle,** as you can see in Fig. 1. The socket and blade are forged from tool steel, and the socket is made to a precise size. The nutdriver operates, like the screwdriver, in the same plane as the bolt it's turning. The only difference is the tip, which fits over the bolthead or nut being worked. The tip, or socket, must fit very closely with the nut, or you can't turn it. Thus you must use a separate nutdriver for each size of nut (with one exception, which you'll learn about later).

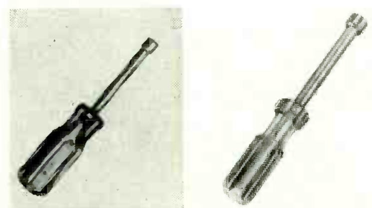


Fig. 1—Common nutdriver is adequately described as a screwdriver wrench. Channellock unit (left) and Crescent driver right are typical examples of available nutdriver types.

Socket sizes and the color code

Hex nutdrivers are available with sockets from 3/32 inch to 7/8 inch in steps of 1/32 inch, measured between parallel faces. Each

A miniature torch—like that shown in Fig. 15—is useful for soldering, brazing and welding small parts, because it furnishes high, con-

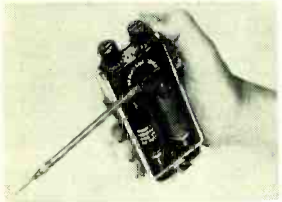


Fig. 15—Miniature torch is useful for soldering, brazing and welding small parts. Microflame unit uses butane and oxygen. Makes a neat handful in use.

trollable heat in a small place. Models are available using oxygen and some sort of fuel gas (butane, acetylene, hydrogen, LP gas or natural gas).

For really large jobs, the only thing to use is a standard size torch, as shown in Fig. 16. This tool uses propane gas as fuel, and comes with

Fig. 16—Bigger soldering jobs require a larger torch. The BernzOmatic JT-50 Jet Torch Kit is illustrated.

several nozzles which allow you to do various jobs.

The soldering technique described so far is called conduction soldering, because heat is physically conducted to the work from the iron tip. A newer method is resistance soldering, in which current passes through the joint by means of probes having a small cross section. The small area has a relatively high resistance, and the high current passing through it heats it rapidly. Thus the joint is rapidly heated to soldering temperature.

Resistance soldering is sometimes an advantage if you have to work out of doors in a windy or cold place, where a gun or iron would lose its heat rapidly to the atmosphere. Resistance soldering concentrates the heat within the joint. This is an additional advantage as you don't run the risk of heat-damaging nearby components as with a gun or iron.

A resistance-soldering outfit uses a stepdown transformer with a low-voltage secondary of a few volts which can supply a relatively high

driver is known by a number which is the number of 32's of an inch its socket measures. Thus a **No. 3** driver has a socket measuring **3/32 inch;** a **No. 28** has a **28/32-inch,** or **7/8-inch** socket.

Few manufacturers make drivers all the way from No. 3 to 28. Most make sizes from No. 6 (3/16 inch) to No. 20 (5/8 inch), as these are the nut and bolthead sizes most often encountered. A few 32-inch sizes are omitted in this range, though.

To make things easier for you, many manufacturers follow the same color code with their nutdrivers. Hence you can tell by the handle color what the socket size is. It goes like this:

No.	Socket size	Handle color
6	3/16″	Black
7	7/32″	Brown
8	1/4″	Red
9	9/32″	Orange
10	5/16″	Amber or yellow
11	11/32″	Green
12	3/8″	Blue
14	7/16″	Brown
16	1/2″	Red
18	9/16″	Orange
20	5/8″	Amber or yellow

You'll note that the colors are repeated; both the Nos. 8 and 16 drivers have red handles. However, the No. 16 is larger than the No. 8, so you can easily tell them apart. After you've worked with a set of drivers for a while, you can grab the right one after a glance at a nut.

The two most common sizes of nuts and hex-head screws and bolts used in electronics are 1/4 inch and 5/16 inch, and therefore the two most useful nutdrivers are Nos. 8 and 10.

There are also **miniature-socket** drivers, with sockets usually of 5/64 inch, 3/32 inch, 7/64 inch, 1/8 inch, and 5/32 inch. These drivers usually come in a set of 5 or 7 (Fig. 2).

For working on European-made equipment, Xcelite has **metric-size** nutdrivers, with sockets from 3 to 17 mm. Models are available with either solid or hollow shafts.

Blade types

Nutdrivers are available with several types of blades (or shanks), depending on the job they're intended for. Most common is the **standard** size shown in Fig. 1. The blade is about 3 inches long, which means the overall driver length is about 6 inches.

The standard nutdriver has a solid blade, but more useful is the **hollow-shaft** type (Fig. 2).It has a hollow blade which slips over a protruding bolt, allowing you to work the nut far down the bolt.

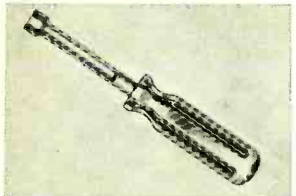


Fig. 2—Hollow-shaft nutdrivers are extra useful as they can slip right over a protruding bolt. Unit shown here is Vaco model S8.

Another variation is the long-hollow-shaft type (Fig. 3), about 9½ inches overall length. It's useful when you have to work a nut in a chassis well or recess.

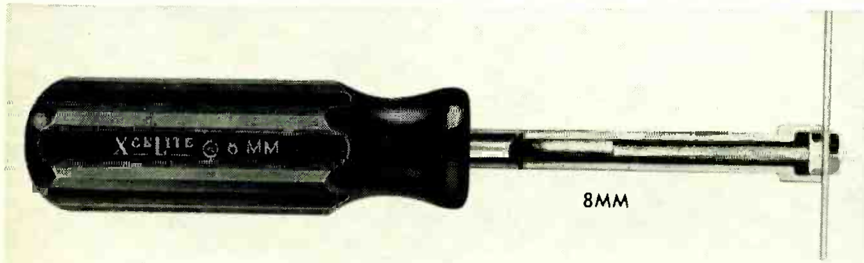


Fig. 3—Long hollow shafts are needed in some special applications. Especially useful in chassis wells or recesses. Xcelite 8 MM is illustrated.

Obviously there are times when a regular-length nutdriver won't fit the work space; then you use a **stubby** (Fig. 4) which has a thick handle

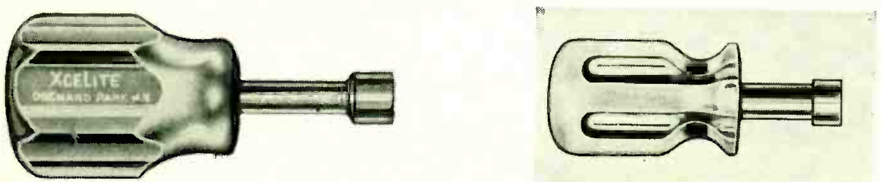


Fig. 4—Stubby nutdrivers have large handles, short blades, and get into tight corners. Left, Xcelite model S10. At right is Vaco stubby nutdriver.

of regular nutdrivers. More handy for field work is a **handle-and-blade set** (Fig. 7), which includes one handle and five or six interchangeable blades. The set is compact; you can slip it in your pocket. Some such kits include screwdriver blades. Another feature often found in a torque-multiplying **T handle** (Fig. 8). There are also **stubby** handles. And Vaco has a **ratchet-handle** nutdriver kit (Fig. 9), which speeds up the work.

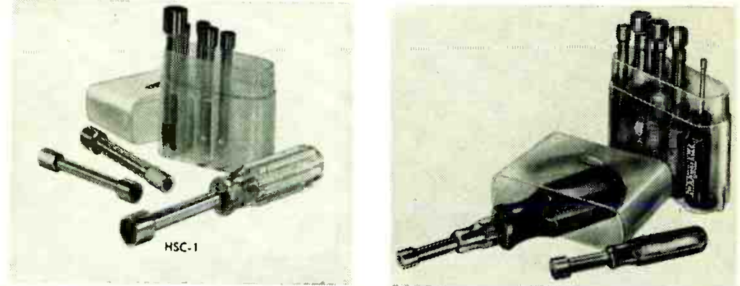


Fig. 7—Nutdrivers come in sets too. They include all of the more common sizes and usually a torque-amplifier large-diameter driving handle too. Left is Xcelite HSC-1. At right is Channellock set.

Fig. 8—T-handle is excellent torque amplifier to boost turning power. Xcelite 99-4 shown.

Fig. 9 — Ratchet nutdriver speeds work. Vaco makes it.

Back-panel service controls sometimes feature a locknut around a slotted adjustment shaft. It can be a nuisance to loosen the locknut with a nutdriver, set the control with a screwdriver, and then retighten the nut, sometimes unsetting the control. Xcelite's unique and useful HSC-1 nutdriver set consists of eight hollow-shaft interchangeable driver blades and a mating **hollow handle** (Fig. 7 & 11). Thus you can pass a screwdriver completely through both handle and driver shaft, and use both hands simultaneously to make locknut and control-shaft adjustments.

and an overall length of about 3½ inches.

The **midget** nutdriver (Fig. 5) is also small—about 3½ inches

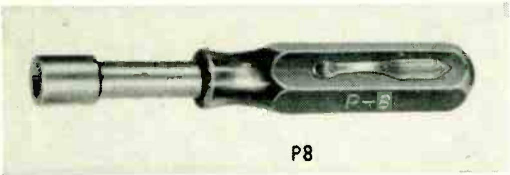


Fig. 5—Midget nutdriver is short, but unlike stubby, has slim handle. Often has pocket clip too. Unit shown here is Xcelite model P8.

overall—but has a slim handle. Most come with a clip so you can carry them in your pocket. They're useful for field work.

Occasionally you may have to work a nut in a live circuit, where the metal shaft could short out something. The answer is Klein's **insulated-blade** driver (Fig. 6) whose shaft is covered with plastic. This driver is available in socket sizes from No. 6 to No. 20.

Nutdriver handles

Few nutdrivers are made with wooden handles anymore, since plastic is a better insulator for electronics use. In addition, nutdrivers are available with **rubber handle grips** (Fig. 8). The rubber is more

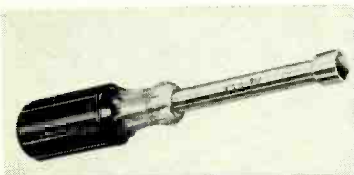


Fig. 6—Rubber handles on a nutdriver don't add insulation, but do add drive power by giving user a better grip. Klein model 630 shown.

comfortable than plastic, and this makes the driver easier to use and reduces fatigue.

Amalite's **swivel-top-handle** nutdriver is a speed-increasing device. You simply apply pressure to the handle end and turn the body with the other hand.

Because the handle of a midget nutdriver is small, you cannot obtain much torque with it. An **auxiliary slip-on** handle is available that goes right over the midget-driver handle. The result is greater turning power. The auxiliary handle usually comes with a set of five or six midget drivers. These don't have pocket clips, which would get in the way of the slip-on handle.

Handle-and-blade kits

You can, of course, buy a set of the five or six most common sizes

Fig. 10—Hole through the handle speeds locknut and control-shaft adjustments. Xcelite makes it.

Another Xcelite innovation is the type 600 **4-way driver** (Fig. 12) The handle contains a ¼ inch nutdriver at one end and a 7/16 inch nutdriver at the other. The reversible blade has a #1 Phillips screw-

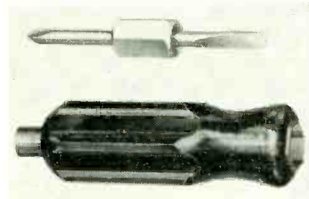


Fig. 11—Four-way driver has two-way nutdriver bit and 2-way screwdriver bit. Handy pocket toolkit. Xcelite model 600.

driver bit at one end and a 3/16-inch slotted bit at the other, and inserts in the 7/16-inch end of the handle.

Somewhat similar is Hunter's 22J **3-way nutdriver,** with 1/4-inch, 5/16-inch, and 3/8-inch sockets.

Specialized nutdrivers

A recent development is the **multiple-size-socket** nutdriver (Fig. 13). It has telescoping hex-driver sockets at the tip, spring loaded. Thus

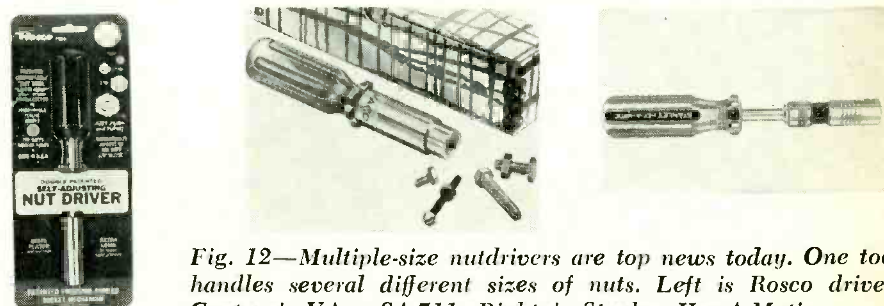


Fig. 12—Multiple-size nutdrivers are top news today. One tool handles several different sizes of nuts. Left is Rosco driver. Center is VAco SA-711. Right is Stanley Hex-A-Matic.

when you push the driver onto a nut the hexes slip back until the proper one fits the nut. Sizes covered are usually 1/4 inch to 7/16 inch.

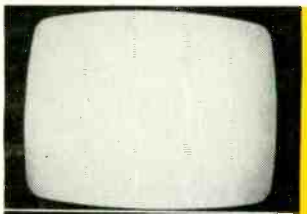
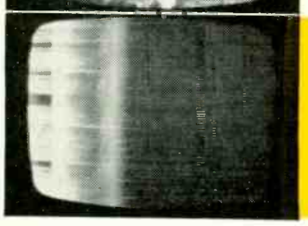
(continued next month)

NEW R-E EXCLUSIVE

Kwik-Fix™ picture and waveform charts

by Forest H. Belt & Associates*

SCREEN SYMPTOMS AS GUIDES — WHERE TO CHECK FIRST

SYMPTOM PIC	DESCRIPTION	VOLTAGE	WAVEFORM	PART
	Whiteout; no video, no sound	Check all Q1 voltages	WF3	All in Q1 stage
	Overload darkout; no video, but sound okay	No specific voltage	WF3	Too many to be specific
	Agc control range reduced; can't whiteout more than this	Q1 emitter	No help	R4
	Bends and flagwaving	Q1 base Q1 collector	WF3	T1 reversed
	Right side of raster blacked out; sync poor; sound okay	Q1 emitter Q2 base	WF3	C3

NOTES:

Use this guide to help you find which key voltage or waveform to check first.
Study the screen and the action of the agc control. Note sound.
Most helpful clues to the fault are found at the key test points indicated in Voltages or Waveform column.
Make the voltage or waveform checks indicated for symptoms you see on the screen.
Use the Voltage Guide or Waveform Guide to analyze results.
For a quick check, test or substitute the parts listed as the most likely cause of the symptoms.

THE STAGES

This agc system is a popular one in transistor and hybrid color receivers and in many black-and-white sets. Pulses from the flyback winding key the transistor agc stage. A distinguishing characteristic is the use of the winding as dc conductor for the agc voltage that is developed.

There is almost always a protective diode at the collector of the keyed stage. (It is at the emitter in some versions, because the keying pulse is applied there.)

This particular agc system develops a dc output that goes more positive as station-signal input increases. For a vhf tuner that uses an npn transistor rf amplifier, this is *forward agc*. (The normally forward-biased rf transistor is biased further forward by the agc as the signal gets stronger.) Most agc-controlled i.f. stages use npn transistors. For them, this is forward agc if the positive agc voltage is applied to the base; if it is applied to the emitter, it is ordinary reverse-bias agc.

In other versions, the dc amplifier stage is phase-reversing. That is, it converts a positive-going agc change to a negative-going one. But not in this version. The dc input is at the base, and dc output is at the emitter. A voltage change at the base produces the same polarity of change at the emitter.

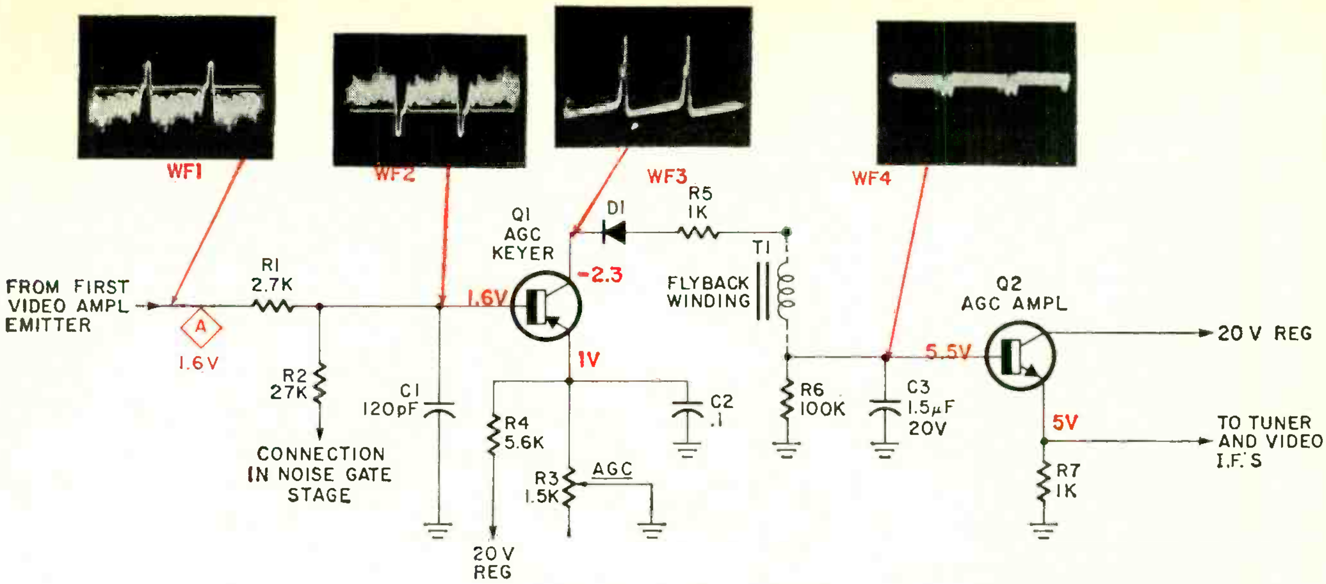
SIGNAL BEHAVIOR

A video signal from the emitter of the first video amplifier is the input for the agc keyer stage. The amplitude of the sync pulses "tells" the stage how strong the station signal is. (Video level changes from scene to scene, but sync doesn't.)

DC VOLTAGES AS GUIDES

voltage change	to zero	very low	low	slightly low	slightly high	high
Key-point-A Normal 1.6 V. Varies with video, from 1.3 to 1.8 volts. Main source is emitter of video amplifier (dc connection).	R4 open R5 open R6 low **C2 shorted C3 shorted **D1 shorted D1 open T1 open		T1 reversed	R7 low C3 open		R1 open R2 low R3 open R4 low C1 shorted
Q1-base Normal 1.6 V. Varies with video, from 1.3 to 1.8 volts. Chief source is same as key-point-A.	R4 open C1 shorted C2 shorted	R6 low C3 shorted	R1 open R2 low R5 open D1 open, shorted T1 open	T1 reversed		R3 open R4 low
Q1-emitter Normal 1 V. Varies with setting of agc control, from zero to almost 4 volts. Is almost unaffected by signal.	R4 open C2 shorted			C1 shorted		R3 open R4 low C3 open
Q1-collector Normal —2.3 V. Varies with signal level at base. Goes as far as —14 volts with no station signal.	*R1 open *R3 open *R4 low *R5 open C1 shorted C2 shorted *C3 open *D1 open *T1 open, reversed	R4 low	R2 low D1 shorted	R6 low R7 low C3 shorted		R4 open
Q2-base Normal 5.5 V. Varies with signal level. With no station signal, goes down almost to zero. Is developed across R6 by Q1 conduction.	R4 open R5 open R6 low C2 shorted C3 shorted D1 open D1 shorted T1 open		C3 open	R7 low		R1 open R2 low R3 open R4 low C1 shorted
Q1-emitter Normal 5 V. Changes some with signal level. With no station signal, drops to about 3 volts. Is developed by Q2 conduction through R7.	R7 shorted		R4 open R5 open R6 low C2 shorted C3 shorted D1 open D1 shorted T1 open	R4 open R7 low		R1 open R2 low R3 open R4 low C1 shorted
	*goes positive **goes negative					

NOTES:
Use this guide to help you pinpoint the faulty part.
Do not clamp the agc line. This guide was prepared without external bias voltages.
Measure each of the six key voltages with a vtvm.
For each, move across to the column that describes the change you find.
Finally, notice which parts are repeated in whatever combination of voltage changes you find.
Test those parts individually for the fault described.
Look for additional clues in the Waveforms Guide.



NOTE: VOLTAGES AND WAVEFORMS ARE TAKEN WITH LOCAL STATION TUNED IN

The sync pulses in WF1 and WF2 are negative-going. They drive the pnp transistor bias forward, setting its ability to conduct in proportion to the amplitude of the sync pulses.

But transistor Q1 isn't able to conduct constantly. It takes a high negative collector voltage (it's a pnp, remember) to make it conduct. That is supplied periodically by a strong negative pulse from a winding on the flyback transformer. The pulse occurs during horizontal retrace and is therefore timed just right to coincide with each horizontal sync pulse that arrives at the base of Q1.

Thus the *time* when Q1 conducts is determined by the keying pulse; the *amount* Q1 conducts is determined by the amplitude of horizontal sync.

Video is wiped out completely in Q1 because the transistor can't conduct at all between horizontal pulses.

Capacitor C3 keeps the "cold" end of the flyback winding (T1) at signal ground. From there on through Q2, there is no signal (WF4 is exhibited only to help spot trouble—it normally is zero).

DC DISTRIBUTION

A high negative dc voltage develops at the collector of Q1 when there's no station signal and therefore no video at the base. It is the average developed by the keying pulse. A small dc bias through R4 lets the transistor conduct slightly. When video is present, the transistor conducts much more during those keying pulses. Increased conduction lowers the negative dc average at the collector. That's a positive-direction dc voltage shift. That shift is, in effect, the basic agc voltage.

Emitter voltage on Q1 is controlled mainly by the agc control. The source is the regulated 20-volt line. R4 and R3 divide it to deliver a steady emitter bias.

Conduction in Q1 sets up a dc path that includes R6, the T1 winding, R5, D1, Q1 and R3. A dc voltage is developed across R6 that is positive at the base of Q2. It is an average dc that depends on conduction of Q1. It is very slight when lack of video keeps Q1 conducting very little; it goes up when the signal is stronger.

More positive voltage at the base of Q2, which is an npn transistor, increases its conduction. That develops a higher positive voltage across R7. This positive voltage is what is fed to the tuner and to the video i.f.'s.

SIGNAL AND CONTROL EFFECTS

The station signal obviously affects practically every dc voltage in both stages. That's their function in the set.

However, signal has very little effect on one dc voltage and on one waveform. The emitter voltage of Q1 is relatively unaffected by anything except the agc control. And the keying waveform (WF3) is unaffected by station signal or by video input to Q1.

Turning the agc control when no signal is present doesn't change much other than the emitter voltage of Q1. However, if a station is tuned in, the agc control affects voltages throughout the agc amplifier (Q2) stage. But it affects them only a little bit as long as there's no video whiteout or overload darkout. When either of those happens, voltages change rather noticeably in the circuit.

For servicing, if the effects of turning the agc control can't be seen in the picture, just set the control at the center of its range.

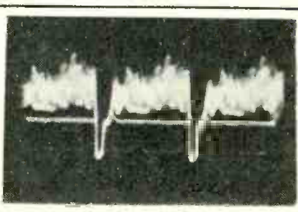
QUICK TROUBLESHOOTING

Don't clamp the agc line to hunt trouble in this agc system. That works well with some, but the voltage and waveform guides in this *Kwik-Fix™* are prepared without external clamping bias. It confuses troubleshooting.

Know the difference between *whiteout* and overload *darkout*. The whiteout is from *too much* agc voltage: i.f. stages are cut off. It takes sound out, too. Darkout is caused by signal overload with *not enough* agc voltage. Sound stays during darkout. The screen (with dc-coupled video sections) gets darker. *Washout* is weak video caused by a little too much agc voltage cutting down i.f. gain.

Using scope waveforms WF2 and WF3: If WF2 is bad, momentarily clamp the agc line (at the emitter of Q2, in this version) to be sure the fault is not in the video or i.f. stages. But remove the clamp voltage to use the Guides. Polarity of WF3 is important. Wiring a new flyback transformer in backward is a common error that causes agc trouble. **R-E**

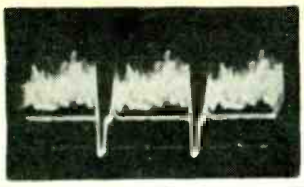
WAVEFORMS AS GUIDES



WF 1 Normal 2 V p-p

This waveform is included for reference only. Sync pulses here are negative-going. The signal source is the emitter of the first video amplifier. It's the video input to the agc section. If it isn't present, clamp the agc line (at Q2 emitter) for a moment. If the waveform appears, the video or i.f. stages are okay. Remove the clamp voltage while troubleshooting the agc stages

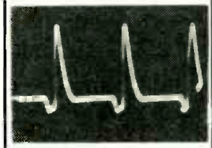
(Turn page for more waveforms)



WF 2 Normal 2 V p-p

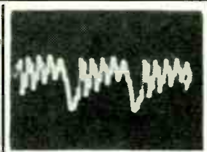
This waveform at the base of Q1 is about the same as WF1. Sync pulses are negative-going. This waveform reveals quite a few defects that occur in the stage. Notice especially its shape, and compare with the symptom photos below. Amplitude doesn't change much, even when there's a fault. The amplitude of these horizontal sync pulses determines the amount of agc.

V p-p low	V p-p high	V p-p zero
R2 low		R2 low R5 open C1 shorted D1 open

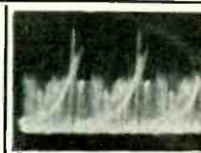


2 V p-p
R1 open

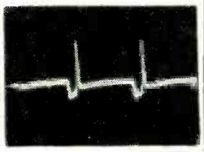
0.6 V p-p
R3 open



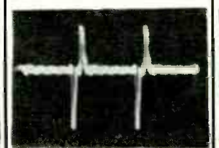
1.8 V p-p
D1 shorted



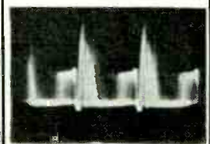
1.2 V p-p
T1 reversed



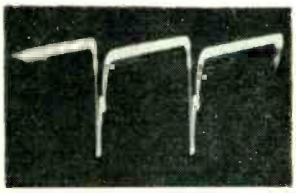
1 V p-p
R4 low
R6 low
R7 low
C3 shorted
T1 open



0.2 V p-p
R4 open
C2 shorted



2.4 V p-p
C3 open

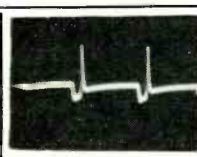


WF 3 Normal 15 V p-p

This is the negative-going keying pulse, taken at the collector of the keying transistor. The pulse comes from a winding on the flyback transformer. Resistor R5 and diode D1 sharpen it up before it reaches the transistor collector. This pulse keys the transistor on during each horizontal sync pulse, so the sync amplitude can set the average conduction of transistor Q1. Amplitude of the keying pulse is constant regardless of signal conditions; but a fault can foul that up quite a bit—as witness the symptoms pictured below.

V p-p low	V p-p high	V p-p zero
T1 open	R6 low R7 low C3 shorted	R5 open D1 open T1- open

0.6 V p-p
R3 open



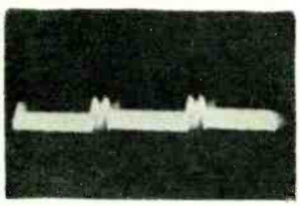
1 V p-p
R4 low

25 V p-p
D1 shorted

12 V p-p
R4 open
C2 shorted

3.5 V p-p
T1 reversed

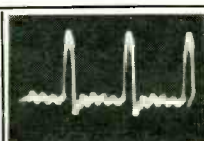
18 V p-p
C3 open



WF 4 Normal 0 V p-p

It's hardly fair to call this a waveform at all. If the stage is working properly, it isn't a waveform. In fact, it's virtually zero. However, it's included—taken at the base of Q2—to show its effect when C3 is open. Almost no other faults affect it.

V p-p low	V p-p high



30 V p-p
C3 open

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

Clamping the agc line is not necessary. Waveforms in this guide are taken without external bias voltages.

With the direct probe of the scope, check the four key waveform points. (Only two of them give most of the trouble clues.) The scope sweep should be set at H or about 5 kHz, to show three cycles of the waveform.

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

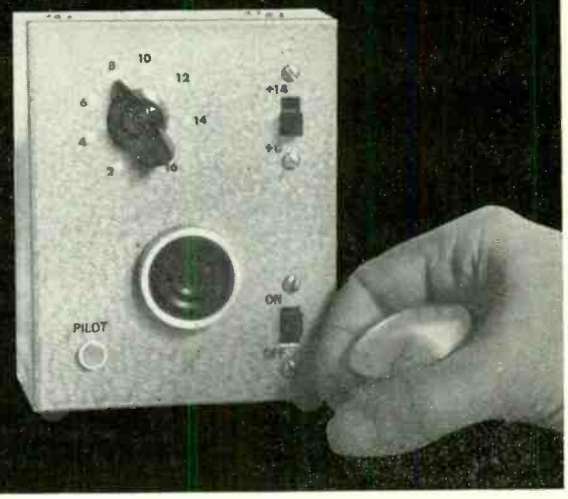
Note waveshape. If there's a change from normal, despite amplitude, check the parts indicated.

For Your Darkroom

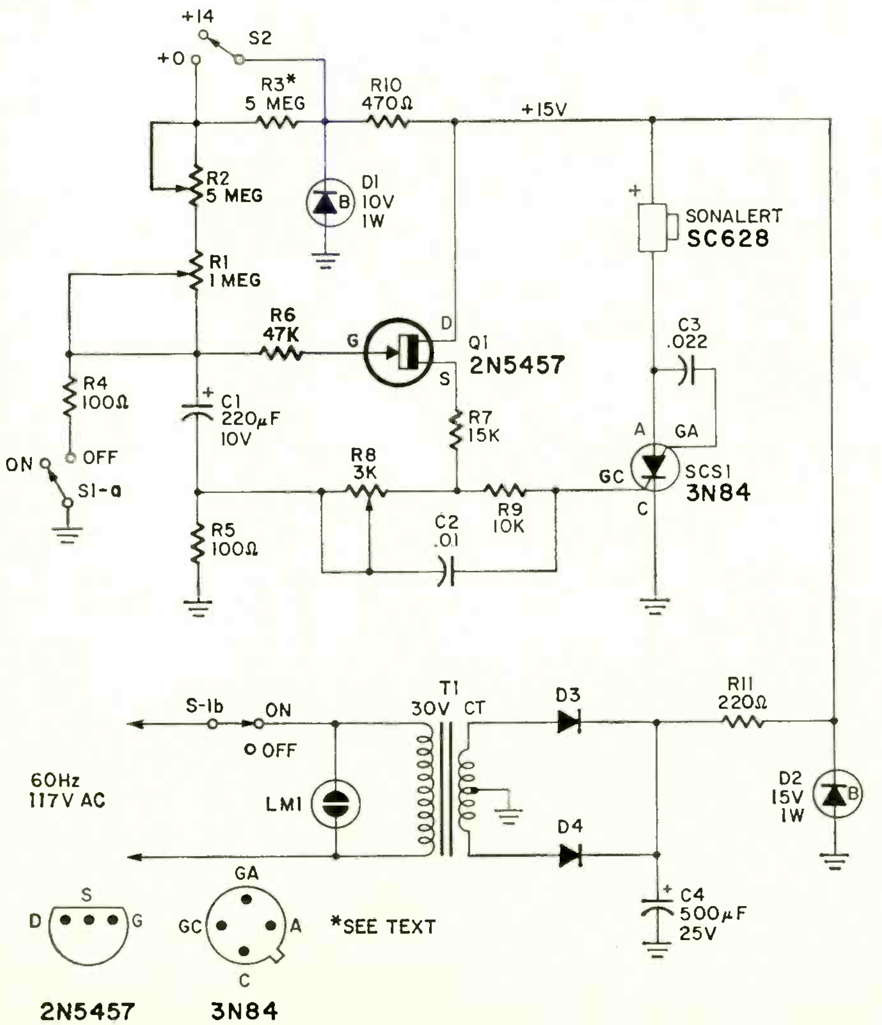
HALF-HOUR INTERVAL TIMER

by FRANK H. TOOKER

Accurate long-term darkroom timing is a past problem once you build this electronic timer. Measures time intervals as long as 30 minutes, accurately



C1—220-μF, 10V, low-leakage tantulum capacitor
C2—0.01-μF, 100V, Mylar capacitor
C3—0.022-μF, 100V, Mylar capacitor
C4—500-μF, 25V, electrolytic capacitor
All resistors ½W, 10% unless noted
R1—1-megohm linear potentiometer (Ohmite CU1052 or equal)
R2—5-megohm linear potentiometer (Ohmite CU5052 or equal)
R3—Two 10-megohm resistors in parallel (see text)
R4, R5—100 ohms
R6—47,000 ohms
R7—15,000 ohms
R8—3000-ohm wirewound potentiometer
R9—10,000 ohms
R10—470 ohms
R11—220 ohms, 1 watt
D1—10V, 1-watt, Zener diode
D2—15V, 1-watt, Zener diode
D3, D4—rectifier diodes (1N3754 or similar)
Q1—2N5457 field-effect transistor
SCS1—3N84 silicon controlled switch
S1—dpdt slide switch
S2—spst slide switch
T1—30V ct, 50-mA power transformer
LM1—120V ac neon pilot lamp (Leecraft 36N2315 or similar)
Mallory Sonalert type SC628
MISC.—5 x 4 x 3-inch aluminum cabinet, power cord & plug, pointer knob, rubber feet, 3-lug terminal strip, small L-brackets, rubber grommet, hardware



RC ELECTRONIC INTERVAL TIMERS usually have a maximum time lapse of about 10 minutes. Beyond this delay, timers have been costly to build, have required relatively hard-to-get parts or have been inexpensive but inaccurate.

The timer described here is different. It's not cheap to construct, but it won't flatten your wallet either. All components are available from catalog sources. The unit has two timing intervals, the longer is ½ hr. Accuracy is ±5% for the low range; ±10% for the upper range.

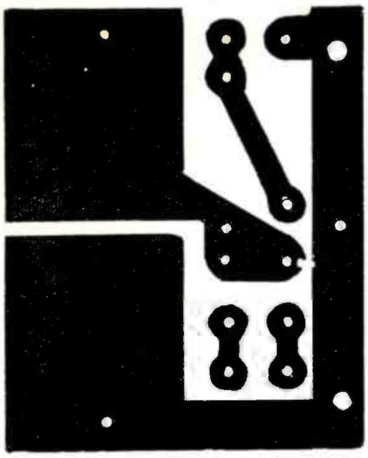
You can use a timer such as this to get your breakfast eggs just right or for timing long-distance telephone calls. In the winter it will tell you when you've been under the sun lamp long enough; in the summer it tells you when to move the lawn sprinkler to another location. If you're a photography enthusiast, it will let you know—even in total darkness—when your negatives are developed, fixed and washed. You'll find a host of other uses once you have the instrument built.

How it works

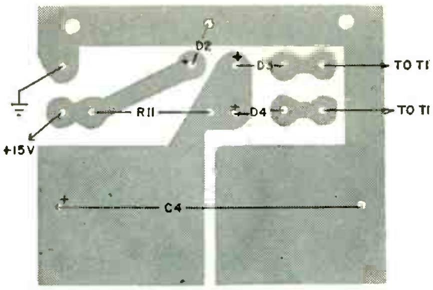
A schematic of the ½-hour interval timer is in Fig. 1. Potentiometers R1, R2 and resistor R3, together with tantulum capacitor C1, determine the timing interval. Resistor R5 has much too small a value to affect the intervals significantly.

The voltage slowly developed across C1 is fed to the gate of field-effect transistor Q1 via R6. The FET is connected as a dc source follower. Gate junction leakage in the FET is very low—perhaps 1 nA at room temperature. Thus, loading of the RC timing components is negligible. Leak-

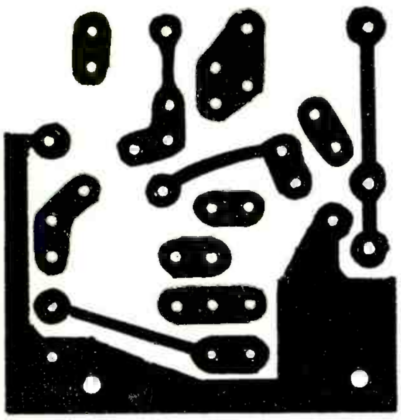
Fig. 1—Timer circuit is relatively simple. It uses an FET transistor and a silicon controlled switch (SCS) to do the hard work.



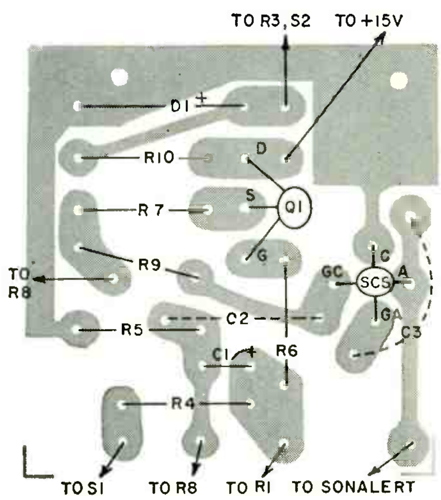
Foil pattern for the power supply circuit board. This is actual-size drawing.



Parts layout on the power supply board. Phenolic board material is ok here.



Foil pattern of the timer circuit board. Drawing is actual-size pattern.



Parts layout for the timer board. For accuracy use a glass-epoxy board.

age resistance of the timing capacitor is the only significant loss in this part of the circuit.

The dc potential at the source junction of Q1 rises as the voltage across C1 rises. This potential appears across voltage-divider resistors R7 and R8. The potential across R8 is fed to the cathode gate of the silicon controlled switch via R9. When this potential rises to the triggering level of the SCS (silicon controlled switch) (about 0.5 volt), the SCS turns on, applying voltage to the Sonalert unit.

The power supply uses a center-tapped transformer, a pair of rectifier diodes and a fairly large filter capacitor, C4. The dc output across C4 is fed through resistor R11 and regulated at 15 volts by Zener diode D2. On the timer PC board, this potential is regulated to 10 volts by R10 and Zener diode D1 before being applied to the sensitive RC timing circuit. Rigid control of the timing-potential supply is thereby maintained. The remainder of the timer is supplied at the regulated 15-volt level.

When the Sonalert sounds, and the instrument is switched off, section S1-b of the ON–OFF switch opens the transformer primary circuit, while section S1-a discharges timing capacitor C1 by short-circuiting it through R4 and R5. The negative pulse that appears across R5 at the instant of discharge is fed to the cathode gate of the SCS via C2, triggering the SCS off. Without this feature, the Sonalert would continue to sound, even though the timer is switched off, until filter capacitor C4 becomes nearly discharged.

Capacitor C3 reduces the sensitivity of the SCS to line-voltage transients. The circuit, however, may at times be triggered by a strong transient pulse, when the potential at the cathode gate is raised near the firing level.

The instrument is equipped with a neon pilot lamp to indicate when the unit is on and timing. (It's discouraging to wait for a ½-hour interval and discover you've forgotten to plug the power cord into a wall receptacle!)

With S2 closed, any time interval between 2 minutes and 16 minutes may be obtained by setting potentiometer R2. When switch S2 is opened, a fixed 14 minutes is added to the timed interval. The calibrated settings of R2 then cover a 16–30-minute range.

The setting of R8 determines the voltage level across capacitor C1 at which SCS1 turns on. This adjustment is made to obtain the 16-minute interval, when switch S2 is closed and potentiometer R2 is set at *maximum* resistance in the circuit. Potentiometer R1 is adjusted to obtain the 2-minute interval, when switch S2 is closed and potentiometer R2 is set at *minimum* resistance in the circuit.

The setup exhibits some variation in the timed intervals as a result of variations in room temperature. Over the range of 65–90°F, these variations fell within the specified tolerances. A variation of 3 min in ½ hr represents a 10% tolerance.

Building a timer

The timer shown in the photos is constructed in a 5x 4x 3-inch utility cabinet. Two PC boards are employed: one for timing circuit components, the other for power supply components. The timer-circuit PC board is preferably of glass-epoxy base material. The power supply board may be phenolic.

Be particularly careful not to overheat timer components when soldering this board. Even slightly excessive heat applied to C1 or the FET can materially affect circuit performance. If the timer cannot be calibrated as described later, or if the calibrated points appear to shift without reason or are otherwise erratic, and all solder joints are clean and properly made, then component overheating should be suspected.

The parts list calls for two 10-megohm resistors in parallel for R3. Using two parallel resistors like this allows the value of one of them to be adjusted slightly higher or lower to bring the longer range of timed intervals within the 10% tolerance. This adjustment is desirable because, as the timing extends beyond 16 minutes, the leakage resistance of C1 begins to have a slight but increasing influence on the timed intervals. As a result of this influence, R3 will appear to have a somewhat larger value when R2 is set at the 16-minute calibration point than when it is set at the 2-minute point. Thus, without compensation, all this effect could appear at the upper end of the range of the longer timed intervals. By carefully adjusting the value of R3 the effect can be divided between the high and low settings of R2, providing a more reasonable tolerance over the entire range.

(continued on page 82)

TECHNICAL TOPICS

by **ROBERT F. SCOTT**
SENIOR TECHNICAL EDITOR

Magnavox's FM Signal Sentry with VVC diodes for a swept i.f. circuit . . . applications of a new monolithic IC agc and squelch amplifier (applied to Shure's 401-A microphone) . . . a blocked-grid keyer

WHEN WE STARTED THIS COLUMN about a year ago, I suggested *we* make it *our* column. I asked you to tell me what you want to see in it and to contribute original or condensed material from foreign-language electronic publications. Well, I've received complements on Technical Topics but no suggestions on contents of future columns. You are really going all out in telling us what you like and want to see in R-E. Perhaps we can insert a few Tech Topics questions in a future questionnaire. But, I can't wait. Fellows, let me hear from you.

A real swinging i.f.

The receiver section of the new Signal/One model CX7 transceiver has, in addition to two cascaded 8-crystal lattice filters, a new patented *i.f. shift* circuit that lets you shift the i.f. carrier plus or minus 2 kHz within its extremely steep-skirted i.f. passband to eliminate QRM. You can attenuate a 500-Hz heterodyne by 50 dB without affecting the desired signal.

The CX7 is full of new and interesting circuit innovations and we plan to cover many of them for you later. In the meantime, let's take a look at a Magnavox circuit that does much the same thing for FM. It appears that it can be adapted for AM as well.

The FM Signal Sentry is what Magnavox calls its swept FM i.f. circuit designed to minimize noise and undesirable sidebands from strong adjacent-channel stations, to prevent the afc from locking in on these undesired stations and to improve selectivity and signal-to-noise ratio. To do this, the engineers use a sharp 10.7-MHz interstage coupling network with VVC's (voltage-variable capacitance diodes) to vary the instanteneous i.f. resonant frequency above or below the nominal 10.7-MHz point in step with the audio output from the FM detector.

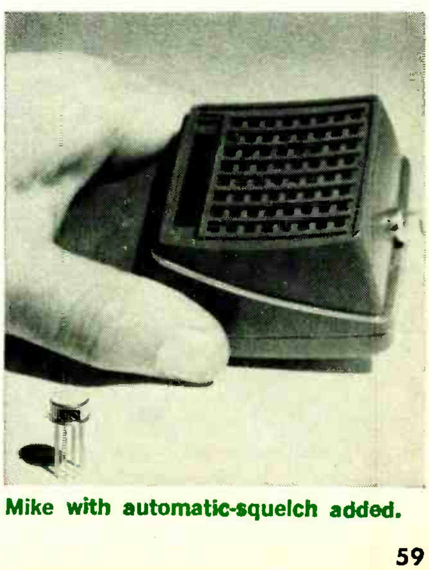
A simplified schematic of the AM-FM i.f. strip in the R223 series AM-FM tuner is shown in Fig. 1. The 10.7-MHz FM i.f. from the mixer is developed across the broadbanded first FM i.f. transformer. The response of the i.f. signal at the base of Q1 is shown in Fig. 2-a. The first and second FM i.f. amplifiers are coupled through transformers T1 and T2 connected back-to-back by a 0.39-pF capacitor.

The high-impedance windings of T1 and T2 are tuned by 20-pF capacitors shunted by VVC diodes D1 and D2 in series with 150-pF capacitors. A fixed negative bias voltage is applied to the anodes of D1 and D2 so T1 and T2 are tuned for a 6-dB bandwidth of 100 kHz (Fig. 2-b) at the base of Q2.

Wideband resistance-capacitance coupling is used between the second, third, and fourth i.f. amplifiers and between the fourth stage and the limiter. Transformer coupling is not needed between these stages because adequate selectivity is provided between the first and second stages.

When a signal is tuned in, a portion of the audio output from the FM detector is fed back to the VVC diodes through the 20-μF capacitor. The audio signal, impressed on the fixed dc bias, causes the effective capacitance of the VVC's to increase and decrease, depending on the polarity and strength of the applied audio. Thus, the frequency of T1 and T2 deviates about 10.7 MHz in step with the audio signal variations. The *apparent* overall bandpass for an incoming signal (indicated by dashed lines in Fig. 2-c) is approximately 250 kHz, while the actual bandpass at any given instant is only 100 kHz.

Since the apparent i.f. bandpass is determined by the amplitude of the recovered audio, we see that higher amplitude audio signals develop a proportionately wider bandpass. At the same time, the narrow (100 kHz)



Mike with automatic-squelch added.

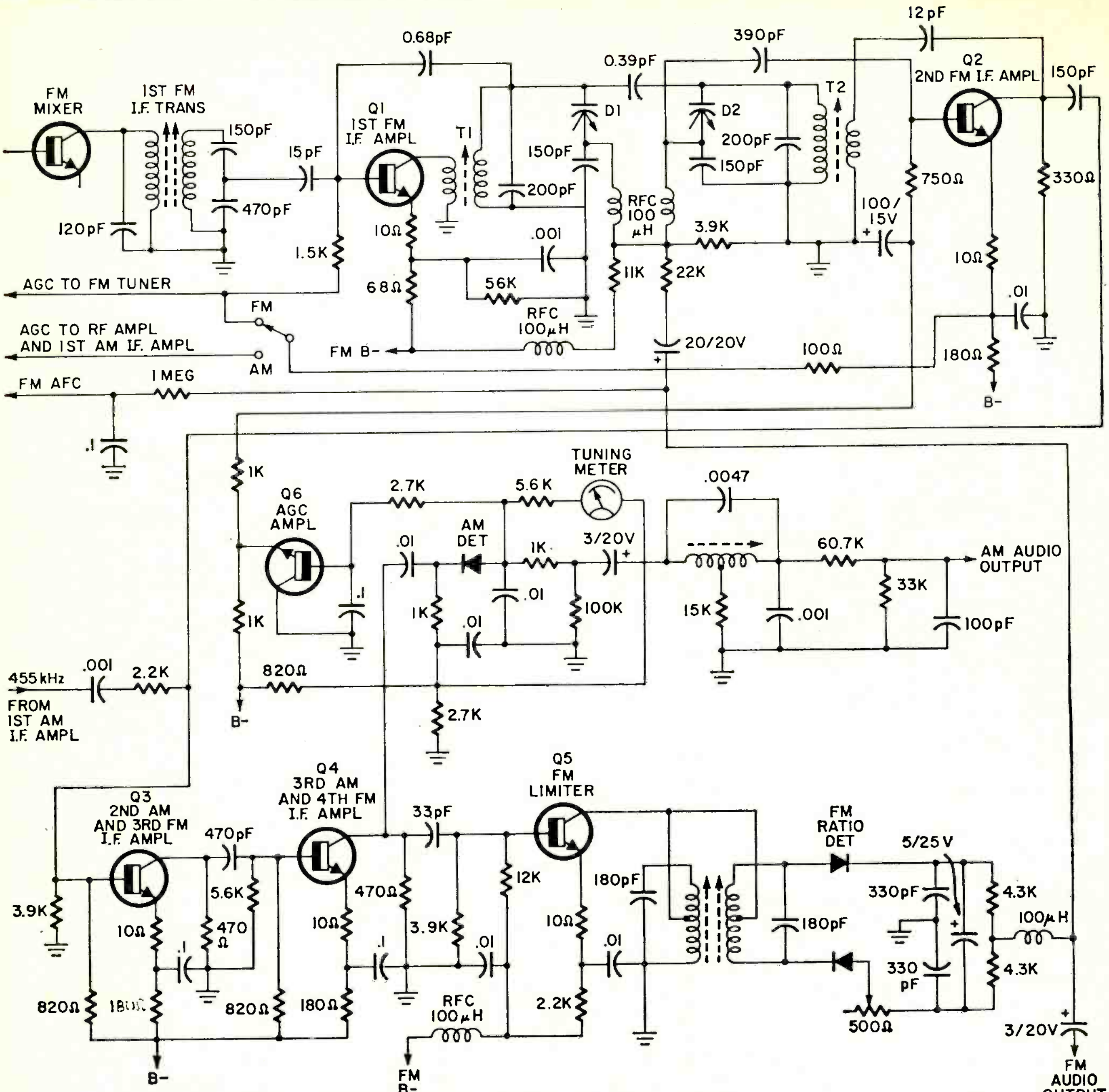


Fig. 1—VVC-diode/transformer combination between Q1 and Q2 receives signal from detector, so T1/T2 tuned frequency swings about 10.7 MHz with the audio.

instantaneous bandpass reduces noise and splatter from strong adjacent channels.

A portion of the dc output of the FM detector is filtered by a 1-meg resistor and 0.1-μF capacitor and fed to the VVC used for afc in the tuner.

AM detector for FM agc

AM and FM i.f. signals at the collector of Q4 are rectified by the AM detector diode. The detector output, negative at the anode end, is coupled to the base of Q6, an emitter follower used as the agc amplifier. This transistor is normally conducting and its collector–emitter current drops as the detector output increases. The emitter of Q6 is direct coupled to the base of Q2 to reverse-bias this stage.

As conduction in Q2 is decreased, its emitter goes more negative. This negative-going voltage is used for reverse-bias agc for the first FM i.f. amplifier, the FM rf amplifier during FM reception and for the AM rf amplifier and first AM i.f. amplifier on AM reception. The tuning meter—connected across the AM detector output—works on AM and FM.

Blocked-grid keying with transistor

The usual blocked-grid keying scheme for CW transmitters has two disadvantages. You either risk a shock from the blocking bias on the key or you have to use an expensive—and often noisy—keying relay. A novel solution to this problem was presented by DM2BLJ in *Funkamateur,* a German ham magazine.

In the circuit (Fig. 3) blocked-grid keying is applied to the vfo. Normal operating grid bias is developed by grid current flowing through R1. This resistor is returned to −25 volts on a voltage divider (R2 and R3) across a −100-volt source. A transistor is shunted across R3. The transistor base is connected through the key to −1 volt on voltage divider R4–R5. When the key is up, the transistor is cut off and the tube is biased off by the −25 volts at the low end of R1. When the key is closed, the transistor is biased on so it short circuits R3 and effectively grounds the low end of R1 so the tube operates normally.

The transistor selected for the job should have a collector-to-emitter breakdown (base open) rating (BV_{CEO}) higher than the drop across R3, and should be capable of carrying the normal operating grid current. R2 and R3 should be selected to provide cutoff bias for the tube being keyed.

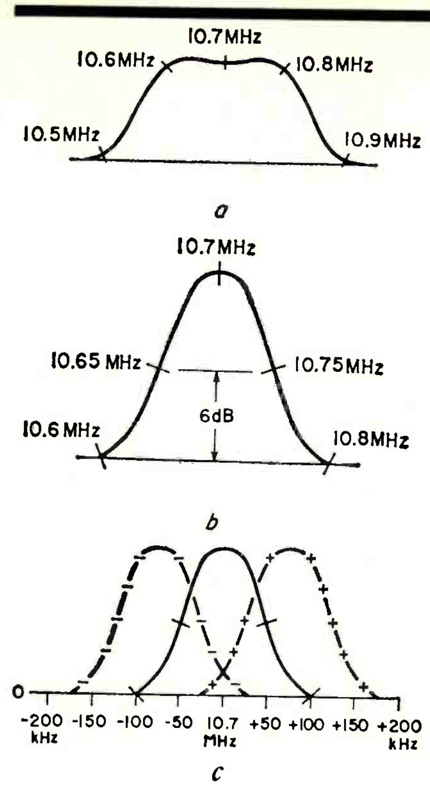
IC for communication systems

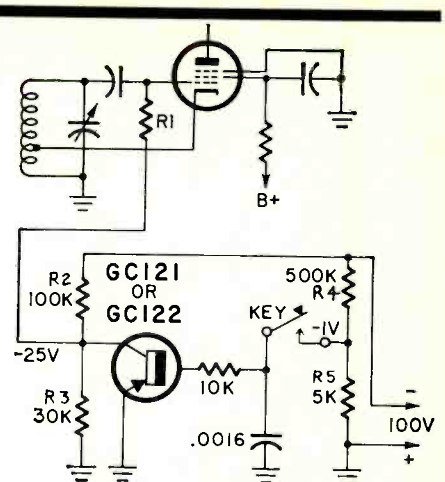
Quite a few circuits and projects designed around IC's have been described in this magazine, but few have impressed me as much as some of those in Application Note AN-11 covering the use of National Semiconductor's LM170/LM270/LM370 monolithic agc and squelch amplifier. The LM170 (−55 to 125°C); LM270 (−25 to 75°C) and LM370 (0 to +70°C) combine a preamplifier whose gain can be controlled by an external dc voltage, two agc detectors and a squelch threshold detector. The IC's, housed in 10-lead TO-5 packages, operate with supply voltages up to 24. Typical current drain is 4 mA at 4.5 volts and 8 mA at 12 volts. Typical voltage gain is 40 dB at 1 kHz.

The principal applications of these IC's are in squelch and agc circuits, but they can be used for alc (automatic load control) in SSB transmitters, remote-controlled audio preamplifiers, automatic squelch-controlled microphones, constant-amplitude audio oscillators and other applications.

Fig. 4 is the circuit of a squelched microphone preamp that may be used to suppress background noise between pauses in speech. The LM170 series can be driven directly from a low-resistance dynamic or controlled magnetic microphone. The IC and suitable 4.5- or 6-volt batteries can be fitted inside the case of some of the smallest commercial microphones.

The 10,000-ohm SQUELCH THRESHOLD control can be adjusted so squelch opens at any desired input level. The release time constant is determined by the values of R1 and C1. The values of R2 and R3 are selected so C1 charges to about 3 volts from a 12-volt supply. The squelch has an extremely fast attack and gain fades to zero following a release time varying from around 200 msec to several seconds. Capacitor C1 may be any value between 5 and 50 μF. The release time can be adjusted by varying the value of C1 or by using a selected value for C1 and replacing R1 with a potentiometer.





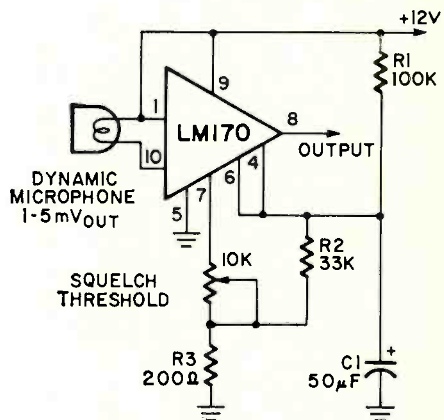


Fig. 2-a-c—I.f. variations: from Q1's base, to Q2's base, with modulation shifts.
Fig. 3 (top right)—Blocked-grid keying applied to the grid of the vfo tube.
Fig. 4 (right)—Squelched-mike circuit.

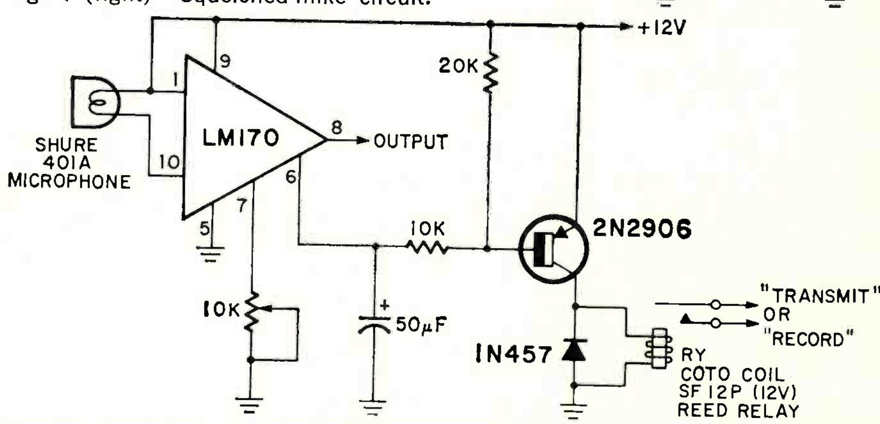
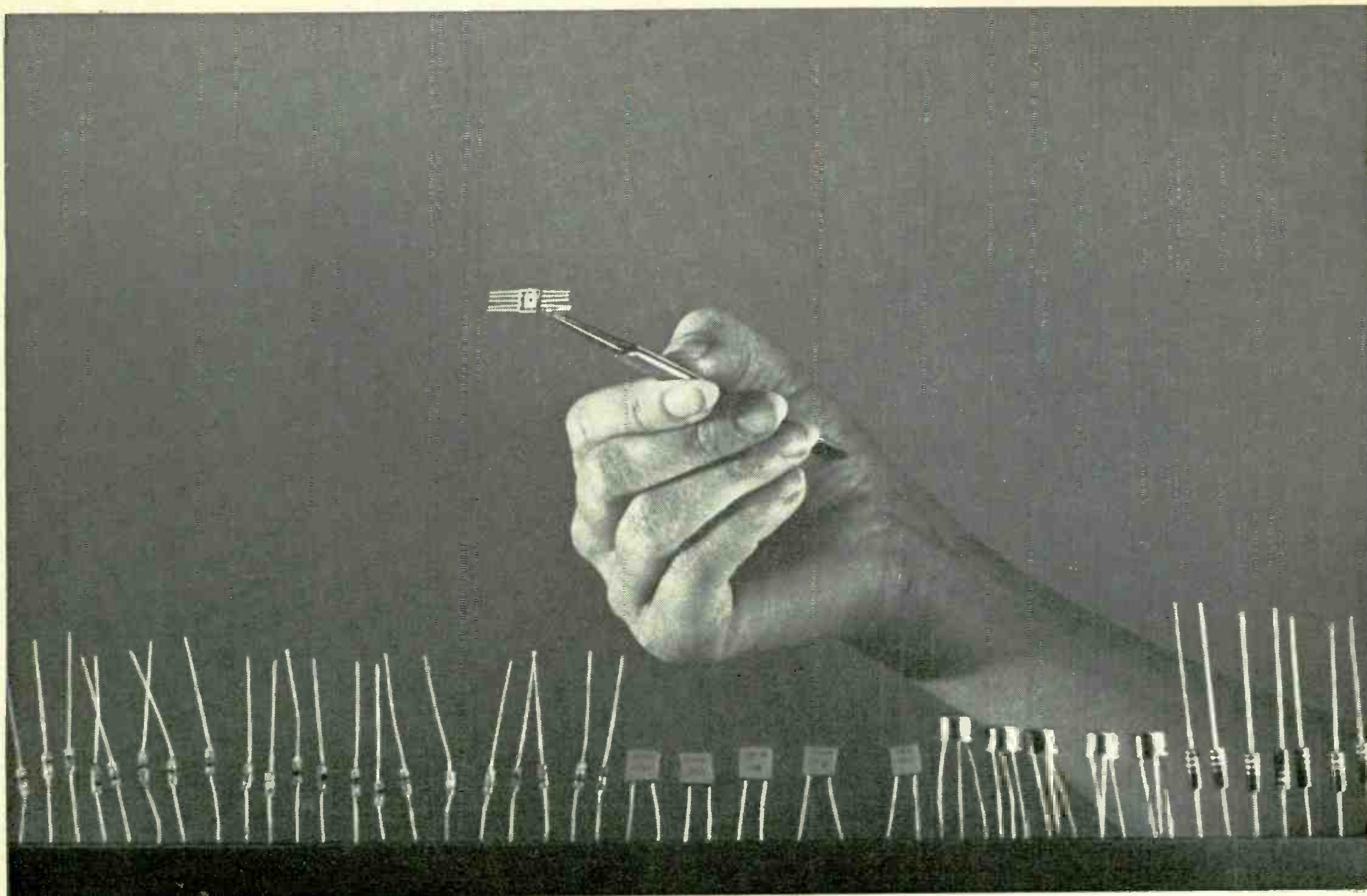


Fig. 5—Squelched voice-operated (vox) circuit application of the LM170 IC. Transmitter or tape recorder is turned on with speech through fast-acting relay.

Individual mikes are often used for panel discussions, conferences, in court rooms, etc. to permit all persons random access to the PA system. In a system of this type, all mikes can be fitted with automatic squelch and their outputs (pin 8 of the LM170 series IC) connected to a common input on the PA amplifier. The background noise at each mike position is suppressed, while close talking permits one or more of the speakers to be heard.

The LM170 can be connected (as in Fig. 5) as a vox (squelched voice-operated transmission) circuit for a transmitter or tape recorder. The recorder or rig is turned on with the first syllable of speech and is turned off when the speech is turned off or drops below a preset level. A small pnp transistor drives a fast-acting relay such as the Coto Coil type SF12P reed relay. If the circuit tends to oscillate or hunt, connect a large electrolytic across the power supply. The relay contacts, number and form as needed, are used to control the transmitter, or recorder motor and other auxiliary circuits. The photo shows a Shure 401A converted to an automatic squelch-controlled microphone. The indicator lamp, controlled by auxilliary contacts on the relay, signals the speaker that he has turned on the transmitter or recorder. **R-E**



50 functions in a single chip. *The functions of 50 separate transistors, diodes, resistors and capacitors can now be performed by the tiny dot in the center of the integrated circuit held by the tweezers.*

The "Chip" ...will it make or break your future job?

THE DEVELOPMENT OF INTEGRATED CIRCUITRY is the dawn of a new age of electronic miracles. It means that many of today's job skills soon will be no longer needed. At the same time it opens the door to thousands of exciting new job opportunities for technicians solidly grounded in electronics fundamentals. Read here what you need to know to cash in on the gigantic coming boom, and how you can learn it right at home.

TINY ELECTRONIC "CHIPS," each no bigger than the head of a pin, are bringing about a fantastic new Industrial Revolution. The time is near at hand when "chips" may save your life, balance your checkbook, and land a man on the moon.

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"One thing is certain," said *The New York Times* recently. "Chips will unalterably change our lives and the lives of our children probably far beyond recognition."

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Miniature Miracles of Today and Tomorrow

Already, as a result, a two-way radio can now be fitted inside a signet ring. A complete hearing aid can be worn entirely inside the ear. There is a new desk-top computer, no bigger than a typewriter yet capable of 166,000 operations per second. And it is almost possible to put the entire circuitry of a color television set inside a man's wristwatch case.

And this is only the beginning!

Soon kitchen computers may keep the housewife's refrigerator stocked, her menus planned, and her calories counted.

Money may become obsolete. Instead you will simply carry an electronic charge account card. Your employer will credit your account after each week's work and merchants will charge each of your purchases against it.

When your telephone rings and nobody's home, your call will automatically be switched to the phone where you can be reached.

Doctors will be able to examine you internally by watching a TV screen while a pill-size camera passes through your digestive tract.

New Opportunities for Trained Men

What does all this mean to someone working in Electronics who never went beyond high school? It means the opportunity of a lifetime—if you take advantage of it.

It's true that the "chip" may make a lot of manual skills no longer necessary.

But at the same time the booming sales of articles and equipment using integrated circuitry has created a tremendous demand for trained electronics personnel to help design, manufacture, test, operate, and service all these marvels.

There simply aren't enough college-trained engineers to go around. So men with a high school education who have mastered the fundamentals of electronics theory are being begged to accept really interesting, high-pay jobs as engineering aides, junior engineers, and field engineers.

How To Get the Training You Need

You can get the up-to-date training in electronics fundamentals that you need through a carefully chosen home study course. In fact, some authorities feel that a home study course is the best way. "By its very nature," stated one electronics publication recently, "home study develops your ability to analyze and extract information as well as to strengthen your sense of responsibility and initiative." These are qualities every employer is always looking for.

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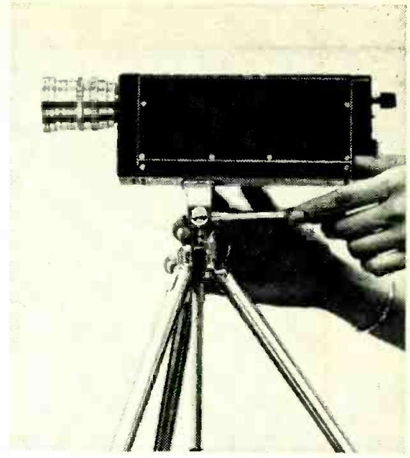

Tiny TV camera *for space and military use is one of the miracles of integrated circuitry. This one weighs 27 ounces, uses a one-inch vidicon camera tube, and requires only four watts of power.*

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BUILD . . .

Electronic Flash Tester

by W. G. Eslick

LATELY, I'VE HAD TO DO SOME REPAIR work on electronic photoflash units. To make the job easier, I built this tester from scrap parts. The jacks for the *coil* and *lite* test are insulated phone tip jacks. I picked up flash tubes and electrolytic capacitors from a camera shop. On my unit I mounted two flash tubes under a glass window and inserted an extra toggle switch to select the desired one. One flashtube is a single turn xenon and the other is a two turn lamp.

Since there isn't any load on the transformer the capacitors charge to about peak voltage. The transformer I used is a small 640 volt CT unit (use ½ of secondary). I installed a 300-ohm pot salvaged from an old tube tester to adjust the open voltage.

The unit is quite flexible and is used to substitute parts in flash units being repaired by connecting test leads between tester and flash unit.

To test an electronic flash, disconnect the hot wire and the ignition wire from tube in the unit. Connect the three wires from the tester lite jacks to tube in flash unit. Set S3 to LITE TEST position, S2 to internal and S1 to HiCap. Turn the unit on and wait a few seconds for all capacitors to charge. Then press flash test push button (S5). The tube in the unit will fire if it is good.

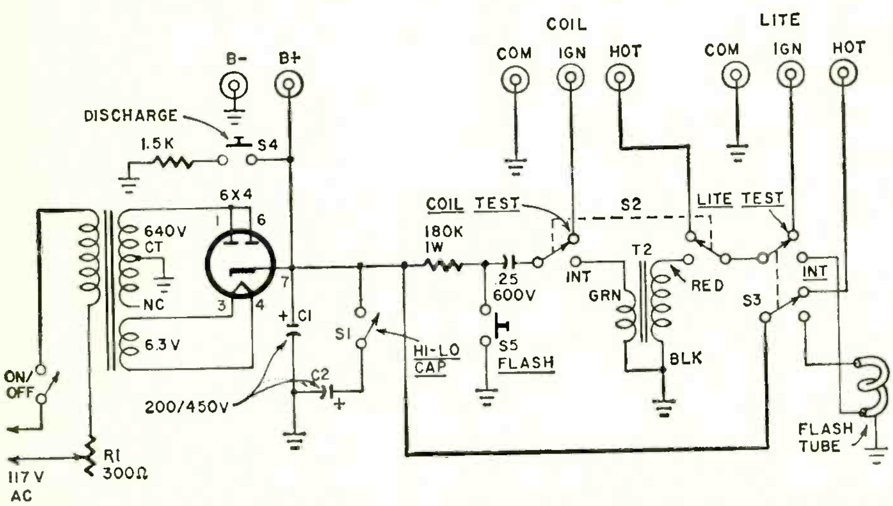
To test the coil in the flash unit disconnect all leads from coil (transformer) in the unit. Connect lead from coil to the transformer in the flash unit. Make sure the hot and ignition leads are right. With S2 in coil test and S3 in internal, turn the tester on and wait a few seconds for all capacitors to charge. Then push flash push button. If the coil in the flash unit being tested is good, the strobe light in the tester will flash.

Like most service shops, a little extra work will help in slack times and most small camera shops cannot repair the flash units. A voltmeter and ohm-meter will go a long way to find the troubles, but the ignition coil and flash bulb must be tested under operating conditions.

Camera shops usually have some old trade-ins that you can get cheaply and your scrap box will furnish most of the other parts. There won't be enough work to spend a lot on test units, but for a few jobs each month, this tester will do. **R-E**

PARTS LIST

S1, S6—spst toggle switches
S2, S3—dpdt toggles, good insulated types
S4, 5—push button switches
C1, C2—200 μF/450 V photoflash capacitors
T1—power transformer, 640 ct, 40 mA
T2—Heiland flash transformer
Other parts from old flash units.



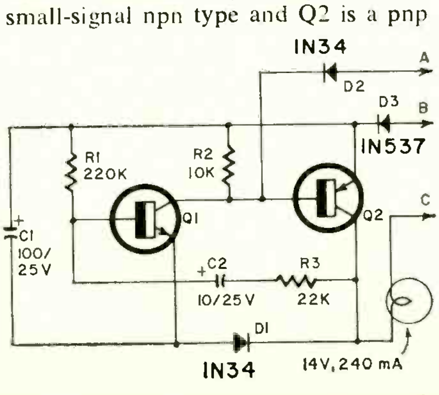
BUILD . . .

Lights-on Reminder

Many arrangements have been made to warn the motorist when he turns the ignition off but inadvertently leaves the headlights on. Most attempts to provide this warning signal have used relays, but they are large, expensive, and subject to mechanical failure. For this reason, the following adaptation of a standard all semiconductor circuit was used. It is small, dependable and very inexpensive. In fact, it can be built from all new parts for around two dollars and the average hobbyist will have all the necessary items on hand.

A look at the schematic will reveal the simplicity of operation. The unit is basically a flasher which draws its operating voltage from the taillight circuit and the car's ground (points B and C). The unit will go on or off with the light switch. However, if a connection is made between the base of Q2 and the accessory terminal on the ignition switch (point A) the unit will be turned off whenever the ignition switch is on.

Because almost any transistors can be used for Q1 and Q2, it would be best to breadboard the circuit to find the most suitable combination of parts to provide the rate of flash desired. Transistor Q1 may be any small-signal npn type and Q2 is a pnp powered device such as a 2N301. The values on the schematic are only starting points.

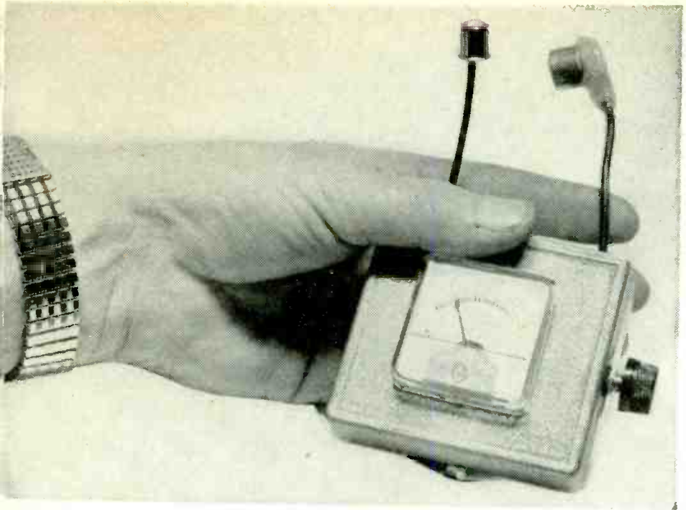


Diodes D2 and D3 are necessary because these points go negative when the respective switches are in the OFF position. Diodes D1 and D2 can be any small current devices or even defective transistors that still have one good junction. However, D3 must be capable of carrying the current drawn by the lamp.

The whole unit can easily fit into a small plastic case smaller than a king-sized cigarette box and can be mounted anywhere under the dashboard away from excessive heat. Mount the signal lamp where it will most easily catch your eye as you begin to leave a car.

If your car has a positive ground, use a small-signal pnp type for Q1 and an npn power type for Q2 and reverse the polarity of the diodes and capacitors.

Good luck and long live your battery.—*Ronald F. Zollweg* **R-E**



Completed unit is compact, easily fitting tube caddy. Plug goes to lead wire from horizontal output tube; cap goes on tube.

HORIZONTAL EFFICIENCY COIL CHECKER

Simple solar-cell circuit makes a compact, portable checker for your shop

by HOMER L. DAVIDSON

HAVE YOU NOTICED A CERTAIN COLOR receiver popping 6JE6's right and left? Is that warranty tube box filling up with 6JE6 and 6DQ6 horizontal output tubes?

Correct adjustment of the horizontal efficiency coil is a key requirement in color TV repair. Improper efficiency coil settings will shorten the life of horizontal output tubes.

The horizontal efficiency coil is adjusted so the flyback transformer will run cool with minimum current. With properly controlled current through the flyback winding, the transformer lasts longer. Also, the horizontal output tube will not be driven too hard to get the correct amount of circuit efficiency.

Adjusting the hard way

The efficiency coil is adjusted with a 0–300-mA meter connected in series with the cathode of the horizontal output tube. You can also check this current in the plate circuit of the damper tube. The horizontal efficiency coil is adjusted for minimum dip on the meter.

Most color chassis in the 23- and 25-inch class have a horizontal efficiency coil is in the high-voltage circuit. Generally, the coil is found on the rear apron of the color chassis. On RCA color chassis the coil is mounted upright on the etched circuit board, close to the damper and horizontal output tubes (see photo).

To insert a current meter in the horizontal output tube cathode circuit, the color chassis usually must be removed from the cabinet, or be pulled part way out.

Then someone came up with the idea of inserting a pilot lamp with two alligator clips in the plate lead of the horizontal output tube. On a dark day or in a dark corner the efficiency coil can be adjusted to a minimum brightness dip with a No. 39 pilot lamp. But if the service tech is working in a lighted room, the dip of the pilot lamp is sometimes hard to see.

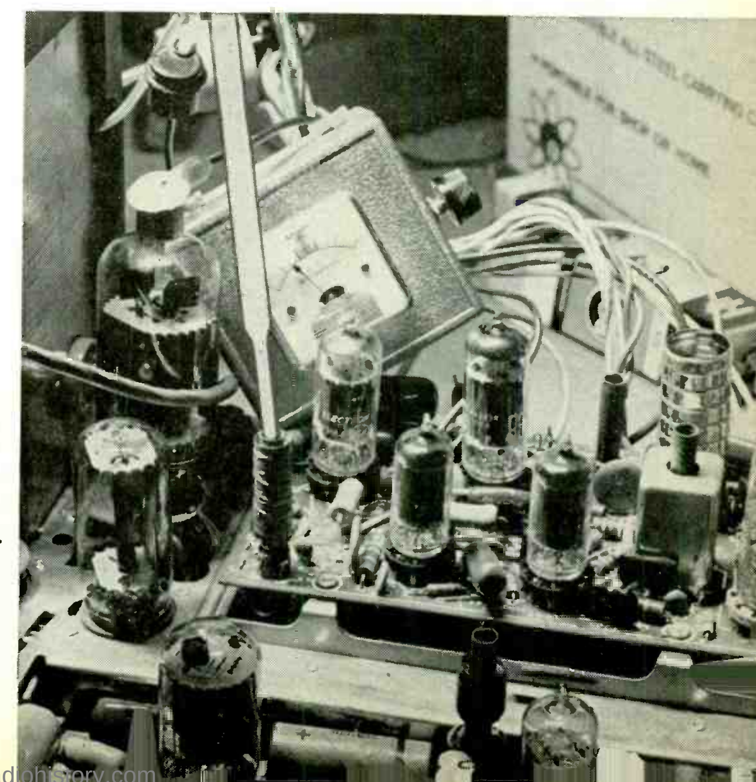
Build a coil checker

It's much easier to see the needle movement of a current meter. The horizontal efficiency coil checker consists of a No. 39 pilot lamp, solar cell and 0–1-mA meter (see Fig. 1). A female plug and male cap are inserted in series with the pilot lamp. The brightness change of the pilot lamp registers on a B3M solar cell. The solar cell generates a voltage when light strikes it, which is indicated on the meter. A 5K pot will control the voltage from solar cell to meter.

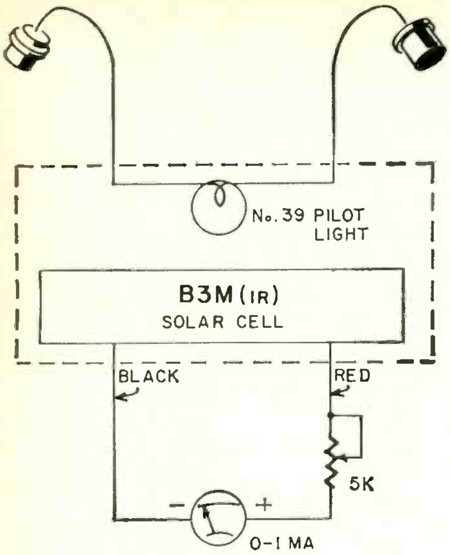
When the horizontal efficiency coil is adjusted there will be a definite point or dip indicated at the correct current setting. As a result, dim light applied to the solar cell will generate less as voltage than when more current flows through the pilot light. The pilot lamp brightness fluctuation controls the reading on the current meter.

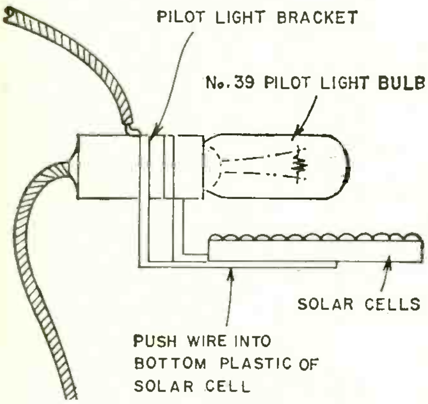
A 3¼ x 2¾-inch plastic box was used to house the small components. A metal container is a shock hazard.

Mount the meter on the top lid of the box. Go slow when drilling holes—to eliminate cracked areas. The pilot-light assembly is mounted on the solar cell (Fig. 2). Remove the regular pilot-light bracket and wrap No. 14 copper wire around it. Bend the wire at right angles, so the pilot light is centered over the solar cell. Place the copper wire underneath the solar cell plastic framework. Push the heavy wire into the plastic solar cell



Horizontal efficiency coil location on an RCA chassis. Coil is on a PC board.





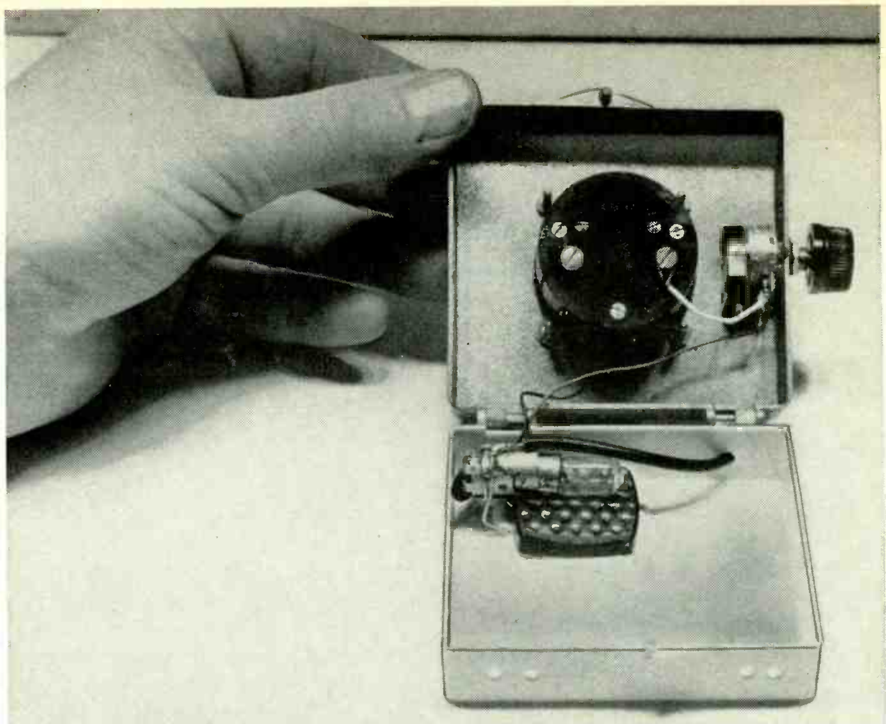


Fig. 1—(left top) Checker circuit converts hard-to-see light from No. 39 lamp into easy readout on current checker. Another version uses voltmeter in place of 0-1-mA meter. **Fig. 2—Mount the pilot-light bracket** directly on the plastic solar cell case. **Meter and potentiometer** can be mounted on lid of plastic box and the solar-cell assembly on the bottom. Spray the case to block light from the cell.

base while heating it with a hot soldering gun.

Run the internal lead from the pilot-light socket through a hole in the case for the male lead cap. To prevent erroneous readings from outside light, spray the inside of translucent cases with black paint. Glue the pilot-light assembly into a corner of the box. Run the black lead from the solar cell to the negative terminal of the current meter. The red or positive wire is soldered to the pot. Connect a piece of hookup wire from the other lug to meter positive.

Remove the plate cap from a defective 6DQ5 tube and solder it to the lead from the lamp socket. After soldering the plate cap in place, fill it with rubber silicone cement. A female high-voltage lead wire and plastic cap is soldered to the pilot-light assembly.

Check operation by placing a bench light over the solar cell. Adjust pot to full scale.

Unplug the lead wire from the horizontal output tube on a color chassis. Insert the male plug from the checker, and place the female cap over the horizontal output tube.

With the set on, the meter will at first shoot upwards. Don't adjust the linearity coil until the color chassis has warmed up for a few minutes. When the meter has stabilized, locate the horizontal efficiency coil on the TV chassis. Adjust the pot on the checker so the meter reads full scale. Insert an alignment tool into the efficiency coil and turn the core until the meter dips to the lowest point or towards zero. Adjust a little farther and the meter will start to rise again. Set coil for lowest meter reading.

In the RCA CTC17 through CTC25X series chassis, adjust the core of the efficiency coil even with the bottom of the coil winding. Then adjust the core CCW to obtain a minimum meter dip. Continue to turn the core in the same direction until the cathode current increases 10 mA beyond the minimum-dip reading. Here's how the checker can be calibrated to read current.

By replacing the potentiometer with a trimmer-type pot, the horizontal efficiency checker can indicate comparative current values. Hook up the efficiency checker as described, and place a calibrated 0–300-mA meter in series with the cathode (to ground) of the output tube.

When the set warms up adjust the efficiency coil slug for maximum current on the calibrated meter in the cathode circuit. Adjust the trimmer pot for a full-scale reading on the checker meter. Mark the current on the calibrated meter dial or on a sheet of paper for reference. Remove the meter from the cathode circuit and see if there is a great change in the reading on the efficiency checker meter. You will notice a change of 0.25 mA or none at all.

Reinstall the calibrated meter in the cathode circuit and gradually decrease the current reading by adjusting the horizontal efficiency coil. Stop at 5 mA and observe the meter reading on the efficiency coil checker. Adjust for the minimum dip on the efficiency coil checker meter.

On most color receivers the best spread of current readings from adjusting, the horizontal efficiency coil is 180–250 mA. Some color chassis will show only a slight change on the meter scale. Most color receivers will not pull over 220 mA; these readings are noted on the high-voltage schematic.

Another meter version

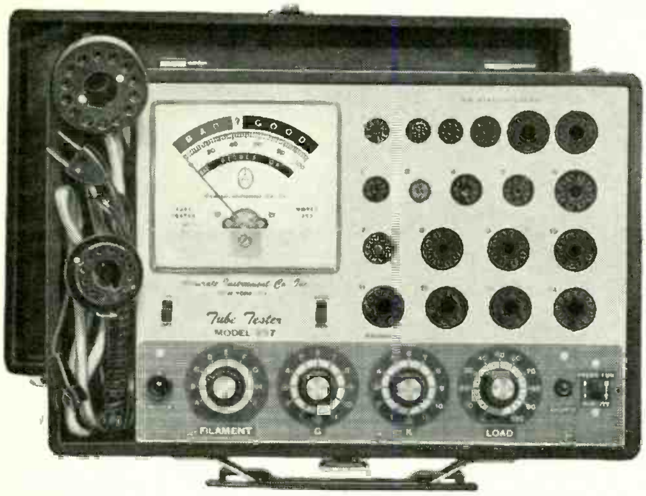
The vtvm or vom will measure the voltage generated by the solar cell. For this coil checker, a smaller box may be used since the 0–1-mA meter is not used. On the vom use a 0–2.5V dc voltage scale; on the vtvm use the 0–5V dc scale.

Two small phone jacks can be used to plug in the meter probes. Construct the horizontal efficiency coil tester as shown in Fig. 1, but wire the leads that would go to the 0–2-mA meter to the phone jacks mounted on the case. Again, adjust the coil for minimum dip.

Both horizontal efficiency checkers are small enough to fit into the tube caddy for house calls. You may save several call backs and expensive 6JE6 or 6DQ5 horizontal output tubes. **R-E**

The New 1970 Improved Model 257

A REVOLUTIONARY NEW TUBE TESTING OUTFIT



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

ANNOUNCING... for the first time

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

COMPLETE WITH ALL ADAPTERS AND ACCESSORIES, NO "EXTRAS"

STANDARD TUBES:

- ✔ Tests the new Novars, Nuvistors, 10 Pins, Magnovals, Compactrons and Decals.
- ✔ More than 2,500 tube listings.
- ✔ Tests each section of multi-section tubes individually for shorts, leakage and Cathode emission.
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- ✔ Single cable used for testing all Black and White Picture Tubes with deflection angles 50 to 114 degrees.
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NOTICE We have been producing radio, TV and electronic test equipment since 1935, which means we were making Tube Testers at a time when there were relatively few tubes on the market, 'way before the advent of TV. The model 257 employs every design improvement and every technique we have learned over an uninterrupted production period of 34 years.
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Circle 28 on reader service card

ULTIMATE STEREO TUNER

(continued from page 40)

nal can be heard from the speaker.

2. With the plates of C1 fully meshed adjust L2, L3, L4, and L6 for maximum quieting of the received signal. Reduce the generator output as needed so that the signal is always slightly noisy. Use a small nylon or fiberglass tool to move the coil turns.

3. Set the generator output to 107.8 MHz and set C1 so its plates are at minimum capacitance. Peak each trimmer capacitor on C1 for maximum quieting, as well as C25.

4. Repeat steps 2 and 3.

5. Set generator output frequency to a quiet spot near the upper end of the dial, around 105 to 106 MHz. Tune the receiver to this frequency and repeak the trimmer on L4 for best quieting. "Rock" C1 about this point while adjusting this trimmer since there is some interaction between peaking this trimmer and the local oscillator frequency. If you do not rock C1 you may only succeed in "fine-tuning" the oscillator frequency and sensitivity will be reduced from optimum.

6. Repeat steps 2, 3, and 5.

7. Tune C1 to a quiet spot near the bottom of the dial and adjust R25 for maximum quieting on a very weak input signal. At this time you may wish to check the sensitivity. It should be 20 dB quieting at less than 1 μV input. L1 should be spaced about 1/8 inch below L2. If sensitivity is too low, carefully push L1 closer to L2 and repeak the antenna trimmer capacitor at 107.8 MHz and adjust the turns on L2 at 88 MHz. Ten sets of transistors were tried in the prototype unit and sensitivity varied between 0.95 to 0.55 μV for 20 dB quieting.

MULTIPLEXER

You will need an oscilloscope and a multiplex generator to align this section. An ac vtvm is also helpful when making separation measurements.

1. Connect the scope vertical input to the wiper of R204 and inject a 67-kHz input at the input to the multiplex board at C201. Tune the slug in T202 for a minimum output as seen on the scope.

2. Connect the scope to the Q202 end of C202. Inject a 19-kHz pilot signal at a 25-mV rms level and tune T201 for maximum trace height.

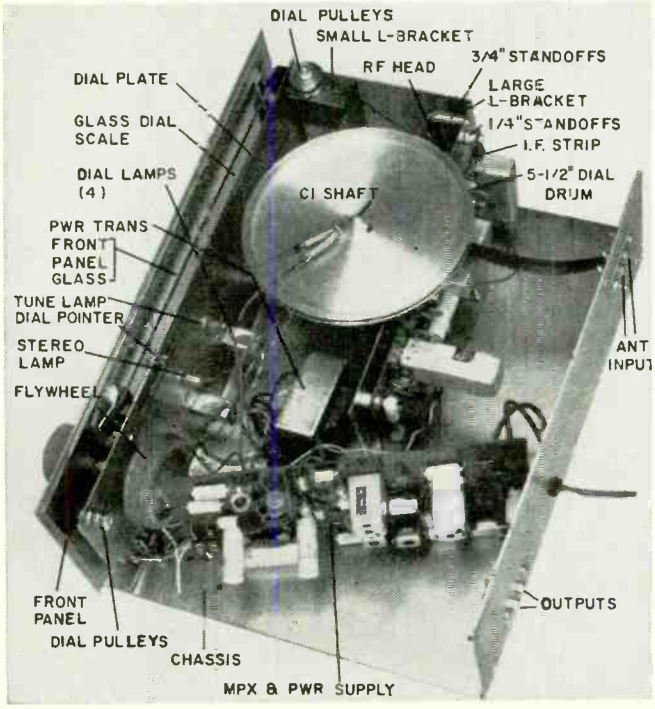
3. Connect the scope to the collector end of C206 and set S202 to the MONO position. Tune T203 and T204 for maximum trace height. Reduce the input level of the generator and carefully repeak the tuning of

transformers T201, T203 and T204.

4. Connect the scope to either channel A or B output and inject a 19-kHz signal at 25 mV rms. Tune oscillator transformer T205 for zero beat as observed on the scope. S202 must be in the STEREO position.

5. Connect the scope to either end of C214 and tune T206 for maximum 38-kHz trace height.

6. Set up the generator to deliver a 0.25V rms L-only or R-only composite signal to the input. Connect the scope vertical input to channel A



Chassis layout of tuner sections used by the author. A large L-bracket supports i.f. and rf boards. C1 is mounted on rf board, concealed by dial drum here.

and the horizontal input to channel B. Slowly tune T205 until the scope is displaying either a vertical line or a horizontal line. One of the settings of T205 will be very unstable; use the setting which is the most stable and connect the scope so that an L-only input gives a vertical line.

7. Repeak T201 for the most vertical line and adjust R204 for the best vertical line. Switching to an R-only input should result in a horizontal line on the scope.

8. Inject an L plus R signal, with pilot, and set R232 and R233 for equal outputs from each channel. **R-E**

SPECIAL TUNER PARTS

The following special parts are needed for the construction of the tuner. All are available from Transitek, P.O. Box 98205, Des Moines, Washington.

Tuning capacitor C1	$7.50
Miller coil No. 9051	$2.04
Miller coil No. 2072	$2.58
Miller coil No. 1354PC	$2.61
Miller coil No. 1355PC	$2.61
Miller coil No. 1361	$1.80
Fairchild 2N3690	$1.25
Crystal filter	$13.50
Rf printed circuit	$5.90
If printed circuit	$7.20
Mx and power supply printed circuit	$9.20

COMPLETE TUNER PARTS LIST

PARTS LIST RF HEAD

All resistors are ¼ W, 5% unless noted as ½ W.

R1, R4—47 ohms
R2, R7—330 ohms
R3, R8—4700 ohms
R5, R22, R24—1500 ohms
R6, R9, R14, R29—100 ohms
R10, R16, R23—220 ohms
R13—12,000 ohms
R15—100,000 ohms
R21, R26, R30—10,000 ohms
R25—2500 ohms, ¼-watt trimmer
R31—1200 ohms
R32—4700 ohms
R11—470 ohms, ½ watt
R12—150,000 ohms, ½ watt
R17—33,000 ohms, ½ watt
R18—4,700 ohms, ½ watt
R19—510 ohms, ½ watt
R20—180 ohms, ½ watt
R27—220 ohms, ½ watt
R28—100 ohms, ½ watt

Capacitors

*C1—4 gang FM tuning capacitor, (2–17 pF per section. Trimmer range 0.5 to 12 pF. Only three trimmers are used. Local oscillator section uses separate trimmer.
C2, C17, C21, C22—6.8 pF, NPO ceramic
C3—3.3 pF, NPO ceramic
C4, C5, C6, C8, C9, C10, C16, C19, C20, C23—.02 μF, 25V cer.
C7, C12—.001 μF, ceramic
C11—70 μF, 20V electrolytic (Mallory MTA-70E20 or equiv.)
C13—.05 μF, 25V ceramic
C14—68 pF polystyrene
C15—200 pF polystyrene
C18—1 μF, 50V electrolytic (Mallory MTA 1D50 or equiv.)
C24—350 μF, 15V electrolytic (Mallory MTA 350 F 15 or equiv.)
C25—3–12 pF ceramic trimmer (Centralab 822FZ or equiv.)
C_T—trimmers on C1

Semiconductors, coils

Q1, Q2—2N3690 (Fairchild)
Q3—3N141
Q4, Q5—MPS 6939
Q6—2N3856
D1—10V Zener diode, 1W, 5%
L1—2T, #26 enamel, next to ground end of L2
L2—4T, #18, ¼" dia, 7/16" long
L3—4T, #18, ¼" dia, 7/16" long, tap at 1T and 3T
L4—same as L3 but tap only at 3T
L5—2T, #18, 5/16" dia, ¼" long, tap at ¾ T from C1d
L6—J.W. Miller 9051

IF Strip (101 to 199 series)

C101, C103, C105, C106, C107, C108, C109, C110, C113, C114, C119, C120, C126, C127, C128, C129, C130, C131, C132—.02 μF, 25V ceramic
C102—6.8 pF, NPO ceramic
C104, C111, C112, C123—.05 μF, 25V ceramic
C115—5 pF, polystyrene
C116, C117, C118—330 pF ceramic
C121—5-μF 50V electrolytic (Mallory 5D50 or equiv.)
C122—350-μF 15V electrolytic (Mallory 350-F15 or equiv.)
C124, C125—omit due to design change

Resistors all ¼ watt 5% unless noted

R101—560 ohms, ½ watt
R102, R112—47,000 ohms, ½ watt
R103—10,000 ohms, ½ watt
R104, R111, R120—2200 ohms, ½ watt

(continued on page 91)

NEW PRODUCTS

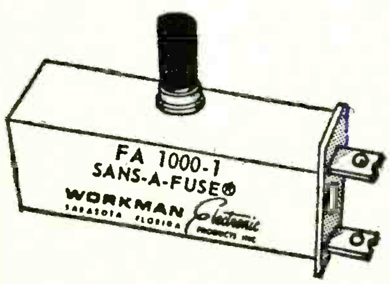
More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card at the left and circle the numbers of the new products on which you would like further information. Detach and mail the postage-paid card.

MINI-SPEAKER, *Minimus 0.5*, 10 watts to 8 ohms through screw terminals or phono jack. Surprisingly heavy, the extra weight is due to materials that

minimize effects of small size. 4¾ x 6⅝ x 4¼". Walnut case; die-cast aluminum frame. Catalog No. 40-1995. $9.95. **Radio Shack**, 730 Commonwealth Ave., Boston, Mass. 02215

Circle 46 on reader service card

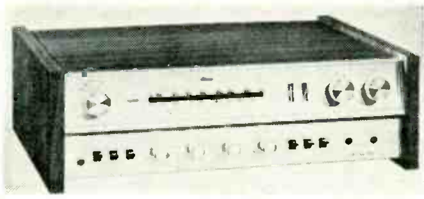
CIRCUIT BREAKER. *Sans-A-Fuse* is color-coded in 12 models for temporary or permanent replacement of blown TV chemical or amp fuses. Fits chassis sockets; can help find cause of breakdown.



Can be left in set when repair is made.—**Workman Electronic Products, Inc.**, Sarasota, Fla.

Circle 47 on reader service card

MULTIPLEX RECEIVER, model *RA-195*, solid-state, 175-watt IHF, FM-AM-FM Stereo, uses two IC's and FET. Has FM sensitivity of 1.5 μV for 30 dB



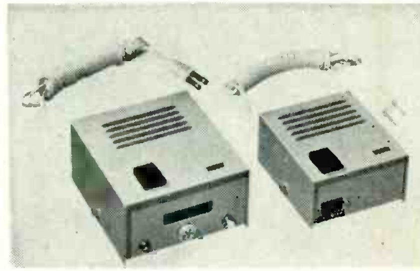
quieting, over 30 dB stereo separation, 30-20,000 Hz, ±3 dB frequency response. Loudness compensation +13 dB @ 50 Hzs +4 dB @ 10 kHz. Hum and noise, −55 dB (mag phono). Output impedance, 4, 8, and 16-ohm. 25 transistors plus 14 diodes. 18 7/16" x 5¾" x 14¼". Uses 110-120 volts ac, 50/60 cps. $249.98. **Olson Electronics**, 260 So. Forge St., Akron, Ohio 44308

Circle 48 on reader service card

SCHOOL INTRUD-ALARM changes building's PA speakers into microphones that detect noises in 1,000-to 5,000-Hz range using *CA-21 Intrusion Detector*. Inherent sounds such as heaters, clocks or compressors, outside noises such as car horns or backfires, and natural sounds such as lightning and thunder will not set off alarm. Internal audible

alarm can be triggered to scare intruder, or remote alarm (*CA-22*) may be sent over telephone wires to police station. *CA-22* panel allows up to 9 school buildings to be monitored by same unit. System can be switched to battery supply in case of ac power failure. Can use magnetic detector switches on windows and doors, if desired. **Bogen Communications Div., Lear Siegler, Inc.**, PO Box 500, Paramus, N. J. 07652

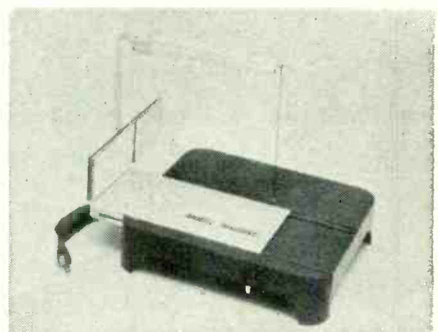
WIRELESS SMOKE AND FIRE ALARM, *model SW-440*. Features solid-state circuitry. Equipped with sensative smoke and heat detectors, emergency pull chain, extra ac outlet for additional signal devices, and provisions for adding external heat sensor. Heat sensor activates



at 135°F. Powerful buzzer. 5½ x 7 x 2½ in. 110-120V ac, 50/60 cps. $59.98. **Olson Electronics, Inc.**, Akron, Ohio.

Circle 49 on reader service card

PLASTIC FOAM CUTTER, *Model Machine*, makes rip cuts, cross cuts, freehand, angle, circular, arc and filagree cuts up to 6 in. deep. Makes dovetails, miters and interlocking joints. Cutting wire works by melting fine cut. No batteries. Low-voltage transformer gives high or low heat for change of speed and width of cut. Ruled grid on base and sliding platform and adjustable fence lock in all positions for accuracy,



3½ lb. Uses 117-volt outlet, 8 watts. Guaranteed against all defects for 1 year. $44. High-density foamed polystyrene comes in standard packs or custom-cut large blocks. Tightly packed closed cells are good for precision work. 400 cu. in. of assorted high- and low-density foam supplied with order. Waterproof and weather-resistant. Order details for additional foam come with order. **Technical Devices**, 1402 Norman Firestone Rd., Goleta, Calif. 93017.

Circle 50 on reader service card

TAPE STORAGE ALBUM, *Stor-A-Pac*, holds 6, 8 or 12 cassettes or 8 cartridges. Bookstyle, rigid construction prevents damage and keeps tapes dust-free. High-

Circle 106 on reader service card

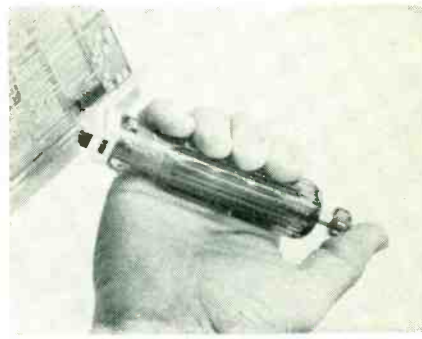
gloss warm blue, hot red and black embossed leatherette. From $3.49 to $4.98 each. **Modern Album and Finishing Co., Inc.**, 119-01 22 Ave., College Point, N. Y. 11356.

Circle 51 on reader service card

MUSIC SYSTEM, *Landmark 100*, includes AM/FM stereo tuner, record changer, *Acoust-Array* speakers, *Servo-Linear* motional feedback circuit in amplifier, *Garrard* automatic turntable. Speakers use 3 full-range loudspeakers and tweeter in small truncated cube enclosure. One faces forward; others placed asymmetrically at back of cabinet. Multi-directional radiation enlarges sound. Since speakers are angled, stereo aspect can be varied by placing speaker on its sides. Walnut-finished cabinets with dark brown grille cloths. 10 x 10 x 10". *Servo-*

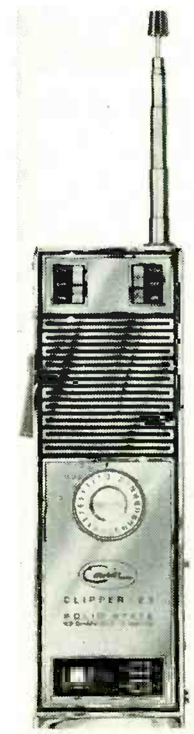
Linear motional feedback corrects any distortion from loudspeakers. Circuits sample actual movement of speaker cone compared to input signal and correct any difference through negative feedback. Amplifier has all-silicon transistor circuitry; is rated at 100 watts music power (±1 dB), 80 watts IHF. AM/FM stereo tuner uses all-silicon transistor circuitry with FET front end for picking up weak signals without interference. Four integrated circuit chips perform functions of AM/IF, FM/IF, and multiplex. *Garrard* turntable has *Stereo-V* magnetic cartridge using dual magnets, one for each channel. High stereo separation, low mass, and excellent tracking ability. Moving system resonance above 20,000 Hz. $399.95. Plastic dust cover, $14.95. **Electro-Voice, Inc.**, Buchanan, Mich. 49107.

Circle 52 on reader service card



IC INSERTION TOOL, spring-loaded, designed for inserting D.I.P.'s into printed circuit boards. Picks up and squeezes D.I.P.'s to fit hole pattern, then ejects them when firmly placed in circuit board. $8.90. #52. **Hunter Tools**, 9851 Alburtis Ave., Santa Fe Springs, Calif. 90670.

Circle 53 on reader service card



CB TRANSCEIVER, "Clipper 23", 23 channel and all solid state, includes 19 transistors, 4 diodes, 2 varistors, and 2 thermistors. Power input: 5 watts at 100% modulation with an effective inland range of 10 miles. Sensitivity: 0.25 µV. Equipped with a full complement of jacks for PA systems, external earphone, a 2-¾" speaker, antenna, mike and power connection. $159.95 complete with a leather carrying case. — **Courier Communications Inc.**, Newark, N.J.

Circle 54 on reader service card

RADIO ANTENNA BOOSTER, designed for campers, motor homes and trailers will last indefinitely (no batteries). For use in remote areas where reception is weak and where radio signals

Circle 107 on reader service card

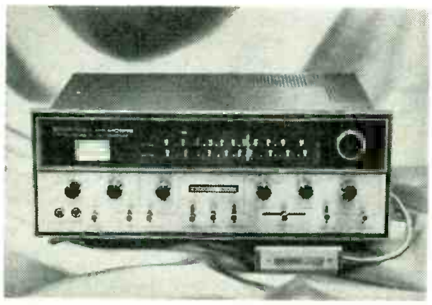
are not normally received. Clip short wire with alligator clip to metallic object such as window screen, door frame or water pipe. Long wire goes through window or door to outside. String it out full length and lay it on ground. Place unit behind radio and move unit to find maximum volume. 4½" x 1" x ½". **Russell Products**, 3651 Oakley St., Riverside, Calif. 92506.

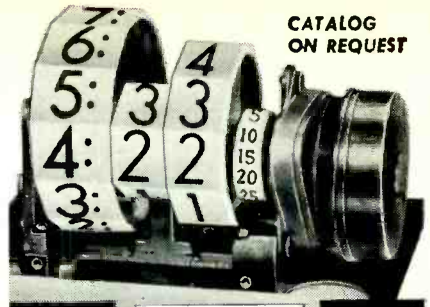
Circle 55 on reader service card

COLOR ORGAN, *Knight-Kit model KG-338.* Solid-state 3-channel circuitry separates high, middle, low frequencies into blue, green and red lights giving 3-dimensional display through prismatic screen. Connects to speaker terminals of any receiver, amplifier or console. $34.95 complete with vinyl-clad wood case, simulated walnut veneer. 8¼ x 14¼ x 5¾". **Allied Radio Corp.**, 100 N. Western Ave., Chicago, Ill. 60680.

Circle 56 on reader service card

STEREO RECEIVER, *KR-7070,* features AM, FM or FM multiplex tuning system and auto-tuning circuit that selects only FM stations, giving instant pinpoint tuning. Its 4 IC's and crystal filter FM i.f. stages provide selectivity and 1.5 dB capture ratio; 3-FET, 4-gang tuning capacitor FM front-end delivers 1.5 μV sensitivity and spurious response ratio. FET mechanical filter AM tuner section. Dynamic amplifier section with power bandwidth of 10 to 30,000 Hz (IHF)

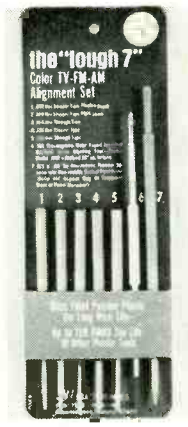




Circle 110 on reader service card

and main input frequency response from 5 Hz to 120,000 Hz (±1.5 dB) drives low-efficiency speakers. 2 pairs of phono input jacks, 2 pairs of stereo speaker output terminals and separate preamp outputs and main amp inputs permit unlimited system expansion. Automatic Protection Circuit (U.S. Pat.) protects power transistors from blowouts. Has individual 2 dB step-type tone controls for bass and treble, new presence control, which gives effect of changing proximity to sound, and 20 dB audio muting switch for temporary pause for quiet, such as phone call. $549.95. **KENWOOD,** Dept. P, 15711 So. Broadway, Gardena, Calif. 90247.

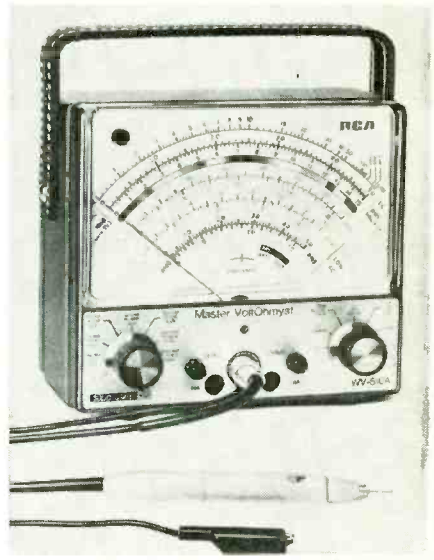
Circle 57 on reader service card



ALIGNMENT SET for color TV-FM/-AM consists of 7 glass-filled polymer plastic tools. Three come in as hex stopper type shank and two in hex through type with diameters of 0.078" and 0.101". One 0.101" nonmagnetic metal-tipped insulated oscillator screw adjustment tool withstands 10" oz. torque. Also, a nonmetallic trimmer adjuster with a conical point probe measures 0.025 x 0.156".—**JW Electronics, Plastic Div.,** Bloomington, Ind. 47401.

PORTABLE VOLTMETER, *Master Volt-Ohmyst, RCA WV-510A,* all solid-state, measures dc voltage from 0.01 to 1,500V, dc from 0.01 mA, to 1.5 amps, ac voltage from 0.2 to 1,500V, ac peak-to-peak voltage of complex waveforms from 0.5 to 4,-200V, and resistance values from 0.2 ohms to 1,000 megohms. 7 overlapping ranges given for ac, resistance, and current measurements, and 8 ranges for dc voltage measurement. Accuracy: ±3% of full-scale reading. Zero stability and linearity, low current drain. Battery test function provided. Input resistance of 21 megohms on most critical low-impedance

Circle 58 on reader service card



circuits. Has large, easy-to-read, 2-color meter with mirror scale. 6⅞ x 5¼ x 3⅛ in. 3½ lb. Comes with dc/ac-ohms probe with flexible shielded input cable (*type WG-401A*) with BNC connector, slip-on alligator clip, current test leads, one *RCA VS036* battery and instructions book. $128. Accessories available: *WG-301A* crystal-diode slip-on probe for measuring rf from 50 kHz to 250 kHz; *WG-411A* high-voltage slip-on probe for measuring up to 50,000V dc; *WG-436A* multiplier resistor. Commercial Engineering, **RCA Electronic Components,** Harrison, N. J. 07029.

Circle 59 on reader service card

MINI COLOR GENERATOR, the *Caddy Bar, Model CG19,* generates color bars, crosshatch, white dots, vertical and horizontal lines. Features reduced circuit drain and, full voltage regulation on all circuits, increases battery life. Timer range doubled. Nearly impossible to have timer jump at any time. Timer controls are screwdriver adjustments. $84.50. 2 lb. **Sencore,** Addison, Ill. **R-E**

Circle 60 on reader service card

Circle 111 on reader service card

NEW LITERATURE

All booklets, catalogs, charts, data sheets and other literature listed here with a Reader's Service number are free for the asking. Turn to the Reader's Service Card facing page 75 and circle the numbers of the items you want. Then detach and mail the card. No postage required!

COMPONENT SELECTOR CATALOG features resistors, rheostats/potentiometers, trimmers, tap switches, variable transformers, capacitors, relays, power controls (solid-state), light dimmers, rf chokes, meter saver, and design aids. 35 pages. *Catalog 300A*. Free from **Ohmite Mfg. Co.**, 3660 Howard St., Stokie, Ill. 60076.

Circle 61 on reader service card

SCOTT STEREO COMPONENTS AND SPEAKERS CATALOG covers AM/FM stereo receiver and stereo cassette recorder), tuners and amplifiers, controlled impedance speakers, compact systems, stereo kits and stereo consoles. Free. **H. H. Scott, Inc.**, Dept. P, Maynard, Mass. 01754.

Circle 62 on reader service card

1970 CATALOG OF ELECTRICAL AND HOBBYIST BOOKS available free covers schematic/servicing manuals, broadcasting, basic technology, CATV, electric motors, electronic engineering, reference; television, radio and electronics servicing; audio and hi-fi, hobby and experiment, test instruments, and transistors in over 125 current and forthcoming books. Features newly revised 1970 edition of *Popular Tube/Transistor Substitution Guide* and, scheduled for publication March 15th. *Small Appliance Repair Guide*. **Tab Books**, Blue Ridge Summit, Pa. 17214.

Circle 63 on reader service card

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

1970 TELEVISION PARTS REPLACEMENT GUIDE. Stancor color and monochrome parts lists 500 transformer and deflection components, and replacement parts for 200 TV manufacturers in part-to-part cross-reference guide. Added section covers flybacks, deflection yokes, vertical outputs, power and output transformers and filter chokes, plus several pages of schematics. For free copy. **Essex International, Inc.**, Controls Div., Stancor Products, 3501 W. Addison St., Chicago, Ill. 60618.

PANEL INSTRUMENTS CATALOG features over 1,500 stock ranges, sizes and types. Includes quick-reference index on cover for getting ranges and types in desired case style. Introduces new Century series with rugged phenolic and glass construction: *Model 2800* digital panel instruments with advanced IC design, nonblinking readouts which change only when measured value changes; accuracy ±0.1%, with resolution of 1 part in 1000. *Bold-Vue* 3-hole mount instruments, contactless controllers and illuminated Designer series VU instruments. Catalog has panel instrument characteristics chart and glossary of terms. All items "off the shelf" delivery. *Bulletin 2801*. **Simpson Electric Co.**, 5200 W. Kinzie St., Chicago, Ill. 60644.

POWER SUPPLIES CATALOG features dc power supplies intended for use in DTL, TTL and MOS logic circuits; SR modular supplies from 3.6V to 48V with currents up to 35 amps. Militarized modular power supplies from 3.6V to 48V with current to 20 amps in 5V package meet all requirements of MIL-E-16400, MIL-T-21200, and MIL-E-4158 basic equipment specs with full power ratings to 71°C. Also has high-performance flat-pack military modular and ultraminiature power supply units. Powertec Div. **Airtronics, Inc.**, 9168 DeSoto Ave., Chatsworth, Calif. 91311. **R-E**

EQUIPMENT REPORT
(continued from page 26)

instantly when it's turned on, flicker between figures for a split second, then go to all zeros. When you feed an ac voltage into it, the reading is displayed instantly. If you're on one of the lower ranges, you'll probably notice that the last digit keeps changing about every half-second or so.

After a little while, you realize what is going on. The thing is actually taking a series of instantaneous readings of the varying values of the ac input, and telling you about it!

Here's what is actually happening: the counter and plug-in are "sampling" the input voltage, at very short intervals. If the instantaneous value of the voltage has *changed* even a tiny bit, a different reading is sent to the display. The time of this sampling can be controlled by a knob on the front panel, from about 0.8 sec up to about 4.0 secs. So, you can read very small variations in the input voltage much faster and more accurately than with a conventional-type meter movement.

Another valuable feature of this instrument is controlled by the same knob. If you're making a test, and you want to know "how much output for so much input?", set up the instruments, get the reading, and then pull the timing knob out. This locks the reading at that instant; the display will then "remember" it for as long as you want!

The ac voltmeter plug-in, the DP-130, has six voltage ranges, from 10.0 mV volts up to 1000 volts, all rms. One very useful feature is the automatic location of the decimal point. For example, on the 10.0 mV range, it will be placed after the left-hand digit.

You might wonder how a 10-mV reading can be shown with only one digit to the left of the decimal point. The display is actually showing "9.99 mV" at full scale. On this range, you can actually read a variation of 10.0 *microvolts* on the last (right) digit. If the input goes above 10.0 mV, an "Overrange" light on the panel glows to warn you that the input has gone above 10.0 mV. The same principle is used on all ranges: the 1000 volt scale reads 999 volts, and so on.

The ac voltmeter input has a tremendously high input impedance: 1000 megohms shunted by about 25 pF. Despite this it is protected against accidental overload. A special fuse is used in the input that will blow within 100 *microseconds*. Its main use is protection of the lower ranges —10.0 mV, 100 mV, and 1000 mV.

On the 10V, 100V and 1000 V ranges, the capacitive divider used in the attenuator has capacitors with very high working voltage. Their values are chosen so that 99.9% of the input voltage is dropped across the divider; only 0.1% is actually applied to the preamplifier input. The instrument is practically immune to damage from overload, on the higher ranges, up to 1500 volts peak.

The construction of these units is beautiful. Epoxy boards are used, and the overall construction is rugged. Operation is simple; the number of controls have been kept to a minimum, and the display is simple and "positive." For lab work, production-line testing or any kind of measurements application, this system should be very useful indeed. The versatility of the "plug-in" system will make it a most desirable member of any instrumentation setup. Prices are well below those of similar units in the past, which is another good point today.—*Jack Darr* **R-E**

DID YOU MISS . . .

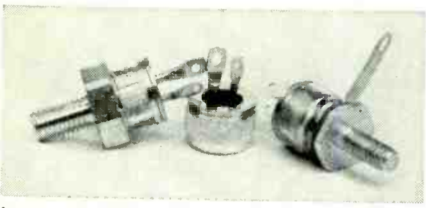
If you're not sure how a flip-flop logic circuit is used in modern digital circuits, take another look at Matt Mandl's do-it-yourself circuits starting on page 44.

Ever hear of a swept i.f.? If you don't know what it is, turn back to page 59.

NEW METAL-CAN TRIACS

A new line of high-performance metal-can triacs with ratings up to 15 amps rms has been designated as the TIC 220, 230 and 240 series by Texas Instruments. The devices are designed for controlling ac power for motor, heat and light controls, and can be used with or in place of electromechanical relays and contactors.

The triac series will handle currents of 6, 10 and 15 amps, respectively. Each is available in voltage ratings of 200, 400 and 500 volts at 125°C. Package configurations are: standard press-fit, stud mounted and an isolated stud providing electrical isolation from the chassis or heat sink.



In lots of 100, prices range from $1.70 for a 6-amp, 200-volt device to $4.15 for a 15-amp, 500-volt isolated-stud unit. For further information, write Texas Instruments, Inc., Inquiry Answering Service, P.O. Box 5012, M/S 308, Dallas, Texas 75222. Request data on TIC 220 triacs. **R-E**

INTERVAL TIMER
(continued from page 58)

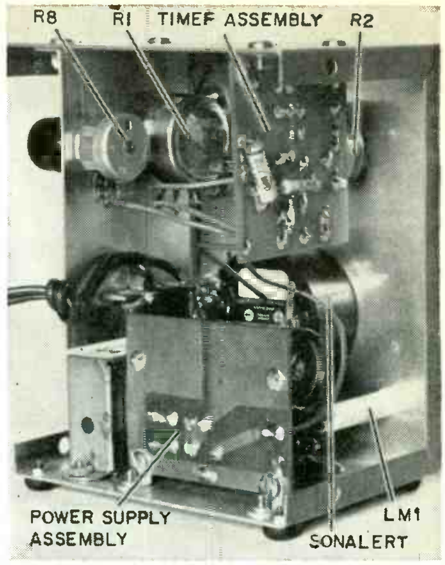
The setting of potentiometer R8 determines the duration of the *longer* timed intervals, while the setting of potentiometer R1 determines the duration of the *shorter* timed intervals. Before turning the timer on initially, set R1 to put about two-thirds of its resistance in the circuit, and set R8 to just a little below midposition.

With R1 and R8 set as described, set potentiometer R2 in its maximum-clockwise position (maximum resistance in the circuit). Make sure switch S2 is closed, shorting R3. Then move S1 to On. Using an accurate electric clock with a sweep second hand, check the duration of the timed interval. It should be 16 minutes. If it is less, switch the timer off and adjust R8 to put a little less resistance in the circuit. Then check the timed interval again. Try to set R8 so that the interval is accurate to within ±10 sec. Check the interval several times, to make sure of the best setting of R8, and to determine the repeat accuracy.

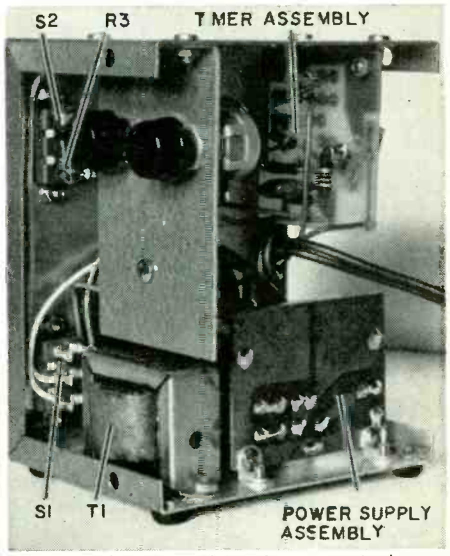
With R8 properly adjusted, turn potentiometer R2 to its maximum counterclockwise position (minimum resistance in the circuit), and check the timed interval. It should be 2 min. If it is less than this, adjust potentiometer R1 to put a little more resistance in the circuit, and check the interval again. With R1 properly adjusted, go back and recheck the 16-minute interval. Readjust R8 slightly, if necessary. Then recheck the 2-minute interval, and readjust R1 slightly, if necessary. Go over these checks and settings several times.

Calibrating the settings of R2 consists of locating the pointer knob positions for the 4-, 6-, 8-, 10-, 12- and 14-minute intervals, and of making a tiny mark on the cabinet front at each position, using a sharp scriber. This can take time, especially when the exact settings for the longer intervals are involved. Having a good book to read during the interim each time will make the task seem less tedious. Be sure to make a mark at the extreme settings of R2 to locate the 2- and 16-minute intervals.

The optimum value for R3 may now be determined, as described previously. When this has been done, the timer is ready for use. **R-E**

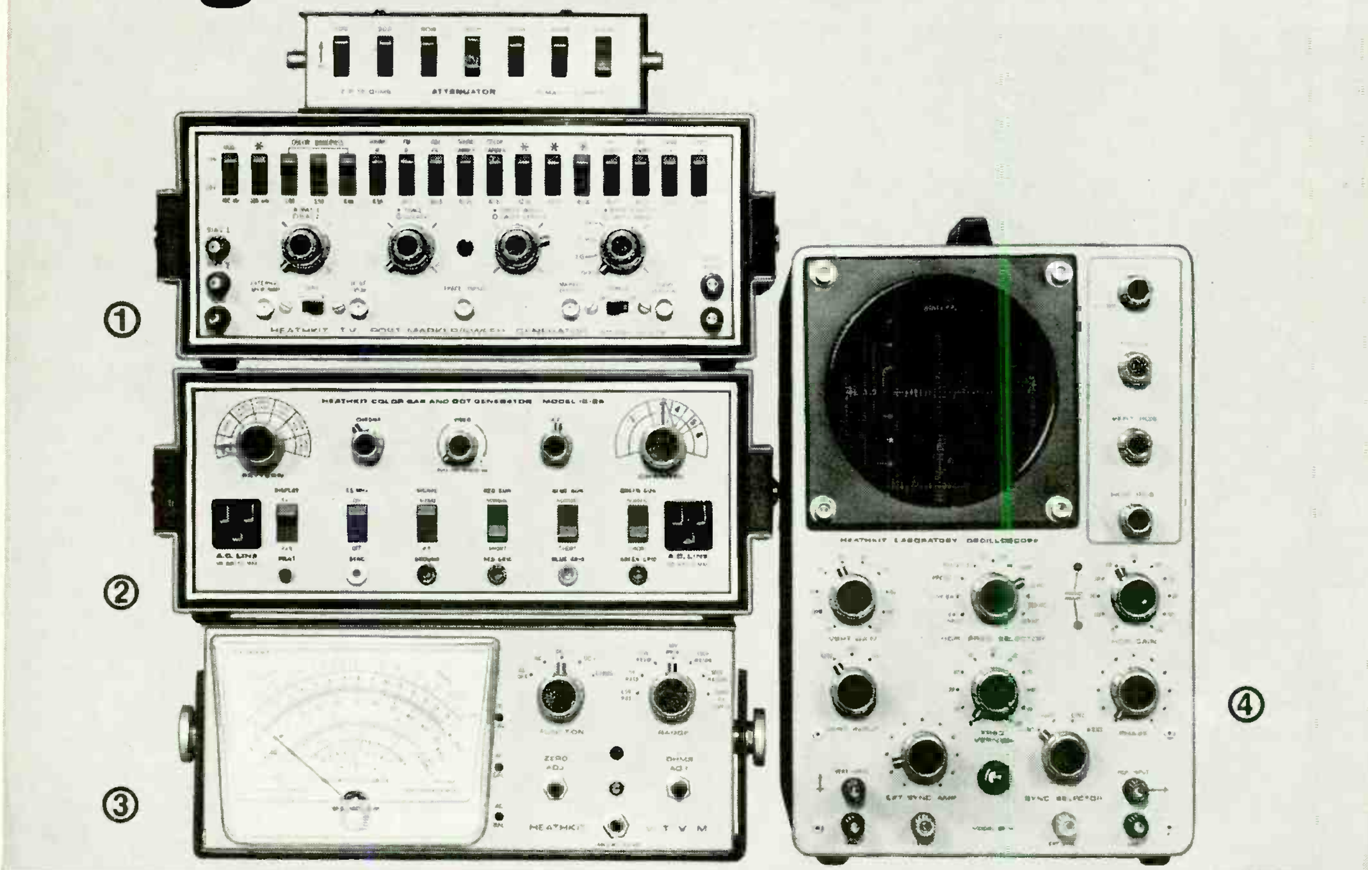


Inside the timer case you get a close look at parts placement. Note the positions of the two circuit boards.



Another internal view shows parts locations from a different vantage point. Follow this arrangement closely.

stack these up against the others . . .



for just the price of other sweep-marker generators, you can get a bench full of Heathkit® color test gear

Stack These Up Against The Others . . . a high performance Sweep-Marker Generator, an accurate Color Bar-Pattern Generator, a versatile VTVM and a rugged, dependable Scope . . . all for only $347.40* . . . $50 *less* than the cost of other sweep-marker generators alone. At Heath, we still believe that you should be able to get a stack of gear without spending a pile of money.

1 **Heathkit IG-57A Solid-State Sweep-Marker Generator . . . $135.00*.** 15 crystal controlled markers for color bandpass, TV sound, IF, picture & sound carriers for channels 4 & 10, FM IF . . . new Video Sweep Modulation allows injection of chroma-sweep directly into IF amplifiers or thru antenna terminals . . . two built-in variable bias supplies . . . 400 Hz modulated or CW output of any individual marker . . . exclusive external attenuator . . . stable, linear sweep signals for the five most used frequency ranges . . . complete scope matching controls . . . quick disconnect BNC connectors . . . complete with all probes, test leads & terminated cables. 14 lbs. Assembled IGW-57A, 11 lbs. . . . $199.00*

2 **Heathkit IG-28 Solid-State Color Bar-Pattern Generator . . . $79.95*.** Produces 12 patterns plus clear raster . . . dots, cross-hatch, vertical & horizontal bars, color bars and shading bars in 9x9 or exclusive 3x3 display . . . all solid-state using computer-type integrated circuitry . . . variable front-panel tuning for channels 2 thru 6 . . . variable front-panel positive and negative video output . . . front panel negative going sync output . . . built-in gun shorting circuit with lead piercing connectors . . . switchable crystal-controlled sound carrier. 8 lbs. Assembled IGW-28, 8 lbs. . . . $114.95*

3 **Heathkit IM-28 "Service Bench" VTVM . . . $39.95*** Measures RMS DC & AC Volts from 1.5 — 1500 . . . AC P-P from 4 — 4000 V . . . resistance from 0.1 ohm — 1000 megohms . . . easy-to-read 6" meter . . . 10-turn vernier controls for zero & ohms . . . single test probe for all measurements . . . ±1 dB 25 Hz — 1 MHz response. 7 lbs. Assembled IMW-28, 7 lbs. . . . $59.95*

4 **The Heathkit IO-18 5" Wide-Band Scope . . . $92.50*** 5 MHz band-width . . . five sweep ranges from 10 Hz — 500 kHz . . . + or — internal, line or external snyc . . . two extra, presetable sweep positions . . . front panel 1 V P-P reference . . . Z-axis input . . . retrace blanking . . . 0-135° phasing control . . . frequency-compensated vertical attenuation. 24 lbs. Assembled IOW-18, 23 lbs. . . . $149.95*

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Circle 119 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.

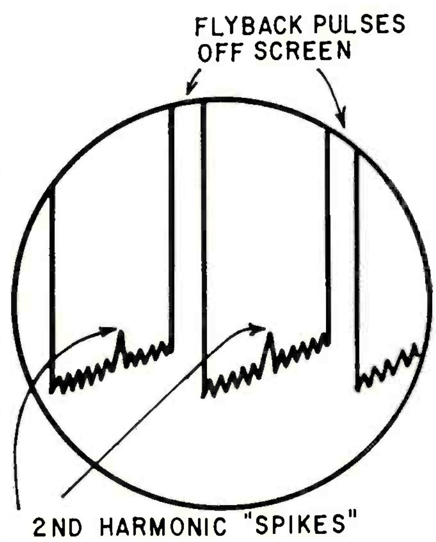
If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 200 Park Ave. South, New York 10003.

White Line in Raster After Flyback Replacement

I replaced the flyback in a Curtis-Mathes 12A1 with a Thordarson FLY-165. Works, but I get a vertical white line in the middle of the picture, about ¾ inch wide. Doesn't seem to be a drive line, for the picture is linear horizontally; no foldover at that point. Can't get rid of it.

Does this flyback match this chassis?—J. G., De Queen, Ark.

Yes, it does. This may be due to the new flyback actually being a little



more efficient than the original! This is a little bit of second-harmonic ringing. If you'll look at the yoke voltage waveform (put the scope probe on one of the yoke wires) you'll see a tiny "pip" in the forward-sweep portion between the spikes (see diagram)!

The cure for this is a drive adjustment. This chassis doesn't have a drive control; reduce the size of the 330-pF horizontal-output coupling capacitor to 200 pF, and the line will go away.

More "push" needed in antenna

I've got a set, located about 75 miles from channels 4, 5 and 8. The antenna is a conical, about ½ mile up on a hill, with open-wire transmission line. Low band stations are pretty good but channel 8 is pretty snowy. What would help this out?—L. M., Knoxville, Tenn.

I believe your best bet would be more gain in the antenna. Conicals are fine, but the maximum gain is about 4–5 dB. Try one of the later all-band Yagi types; these have gains up to 12–14 dB all the way across the band, and might help.

Also, you're losing that high-channel station in the transmission line, most likely. Losses are much higher in highs than lows. Might try a small antenna-booster, either at the antenna site or cut into the line say about half-way up. This length of line is okay. Be sure to put a *good* lightning arrester at the antenna.

Line-noise TVI

On a G-E M5 chassis (at the home) I get a band of dots and flashes about 2–3" high that slowly crawl up and down the screen. Sometimes there are two equally spaced smaller bars. It's worst on channel 2, sometimes present on 4-5, and hardly visible at all on 7, 9, 11 or 13. I've tried high-pass and ac-line filters with no help. It stops when the antenna is removed, and also when the rf amplifier tube is pulled. What is it?—H. F., Gardena, Calif.

It's ac power-line noise. This sounds like hardware noise—tiny arcs from the hot lines to any of the metal mounting hardware on a power pole. This can often be eliminated by tightening all hardware for three or four blocks.

Report this to your local power company. Or you can check it out with an auto radio. Listen for a roaring interference near certain poles.

Hash on screen

I get a sort of "hash" and flicker-

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NEW Heathkit "Spectre" ⅛ Scale R/C Car
Join The Most Exciting New Hobby In America . . .

building and racing radio-controlled Grand Prix cars up to scale speeds of 200 mph. The Heathkit "Spectre" R/C car reaches that speed and has already proven itself a winner. And no wonder; its design is unique. It has a chrome plated steel chassis, adjustable caster and toe-in, specially formulated rubber tires that lock onto the cast nylon wheels, independent front suspension for excellent cornering and a 5.5:1 gear ratio for maximum torque at all speeds. The snap on, ⅛ scale car body (length: 19¾") is of high impact plastic — almost indestructable. Suspension is by real coil springs. The radio equipment compartment is dirt and oil proof. The Heathkit "Spectre" is the only complete car kit available. You get the body, chassis, wheels & tires, 4 oz. fuel tank & tubing, equipment case & protective foam, centrifugal clutch & gears, axles, servo linkages & mounting tape, all hardware, decals, numbers and a comprehensive manual. The "Spectre" accepts any .15 to .23 cubic inch R/C engine and any proportional R/C electronics system. It requires only two servos to operate the steering, brake and throttle. Get in on all the thrills of R/C car racing at the lowest possible price . . . order a Heathkit "Spectre".

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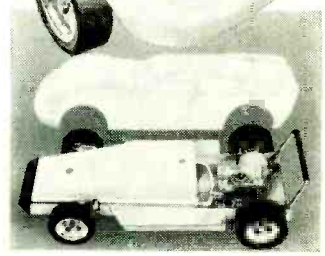
Assembled GDA-101-1, Veco® .19 R/C engine, 1 lb................**$19.95***

Heathkit GD-101
$49^95*



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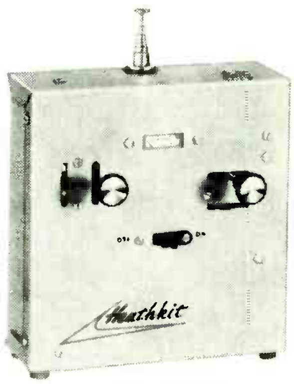
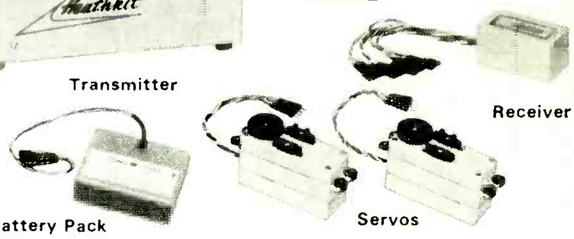
Kit GDA-57-2, receiver only, (specify freq.), 1 lb..................**$34.95***



Transmitter

Heathkit GD-57
$129^95*



Receiver

Battery Pack

Servos

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Hey Chief! Save up to 60% on a new electronic siren/PA system by ordering the low cost Heathkit GD-18. The siren gives both "wail" and "yelp" warnings at 55 watts output power, and you can adjust the pitch. As a public address it will amplify your voice with a full 20 watts of power, and it's practically immune to acoustical feedback. (Either PA or siren can be interrupted to use the other.) Incoming radio calls can be channeled through the GD-18 so you can hear them when away from your vehicle. Use it on any 12-volt auto electrical system with either positive or negative frame ground. It will operate from -20° to 150° F conditions. Control panel is lighted. Comes with gimbal bracket mounting. Take your choice of speakers . . . concealed or exposed.

Kit GD-18, Siren/PA Amplifier, 7 lbs..............................**$54.95***
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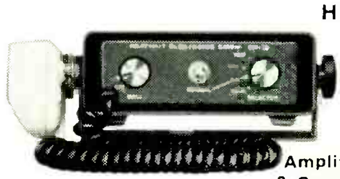
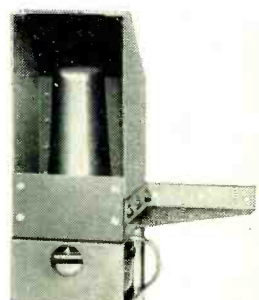


Amplifier & Controls

Exterior Horn



Concealed Horn

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Circle 121 on reader service card

ing effect on the left side of the screen on low channels only. It's worst on channel 2. What causes this kind of stuff?—R. W., Rego Park, N. Y.

Any interference on the left half of the screen should be caused by something in the damper, boost, or boosted-boost circuits. They supply the scan for that side. Try new tubes in the damper, high-voltage rectifier, and voltage regulator sockets. Also try a new horizontal output tube.

Make sure all shields, covers, etc., are in place and tight. This kind of problem is often caused by radiation from the horizontal sweep getting into the tuner or i.f. circuits. Yoke cables can cause it, which accounts for its positioning on the screen. The problem is often mistaken for yoke ringing. Could be a small arcing in the yoke. Check for corona.

Capacitors that squint

Question: you've got two identical capacitors, say 0.1 μF. One makes the "eye" on a capacitor tester open wide, and the other opens the eye at the same place, but only about half as much, or less. Does this mean the narrow-eye capacitor is bad?—B. R., East Chicago, Ind.

Not necessarily, but maybe. The capacitor with the "squint" may have just a tiny bit more leakage than the other. They both have the same *capacitance*, since you get the reading at the same point on the dial.

I seldom check paper capacitors for capacitance, but always check them for leakage. If I were working on a hi-fi amplifier, I'd certainly use the one with the wide eye in coupling applications, and the squinty in nonsensitive applications such as cathode bypassing.

Multicolored bars on right

In a Zenith 25MC33 chassis, there are multicolored vertical bars on the right side of the screen—sometimes one, sometimes two. They look like Barkhausen oscillation, but why the colors?—R. D. H., Little Rock, Ark.

They are Barkhausen bars, most likely, especially if they have all the other typical symptoms. Change the horizontal output tube.

The multicolored effect is natural; Barkhausen oscillation is a pretty high frequency, and not too "pure" a sine wave! You've got harmonics, and the harmonics have harmonics, and somewhere in there you've got little bits and pieces of all kinds of frequencies, many of them in the range of the color signals. Very similar to the "fringing" seen when fine tuning is mistuned.

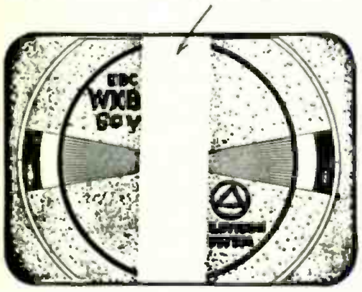
CATV "Leakage?"

We have a community antenna system here. It's causing a lot of interference to homes that use antennas. Is this normal?—H. J., Uhrichsville, Ohio

No it isn't, not if it's definitely cable leakage. A *properly installed* CATV system must hold its rf leakage down to a very low level. The most common problem is running line amplifiers too high, (or someone forgetting to put the shielding lids on amplifier boxes).

There's a good test you can make. Turn an antenna so that it points toward the TV station and a line-amplifier box as well, if you can. Now, look for a TV screen symptom something like that in the drawing.

WHITE OR LIGHT BAR IN CENTER OF SCREEN



If the CATV amplifier *is* radiating, you'll see what we used to call a cable bar. It's the horizontal blanking bar from the same signal, delayed a few microseconds in passing through the coaxial cable.

Check 2: Find a house with an antenna and rotator, so that you can aim the antenna *directly away* from a given TV station but directly at a suspected line-amplifier box. If you get a good picture by aiming at the box, it's radiating. For a better test, put the TV station at right angles to the front of the antenna. Some antennas have a poor front-to-back ratio, but very few have much pickup directly to one side.

Notify the CATV engineering staff. If they won't take care of the interference, yell to the FCC.

Low brightness after CRT conversion

I've converted a CTC5 RCA chassis from the original 21AXP22 to the newer 21FPB22. Works fine, but I've got some problems. When I turn the brightness up I get a bad blooming, a drop in the HV and loss of focus. Is there a further modification that should be made to get better brightness?—B. S., Denver, Colo.

I'd recommend a thorough going-over of the HV supply circuits. RCA's service data call for only 19,500 volts of HV in the original circuit. Your focus voltage is (and should be) a *percentage* of the HV,

(continued on page 95)

TECHNOTES

NO COLOR WITH AFT IN

A common complaint is that, on certain channels, color is received with aft off but not when the aft switch is set to the AFT ON position. The service technician may attribute this to misalignment or other trouble in the aft circuits.

Almost invariably, the trouble can be traced to the color-killer control being set too high. This results from using the older method (setting the color killer to eliminate colored show on an unused channel) of setting the color-killer control. Use the following procedure on receivers with aft:

1. Set the killer control fully counterclockwise.
2. Turn the aft off.
3. Tune in a color transmission and adjust all controls for best color picture. The color control probably will be turned up about halfway.
4. Switch to a channel transmitting b/w and adjust fine tuning for slight sound interference. This causes false color in the picture.
5. Turn the killer control slowly clockwise, to just eliminate the false color.
6. Check the setting of the killer control by tuning to all channels transmitting color. If the color drops out on any channel when aft is switched on, back slightly on the killer control until color appears.—*DuMont Field Service Bulletin*

OLYMPIC CTC 30

Some early-production chassis have poor color-killer action. This is due to an incorrect connection of C170—a 0.01-μF disc capacitor. A few chassis have one end of C170 connected to the junction of R189 and diode SR109. The correct connection for this capacitor lead is to the junction of resistors R188 and R189.—*Olympic Service Bulletin*

OLYMPIC MA-100 AND SA-100

Complaint: Insufficient volume when the tone control is turned counterclockwise.

Remedy: 1. Remove four Phillips-head screws from the changer board and remove entire assembly from the case.

2. (MA-100) Connect a 470,000-ohm ½-watt resistors, across the tone control terminals on the bottom of the amplifier PC board as shown in the diagrams.

3. (SA-100) Install two 470,000-ohm ½-watt resistors, one each from the center lug to the high side of the tone control in each stereo channel. The high side of the tone control can be identified by the brown lead running to the phono pickup.

4. Reinstall changer board in the case and test the tone control operation.—*Olympic Service Bulletin* **R-E**

A LOOK AHEAD IN R-E

If you like the construction and special interest features you've been reading, you won't want to miss what we've planned for coming months.

- **July**—Sound reinforcement is the special feature. One article provides valuable tips on microphone types and techniques.
- **August**—TV cameras and vtr's are up front. Find out about the latest color cameras and equipment.
- **September**—TV antennas will be featured. R-E takes a close look at the uhf types and how they work.

COMING NEXT MONTH

JUNE 1970

- **Build R-E's "RADAR" Burglar Stopper**
  Dual-function alarm uses ultra-high frequency to fill rooms with an invisible protective shield. Auxiliary circuit protects doors and windows. Permits connecting sensors for fire, smoke, cold, etc.

- **Stereo In Your Car**
  8-track cartridge or 4-track cassette — both are ready for your car now. Pros and cons of both systems are presented and a rundown of current equipment too.

- **Careers In Aviation Electronics**
  Fast-growing aviation industry has a large number of openings for electronic technicians. See what you must know and how you can get started in this new electronics industry.

- **The Amplified Zener**
  Combine a diode with a transistor and get an effective Zener diode that handles real power. An interesting new technique.

- **Plus these regular features**
  Kwik Fix™
  Service Clinic
  In The Shop
  Tools Report

TRY THIS ONE

SIMPLE CABLE STRIPPING

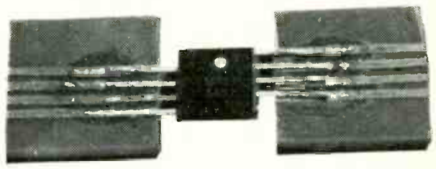
An easy way to cut through the insulation on all types of plastic-coated TV lead-in, microphone cable, etc. is to bend wire into a loop, then press a sharp knife into the insulation. The insulation separates before the blade has cut all the way through to the braid or inner conductors and they will not be nicked by the knife blade. Strip the insulation off by pulling with pliers.—*H. Josephs*

PERFECT REPAIR TOOL FOR BROKEN ANTENNAS

Most broken telescoping radio and TV antennas can be quickly and rigidly repaired with a common tubing cutter. The soft, thin metal scores easily before cutting, which is the secret of this repair. First, use the tool to cut off both tips of the broken pieces. This leaves both edges knurled inward. The lower piece is then stretched to its original size by rotating the tip of long-nose pliers inside. The upper section will then slide inside the lower one, after which the tubing cutter is used again to make a couple of scores, crimping the doubled area. Depending on where the antenna is broken, it will sometimes continue to telescope fully, and in other cases be only slightly restricted. In either case, this is a real confidence builder among customers who might feel an expensive replacement is more than their set deserves. The smallest, cheapest tubing cutter does the job.—*B. M. Carrie*

FLAT-PACK HOLDER

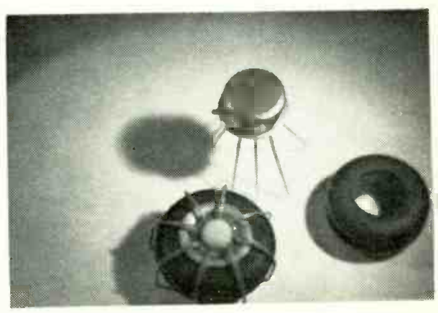
You can make inexpensive holders for flat-pack IC's. Take 2 pieces of ½-inch square copper-clad board, cut masking tape (or equivalent) into $\frac{1}{32}$-inch strips and space them on the



copper clad to pick up each tab on the flat pack. Place the taped squares in some etching solution to remove the excess copper. Remove the tape and you're ready to mount your flat-pack.—*A. E. Plavcan*

IC MOUNTING TECHNIQUE

The photograph illustrates a method of mounting TO-5-case IC's that is particularly well suited for experimental breadboards and prototypes.



The major advantage of this method is that each lead of the IC is easily accessible. Clipleads and probes are readily attached to any lead for waveform or voltage checks and measurements.

A rubber grommet of the proper size is pressed over the IC case and used as a form for bending the leads (photo). The grommet is removed and the IC is inserted into eyelets that have been set in perforated board. This method works well with any multilead TO-5 device—*Royland Pettersen* **R-E**

ULTIMATE TUNER
(continued from page 72)

R105, R138, R144—1000 ohms
R106, R110, R117, R139, R140, R145—220 ohms
R107—510 ohms, ½ watt
R108—4700 ohms, ½ watt
R109, R121—22 ohms, ½ watt
R113—6800 ohms, ½ watt
R114—220 ohms, ½ watt
R115—470 ohms, ½ watt
R116—47 ohms, ½ watt
R118—2700 ohms, ½ watt
R119—100 ohms, ½ watt
R122—47,000 ohms
R123—6800 ohms
R124, R125—5100 ohms
R126—1000 ohms, ¼-watt trimmer
R127—22,000 ohms
R128, R136, R141—47,000 ohms
R129, R137, R142, R143, R146—10,000 ohms
R130—4700 ohms
*F101, F102—XTAL FILTER, $13.75 ea.

Specifications for F101 and F102:

Center frequency—10.7 MHz
Bandwidth—1.5db, 200 kHz min., 3db, 240 kHz min., 20db, 500 kHz max., 50db, 1100 kHz max.
Ultimate attenuation—50dB minimum
Maximum insertion loss—5dB
Phase linearity—Within plus to minus three degrees of best straight line over 200 kHz minimum bandwidth
Input to filter—500 ohms plus 4.2 pF
Load on filter—500 ohms plus 7.5 pF
Size—51mm long, 18mm wide, 33mm high
Operating temperature—45 to 110 degrees F.
T101—J. W. Miller 2072
T102—J. W. Miller 1605 PC
Q101, Q102, Q103, Q104—MPS 6939
Q105, Q107—2N3860
Q106—2N5355
D101, D102—IN34
LM101—12-14V, 25-40 mA

Multiplex and Power Supply (201-299 series)

C201, C209, C224, C225—1µF/50V, electrolytic (Mallory MTA 1D50 or equiv.)
C202—560 pF polystyrene
C203, C206, C207, C211, C212—.01-µF polystyrene
C204—.02-µF or .05-µF, disc ceramic; see text
C205—.001-µF polystyrene
C208—.01-µF disc ceramic
C210—15-µF, 35V, electrolytic (Mallory MTA 15E35 or equiv.)
C213—5-µF 50V, electrolytic (Mallory MTA 5D50 or equiv.)
C214—.0015-µF, polystyrene
C215, C216, C217, C218—.002-µF temp. stable ceramic
C219, C220—.001-µF temp. stable ceramic
C221, C222—.05-µF, disc ceramic
C223—10-µF, 35V, electrolytic (Mallory MTA 10D35 or equiv.)
C226—500-µF, 25V, electrolytic (Mallory TC-2505B or equiv.)
C227, C228—500-µF, 15V, electrolytic (Mallory MTV 500DN15 or equiv.)

All resistors ¼-W, 5% unless otherwise noted

R201, R206, R212, R213, R214, R215, R216, R217—10,000 ohms
R202, R207—2 megohms
R203—3300 ohms
R204—1000 ohms, ¼ watt trimmer
R205—1000 ohms
R208, R218—6800 ohms
R209—2,200 ohms
R210, R234, R235—100,000 ohms
R211, R230, R231—4700 ohms
R219—560,000 ohms
R220, R221, R222, R223—39,000 ohms
R224, R225, R226, R227—150,000 ohms
R228, R229—1 megohm
R232, R233—25,000 ohms, ¼-watt trimmer
R236—220 ohms, ½-watt
R237—100 ohms, ½-watt
R238—56 ohms, ½-watt
R239—470 ohms
T201, T203, T204—J.W. Miller 1361
T202—J.W. Miller 1362
T205—J.W. Miller 1354-PC

(continued on page 93)

PHOTOCELLS FROM TRANSISTORS

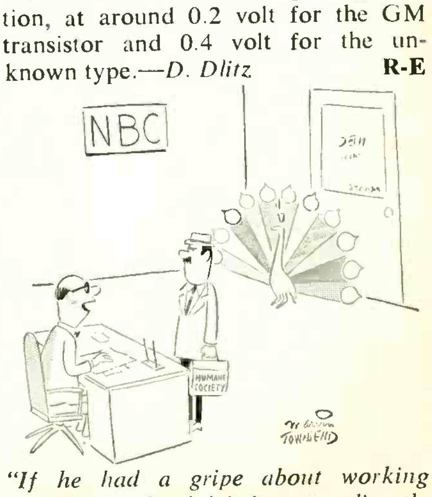
Recently, I needed some photocells for an experiment. Recalling that the diode junctions of most transistors are photosensitive, I decided to investigate the possibility of using defective transistors in my experiment.

These transistors, in TO-3 cases, were opened up by using a carborundum wheel to grind away the top. Of two of the units I opened, one was a GM with the base connection made to a ring around a piece of crystalline material. The other, an unknown type and brand, had a grid-like emitter visible on the top layer of the transistor.

The emitter connections were removed and then tests were made on the photosensitive base–collector junction. Using the R $\times$ 10,000 scale of a multimeter, the B–C junction of the GM unit read about midscale when the diode was reverse biased and much lower when forward biased. With reverse bias, a resistance range of about 2 to 1 was obtained when light intensity was increased by moving closer to a 40-watt lamp. Thus, this device was not a good photoresistor. However, when used as a photoemissive cell connected to the 80-μA range of the meter, it would drive the needle off scale when close to the 40-watt lamp.

The second transistor with the grid-type emitter made an excellent photoresistor. Reverse biased, its resistance was more than 10 megohms in complete darkness. Resistance dropped rapidly as light intensity was increased. Stronger light caused the needle to drop *below* zero resistance. This indicates the diode resistance ranges from near infinity to a very low value and that with strong light, it also generates a voltage that augments the 7.5-volt battery in the ohmmeter—to drive the pointer off scale.

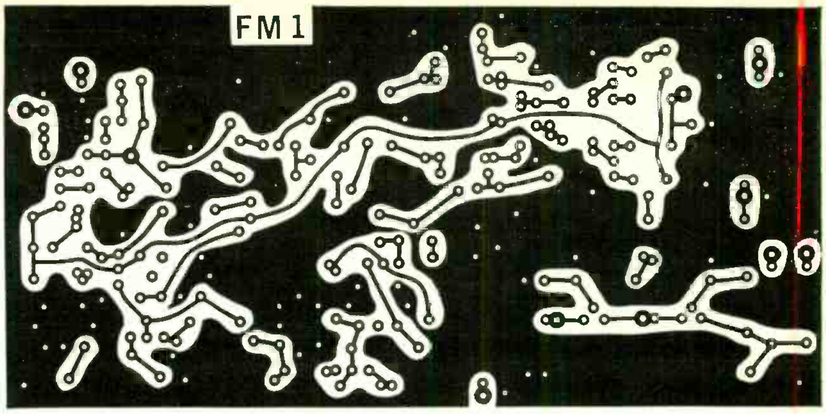
The voltage output is nearly constant for medium and high illumination, at around 0.2 volt for the GM transistor and 0.4 volt for the unknown type.—*D. Dlitz* **R-E**



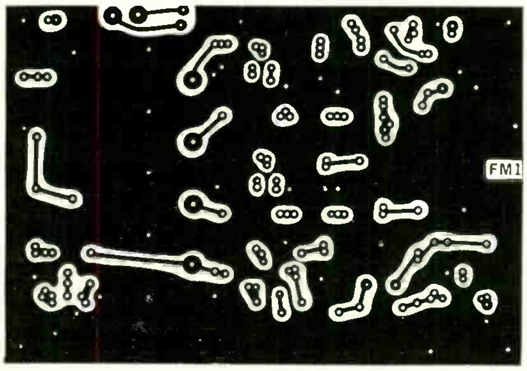
"If he had a gripe about working conditions why didn't he come directly to me?"

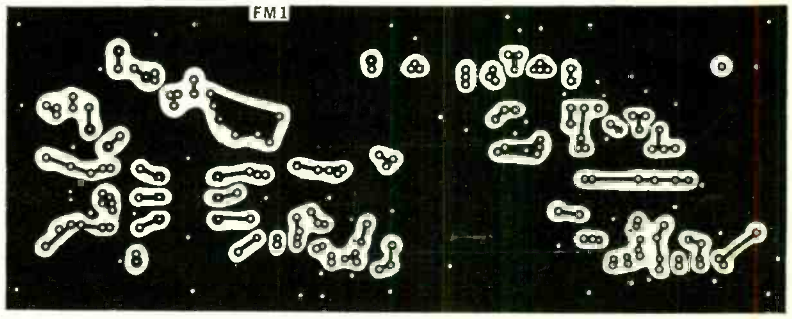
ULTIMATE TUNER
(continued from page 91)

T206—J.W. Miller 1355-PC
T207—117V pri., 24V CT secondary, 1A power xfmr.
D201, D202, D203, D204, D205, D206—1N-4154
D207, D208, D209—40267
D210—13V Zener diode, 1W, 5%
Q201—2N3391
Q202, Q203, Q204, Q206, Q207, Q208, Q209—2N3860
Q205—2N5355
Q212—40408
Q213—40407
S201, S202—rocker switches
LM201—12-14V, 25-40 mA pilot bulb



Here are the printed circuit patterns used for the FM-1. They are shown one-half actual size and must enlarged photographically. The multiplex/power supply is above, the rf head below (left) and the i.f. strip is below.





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COLOR ORGAN KIT $7.50. Power Supplies $3.98. Catalog. **MURPHY**, 204 Roslyn Ave., Carle Place, N. Y. 11514.

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Circle 134 on reader service card

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Circle 137 on reader service card

Circle 139 on reader service card

SERVICE CLINIC
(continued from page 87)

about 4000–4200 volts. It sounds like your HV regulator is overdoing it.

Check the cathode current of the 6BK4. I like to set this so that at high brightness levels (with the CRT drawing its maximum beam current) it is drawing a very small current, not more than about 40–50 μA. At a dark-screen setting, this should go up to not more than 1.0–1.2 mA. HV then should be close to 22,000 volts.

Put a 0–500 dc milliammeter in the cathode circuit of the 6CB5 horizontal output tube, and "tune up" the horizontal efficiency coil for a dip in this current. Maximum current should be around 210–220 mA. The HV output should increase slightly at the dip, since this is the point of maximum efficiency or the whole horizontal output stage. Check the damper tube, since this depends on boost voltage. If the damper is down a little it will reduce output of the circuit.

Tape bars on color TV

I've had a color set for about 6 months. Every so often, I get horizontal red and green bars about an inch or so high across the screen. I complained about this, and they told me it was probably the TV station equipment. Are they pulling my leg?—A. R., Pontiac, Mich.

No. The symptom you describe is typical of a color videotape reproducer with trouble in one or more of the heads. It will normally make horizontal bars (actually 16 lines high) across the screen. These seem to be red and green for some reason.

The problem can take different forms: if one head is bad or dirty, you may see a single red bar about every 5"s down the screen. In bad cases, the whole picture may tear up into sawtoothed bars every 16 lines. This effect is most visible on commercials with solid color backgrounds.

Tape recorder belt trouble

I'm having a problem with a Concord 120 tape recorder. The take up belt keeps slipping up until it hits the upper part of the drive-shaft groove. This tears off bits of rubber

(continued on page 97)

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SERVICE CLINIC

(continued from page 95)

that get into everything. What causes this? The shafts seem to be aligned.—E. H., Washington, D. C.

The two shafts may seem to be aligned, but they're probably not. You can't "eyeball" this, but you can tell the minute you start them running. If the belt "climbs" or drops, it will mean that they are not parallel, as they must be.

Many tape recorders use flexible suspension on the motors: a set of soft rubber grommets or pads, with the mounting bolts going through the holes. You can align the motor by tightening or loosening these bolts. Better still, by adding more padding or a new grommet. If one of these grommets has gotten old, fallen out or become compressed, this will throw the whole thing out of line.

Replace them with new grommets, and try a test run to see which way the belt wants to travel. **R-E**

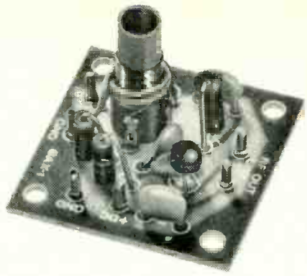
MXX-1 Transistor RF Mixer $3.50

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.

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Hi Kit 20 to 170 MHz

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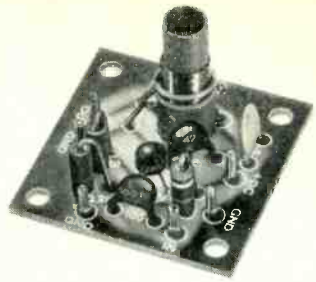

PAX-1 Transistor RF Power Amplifier $3.75

A single tuned output amplifier designed to follow the OX oscillator. Outputs up to 200 mw depending on the frequency and voltage. Amplifier can be amplitude modulated. Frequency, 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.

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Circle 141 on reader service card →

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A pioneer in electronic servicing, Mr. Wellington was also one of the first of those alert distributors who have installed The Re·Place in their stores.

The Re·Place is both a showcase and a self-service store within a store, all in a compact 5′ x 2′ area. It organizes capacitor inventory and makes it easy for customers to select and to buy from a complete stock of twist-prong aluminum electrolytics, tubular electrolytics, miniature electrolytics, ceramic discs and mica capacitors.

You can provide instant service to your customers with The Re·Place—and profitably increase your turnover, too. Call your CDE Representative today. Or write for full information about The Re·Place.™

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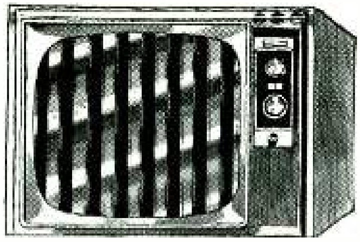
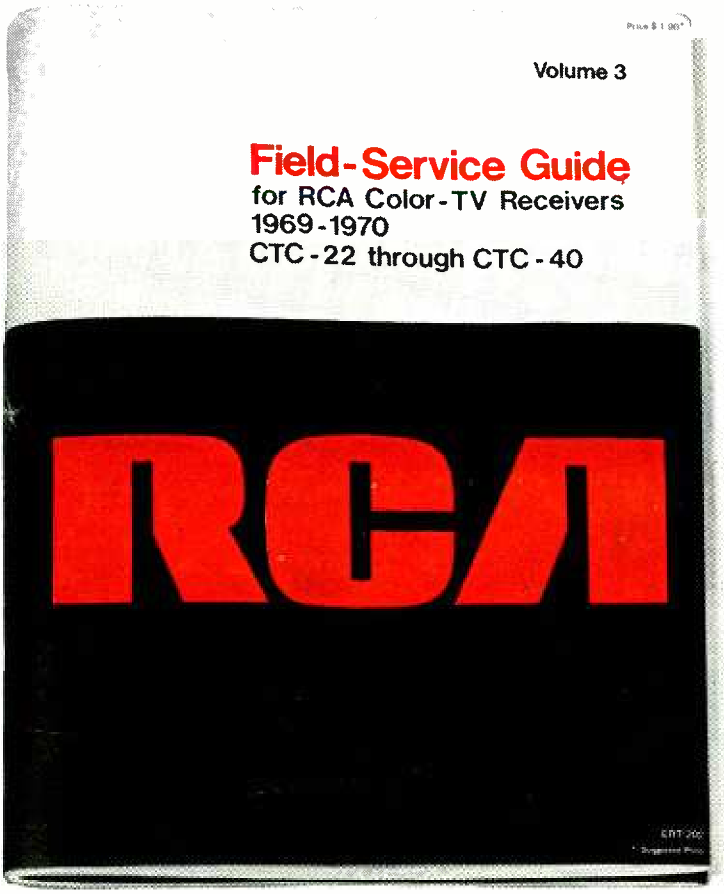


take this book to the home.



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