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Radio-Electronics®

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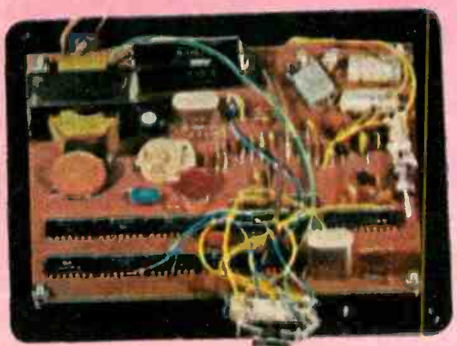
SPECIAL ISSUE

COLOR TV 1970

THE NEW COLOR TUBES!



or pattern generator

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NEW! Color TV Circuits

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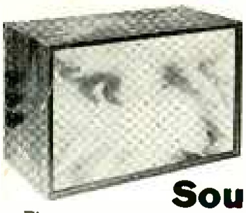

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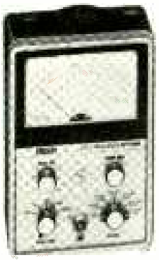

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Volume 41 Number 1 RADIO-ELECTRONICS January 1970

TV X-RAYS—HOW THEY STOP THEM

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

The top-priority crash programs initiated by all color TV receiver manufacturers to eliminate any possibility of X-ray leakage are already having their effect on current products, an industry-wide survey shows.

The new federal X-ray standards for color sets provide for a gradual tightening of the formerly voluntary radiation limits. Phase 1 of the new regulations gives force of law as of Jan. 1, 1970—to the limit of 0.5 milliroentgen (mR) per hour at any point 5 cm from the surface of the receiver, but adds the conditions that measurements must be made with a line voltage of 130 and all user controls set to produce maximum radiation. Phase 2, in effect June 1, 1970 stipulates that the 0.5-mR limit must be observed with all service controls set to produce maximum radiation. Phase 3, as of June 1, 1971, maintains the 0.5-mR limit, but adds simulated failure of components to produce maximum radiation.

We asked all major color TV receiver manufacturers what they were doing to hold down radiation, and most responses made it clear that they feel that they already meet the Phase 2 requirements and hope to be observing the Phase 3 conditions long before the deadline.

COLOR TV 1970

All chassis redesign efforts are directed toward the three potential radiation-producing components—the picture tube, the high-voltage rectifier and the shunt regulator. The former should soon cease to pose a problem, since all domestic picture tube manufacturers are now phasing into their product a new glass formulation containing strontium and providing five times more radiation absorption than the former formula which contained barium as the X-ray blocking element.

While manufacturers chose to stress different aspects of their anti-radiation programs, the following summary of replies to our survey gives a good representation of the progress made in the industry-wide war against X-ray leakage:.

Admiral—Sets are designed to operate considerably below the recommended 0.5-mR limit. Receivers are checked for radiation during production and after leaving the production line. The designs and sets are also monitored by outside agencies, including Illinois Institute of Technology Research Institute and Nuclear-Chicago, whose reports confirm that the sets operate well within the limits under high line voltage conditions.

Service dealers and technicians have been instructed to ascertain that all shielding is in place, and they automatically check high voltage with a special meter on every service call.

Andrea—At press time was conducting trial-run tests of a new color chassis with an Andrea-developed hold-down circuit designed to assure that high-voltage failure does not result in radiation beyond acceptable limits. Upon successful completion of the test, Andrea will incorporate this safety device in all models as quickly as possible.

Emerson—Declines to list specific steps taken but says its sets never have exceeded specified X-ray limits and that the company is making whatever improvements are required to be certain that excessive radiation is impossible.

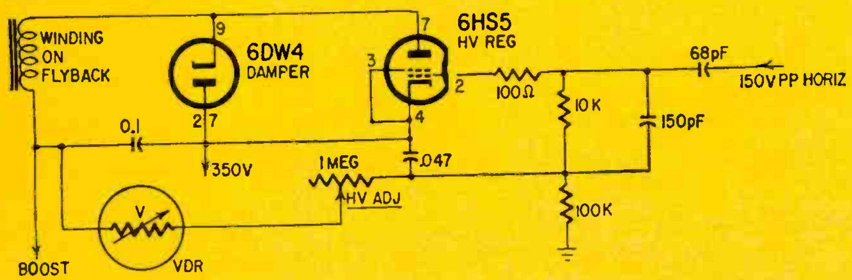
General Electric—GE's long-term anti-X-ray programs include: (1) Pioneering design of color sets operating at lower voltages and using fewer components capable of producing radiation. (2) Improved high-voltage rectifier and shunt-regulator tubes having rigid X-ray controls and published specifications. (3) Introduction of improved high-voltage hold-down circuits using redundant components to further insure reliability. (4) Advanced shielding techniques. (5) A reduced range of high-voltage adjustment. (6) A series of instructional courses to teach service technicians proper procedures and practices.

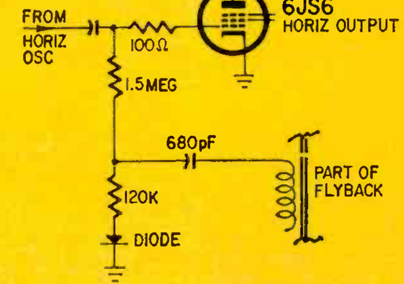
Among GE's improved design and manufacturing techniques: (1) Thicker, higher-lead-content regulator and rectifier tube envelopes. (2) Thicker or improved anode and shield designs. (3) Unique basing arrangements on new tubes to eliminate use of older types as replacements. (4) Close supervision of suppliers' products. (5) Special cleaning processes for component parts. (6) Improved high-voltage aging. (7) Improved internal quality control and test procedures. (8) New automatic radiation test which accommodates larger samples, employing circuitry developed by the Department of Health, Education and Welfare. Sets have been designed not to exceed the 0.5-mR level even under most conditions of misadjustment.

Magnavox— Has recently added a new type of hold-down circuit which causes high voltage to decrease rather than increase if the shunt regulator fails. Example: In a typical set operating at 130 volts line and with all controls misadjusted to give maximum high voltage, the voltage will be 27 kV. With the shunt regulator pulled out, the voltage drops to about 22.5 kV. Improved shielding is tested with special shunt regulators radiating as high as 300 mR and rectifier tubes at 80 mR (Magnavox's normal limits are 2 mR for both)—yet no radiation is detectable outside the high-voltage cage.

(continued on page 4)

Zenith high-voltage limiter uses power tetrode to sample B-boost and flyback pulse and load the damper circuit to reflect a constant load on the horizontal sweep. VDR improves regulation with changes in load. **G-E circuit** (right) is similar to do-it-yourself circuit on page 68.





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$50 and no hold controls

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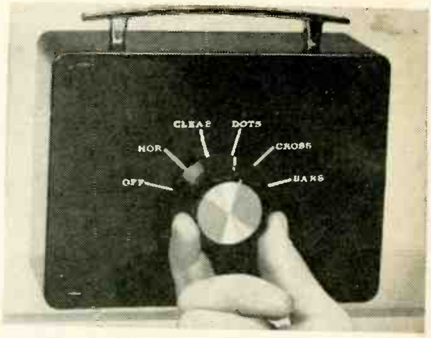
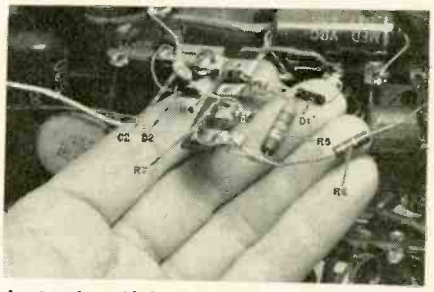


Dot-Bar pattern generator puts J-K flip-flops to use and eliminates touchy hold controls. Features a high-stability output. See page 44



Just a handful of components added to your color set can stop dangerous high voltage runaway and X-ray emission. See page 68

Super-bright tubes are in! Learn how the new tubes let the color pictures come through. See page 33

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LOOKING AHEAD

(continued from page 2)

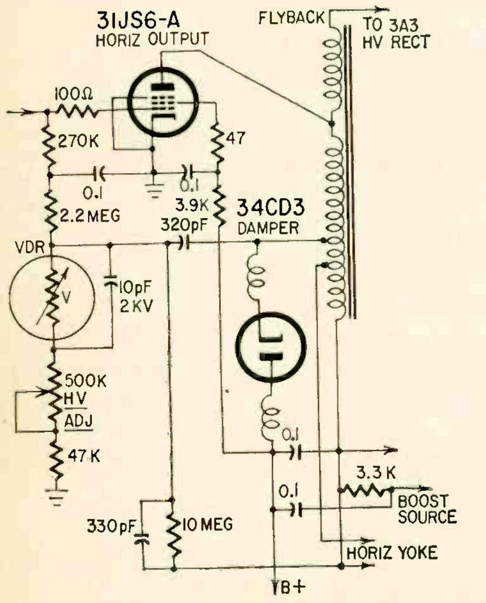
Other Magnavox precautions: (1) Radiation is continuously measured on finished products coming off the production line both in normal operation and at 130 volts line with shunt-regulator circuit defeated, and at varying picture tube beam currents. (2) CRT X-ray measurements are made both before and after continuous life testing. (3) Suppliers must submit products for systematic and in-depth radiation studies by the company's Engineering Section. (For example, Magnavox will accept no high-voltage rectifier or shunt-regulator tubes unless the glass contains 49% lead.) This program has resulted in the rejection of several foreign and domestic components which did not meet the company's standards. (4) Service technician warnings against removal of shielding and on voltage adjustment are posted within each receiver, as are additional notices advising of radiation precautions to protect the technician.

In its production facilities, all color TV workers wear film badges to determine their exposure to radiation. The observed readings have been only slightly above the normal exposure from natural background sources. Lead shielding has been added to all test fixtures which could possibly radiate.

Motorola—Was the first domestic set manufacturer to use a solid-state high-voltage rectifier in color sets, eliminating the possibility of radiation from this component. The solid-state rectifier is now being phased into the entire line as rapidly as possible. Other safeguards: (1) Several years ago, Motorola eliminated the shunt regulator from its sets. (2) A new radiation-reducing high-voltage rectifier is being used in tube-chassis sets. (3) Shielding has been redesigned and its use increased. (4) High-voltage control has been made virtually inaccessible to the service technician, so that adjustment beyond design limits is unlikely without removing part of the chassis. (5) Prominent labeling, adjacent to the high-voltage control and on the high-voltage cage, warns technicians against misadjustment and against servicing the set without shielding in place.

Design and verification: Receivers are designed to radiate considerably under the 0.5-mR standard. New designs are tested and verified by an outside radiology consultant. The company's Safety Engineering Group tests for radiation all receivers from engineering pilot runs, production pilot runs and from initial production, as they come off the line and in extensive life tests.

For the protection of production personnel, all component test positions are shielded where necessary and all positions monitored for radiation regularly. X-ray detection badges are used by employes in all areas where high voltage is present. As part of its technician information program, radiation precautions are covered by Motorola regional service technicians and technical representatives who instruct some 17,000 technicians per year.



A fairly common circuit has VDR in feedback loop to grid circuit to hold sweep—and thus the HV—constant under varying load conditions.

Packard Bell—Expects to comply with the Phase 3 standard at least a year before it goes into effect. Modifications already made in the 1970 line: (1) Fail-safe component-failure protection. (2) Limiting of high-voltage control to a narrow range, making it impossible to exceed standards. (3) Redesigned and improved shielding. Very specific instructions have been sent to service personnel. Factory-owned service branches send technicians out to recheck sets when customers call in with concern about X-rays. A rigorous factory quality-control program has been instituted.

Philco-Ford—Has established a Safety Committee, whose duties include X-radiation policy. For the last two years, Philco's sets have not included shunt regulators. Prototypes, engineering samples and pilot production sets get rigid tests before production okay is given.

During assembly, all shields are put in place before any power is turned on. Quality Control Department makes certain that safety precautions are observed before power is applied. Under power, the receiver is adjusted to the correct high voltage and is subject to continuous monitoring. After the picture tube has been converged and before the back is put on, the set is checked again, the voltage readjusted if necessary, and sealed with tape. The high-voltage cage is labeled with the precise setting to guide the technician. A percentage of sets are removed from the storage warehouse and put through a complete quality audit, including X-ray check. The company publishes instructions and guidelines for technicians and informs them of any new developments relating to previous models.

RCA—Chassis developments: (1) High-lead-content bulbs are used for the high-voltage rectifier tube. (2) A special shield is used in the rectifier socket. (3) The rectifier enclosure is made of cold-rolled steel. (4) A taller shunt-regulator shield is used. (5) All unnecessary holes are eliminated in the rectifier and regulator compartments. (6) A hold-down circuit is used to control the high-voltage levels should the regulator fail. (7) Solid-state high-voltage regulators and rectifiers are used in some sets. (8) A precision resistor divider is used to eliminate any chance of misadjustment during servicing. (9) The solid-state chassis has a limited voltage-adjustment range as well as a line-regulated B+ system which prevents high voltage from rising with line-voltage increases.

Production and quality control: Before a receiver is shipped, it is subjected to several production-line radiation checks. The high voltage is the first and last item checked. The hold-down circuits are checked during chassis alignment to assure proper operation. Two percent of the production is given an exhaustive check under high line-voltage conditions and various brightness settings. If any sets are found exceeding 30% of the 0.5-mR limit, a hold is put on all sets of that type until the reason has been found and corrected.

Servicing: RCA supplies information about high voltage and X-radiation in every set's service manual. It attaches warning labels to every set in conspicuous locations. It conducts training sessions and workshops for service personnel in which good servicing techniques regarding radiation are stressed.

Sylvania—Current chassis: (1) Careful shielding of the high-voltage rectifier and shunt-regulator tubes with extra-thick metal and by the mounting position. A hinged lid minimizes the possibility of X-ray exposure during servicing. (2) X-ray-absorbing glass is used in the high-voltage rectifier, shunt regulator and picture tube. (3) Hold-down circuits prevent high voltage from

(continued on page 12)

LOW-COST CASSETTE COLOR VTR

A cassette-cartridge vtr playback machine (photo) costing only $350 when marketed late this year has been introduced by Sony Corp. A $100 add-on adapter will enable black-and-white or color programs to be recorded and played back from $20, 90-minute video cassettes.

Resolution of the machine is reportedly 300 lines for b-w and 250 lines for color. The ¾-inch tape runs at just over 3 ips.

Panasonic has also announced a cassette-type vtr with color capabilities to be on sale by 1972. High-speed duplication techniques will provide mass-produced pre-recorded tapes for entertainment and training.

Also shown by Panasonic is a reel-type vtr that uses regular ½-inch tape instead of 1-inch tape for recording color. An automatic phase control circuit stabilizes color images by automatically compensating for phase and frequency shifts.

COMMISSION SAYS TV SETS CAUSE FIRES

WASHINGTON—The National Commission on Product Safety recently reported that some 10,000 fires are started each year by TV sets, even when they may be turned off.

Although not spelled out in commission reports, the usual cause for such fires are voltage surges that may short out bypass capacitors across the ac line. Manufacturers have been recommending in service notes that technicians increase the voltage ratings of these capacitors. Similar capacitor failures in other appliances have caused the same problem.

The commission's estimate was based on a spot check of fires caused by TV sets around the country, including an estimated 361 in New York City in 1968.

Blame for a number of the fires was placed on insulation failure in the high-voltage section of color sets, where temperatures up to 150° and 25,000-volt potentials can be hazardous.

AUDIO-VIDEO DIPLEXING FOR SATELLITE TV

TORONTO—A technique for diplexing the audio and video portions of TV programs for transmission over a single satellite channel was revealed at the International Electronics Conference here in October.

The technique was developed by the Northern Electric Laboratories in Ottawa as a means of reducing costs and the complexity of transmitting video and audio TV signals separately. Audio is usually routed on separate radio channels or land lines, while the video is transmitted by microwave. The company is anticipating use of satellites to reach remote areas in Canada.

Audio is sampled by an encoder and converted to a delta-modulated pulse train at 16 times the horizontal line frequency (15, 750 Hz.). The coded signal is compressed and gated into the normal

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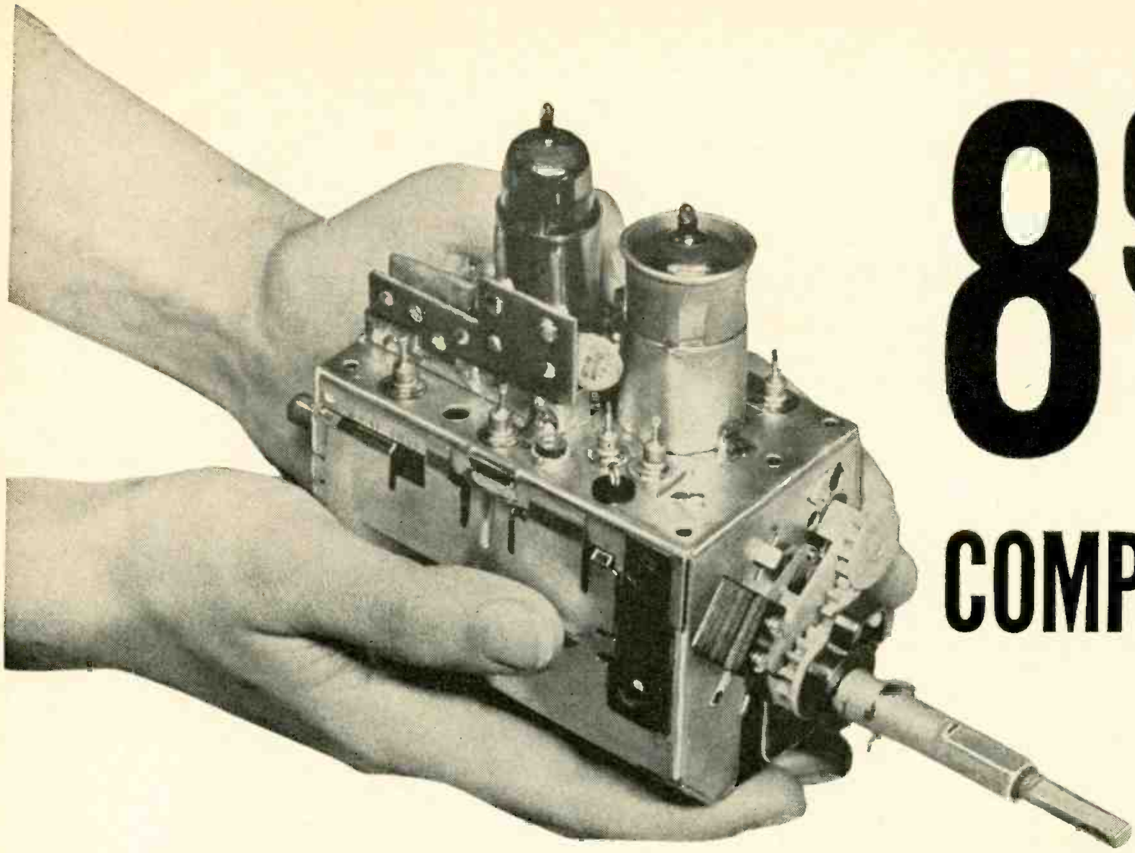

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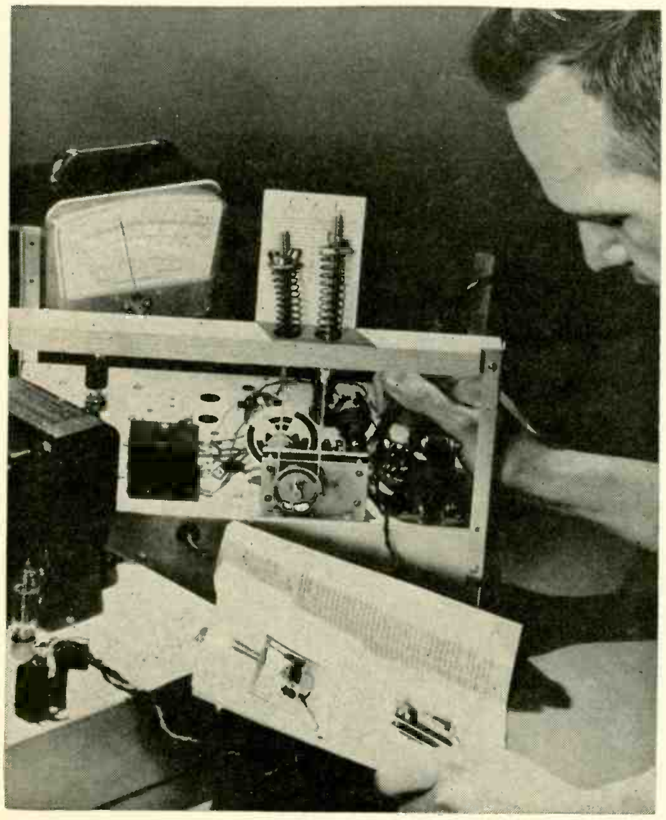

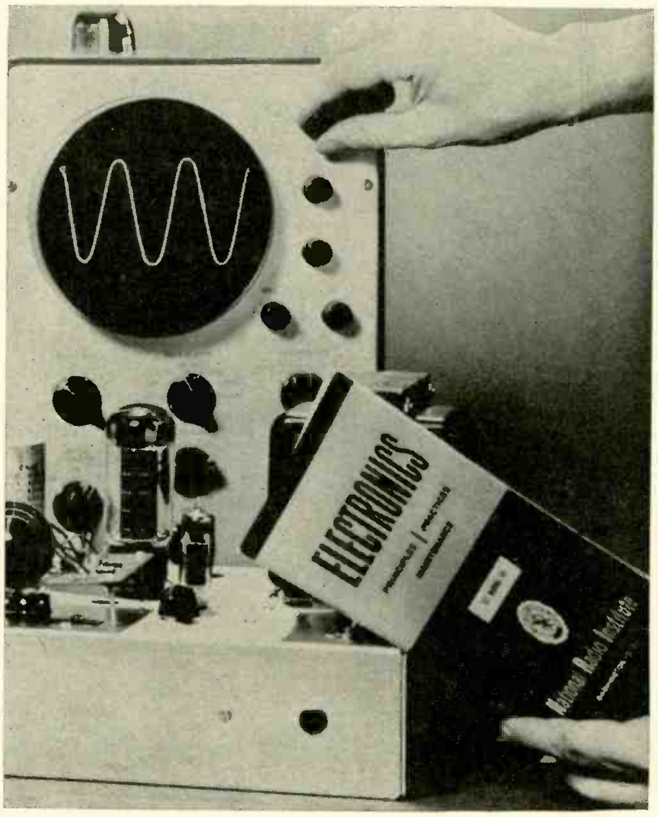

LOOKING AHEAD

(continued from page 4)

exceeding 30 kV in case of shunt-regulator failure or misadjustment. Sylvania says other major manufacturers have adopted its patented circuit.

In new chassis, due later this year: (1) High-voltage tripler, replacing rectifier, will eliminate that potential radiation source. (2) Fail-safe voltage hold-down circuit will keep high voltage below 30 kV at all times, making it impossible to exceed X-ray limit from the picture tube.

Warwick Electronics (Sears)—(1) Uses only those rectifiers and regulators in which radiation is held to the lowest possible amount. (2) Achieves double protection by improved shielding of both tubes. (3) Redesigned circuits have eliminated the high-voltage adjustment, largely through use of more precise components. (4) A voltage hold-down circuit is used. (5) Solid-state circuits are under development to eliminate all sources of radiation except the picture tube. (6) Warwick has conducted tens of thousands of checks on its receivers in production plants to insure that they produce minimum radiation. (7) Programs and procedures have been established to assure that all future designs either eliminate radiation completely or hold it to the lowest possible point.

Zenith—Engineering design: (1) A pulsed voltage regulating system, in use for several years, eliminates the major source of radiation and minimizes potential radiation from other components by achieving greater reliability of the regulator tube and associated parts. (2) A new circuit in current models reduces the possibility of excessive high voltage in case of regulator failure. (3) The voltage-adjustment range has been narrowed through use of close-tolerance components. The control has been changed to a type which cannot be accidentally misadjusted. (4) Greater built-in shielding and improved external shielding have been added to high-voltage rectifier tubes. Zenith is using an improved rectifier tube and is supplying improved regulator tubes as replacements for older color sets in use.

A company-wide committee of top engineering, scientific and medical personnel constantly reviews Zenith's programs, which cover design, manufacture, quality assurance and testing, field service training, and monitoring of all production areas. Zenith's quality control test programs confirm that any radiation present is far below the permitted limit. These programs are an integral part of daily production, and results are checked by radiological consultants. The company has trained thousands of service technicians in special radiation safety procedures, and keeps them constantly informed in special training bulletins and sessions. **R-E**

New & Timely

(continued from page 6)

horizontal sync pulse interval for transmission. At the receive end, the coded signals are detected, stored in a register and decoded into the original audio signal.

Prototype diplexing gear for the experimental process is shown undergoing tests.

RAPID RECHARGING

LOS ANGELES—Nickel-cadmium batteries can now be recharged in minutes instead of hours with a new charging technique developed by McCullock Corp. The battery is short circuited for microsecond intervals in between a series of very high current charging pulses. As a result, gas layers on plate surfaces are broken up.

ALL-PLASTIC CONSOLES

A technique that uses injection-molded polystyrene with pressure-formed polyurethane backing for complete plastic hi-fi and TV consoles is being adopted by G.E. Called Acoustaform, the process sonic welds cabinet parts together so they perform as a highly-damped air chamber.

(continued on page 14)

Santa Barbara, Calif.—An infrared communicator that transmits and receives either voice or digital information over a laser beam for distances up to 6 miles is shown under test.

The communicator uses a gallium arsenide pulsed laser beam as the carrier. To speed alignment, a 1000-Hz tone burst modulates the beam. Then voice or data transmission varies the laser pulse repetition rate.

Applications for the device are expected in police, industrial and military situations that require secure communication. Santa Barbara Research Center, A Hughes Aircraft Co. subsidiary, developed the communicator.

ALL-CHEMICAL LASER NEEDS NO ELECTRICITY

A 1000-watt laser may require at least 20,000-watts of electrical power as an input. But now two scientific teams at opposite sides of the country have developed a laser that requires no electrical power—it's all chemical.

Laser energy is released by chemical reaction, which produces coherent light much more efficiently than conventional lasers that usually run at less than 2% efficiency.

The International Journal of Chemical Kinetics, reporting the discoveries at The Aerospace Corp. and Cornell University, says that controlled atomic fusion may be possible with the huge amount of power available from large chemical lasers. In principle, power output would be limited only to size of the optical chamber and the rate at which chemicals could be fed in.

AVALANCHE DIODES EMIT UHF WAVES IN ANOMALOUS MODE

PRINCETON, N.J.—By operating avalanche diodes in the so-called "anomalous mode," RCA scientists have achieved the most powerful uhf radio waves yet from a solid-state device.

This mode occurs when the diodes are placed in a circuit tuned to oscillate at rf frequencies below the oscillation capability of the devices. When electrical pulses are then applied to the diodes, they abruptly and unexplainably begin to generate high-powered microwaves.

Five diodes in a small package have produced peak powers above 1200 watts.

The discovery could revolutionize radar, says RCA, who forsee applications in powerful phased-array radars, which use thousands of individual transmitters in place of the single high-power source in conventional radars.

4-CHANNEL ENCODING PROVIDES HI-FI AND GOOD SEPARATION

Despite widespread interest by manufacturers in the new, experimental 4-channel "surround" stereo (New & Timely, December 1969), not everyone is going "all out" for 4-track tape machines as a sound source.

Manufacturers may be taking a closer look at an analog encoding technique for 4-channel sound developed by engineer-inventor Peter Scheiber of Auto-data in Rochester, N.Y.

Scheiber's patent-pending process uses an encoder to put the two additional rear channels on the same record grooves, tape tracks or FM band as the front-channel stereo. An inexpensive decoder circuit in the tuner or preamp then separates the 4 channels.

Biggest advantage to the system is its compatibility. A regular stereo cartridge can be used with the decoder to obtain 4-channel sound, but anyone playing the encoded record would be unware it differed from a regular stereo record. Similarly, the technique could put 4 channels on normal stereo cassettes, open-reel tapes or FM without affecting the stereo channels.

One observer who heard a demonstration of Scheiber's system said the process maintains good separation and fidelity on each channel.

JAPAN MOVES TO IC'S

OSAKA, JAPAN—The switch to integrated circuits was evident throughout the Japanese electronics at the 1969 electronics show. According to a report in *Electronic News*, IC's are being used in many TV sets, radios and stereo phonographs.

Sanken Electric Co. revealed a hybrid IC with a 120-watt output. A number of manufacturers showed varactor-tuned uhf TV tuners, and one company had a pocketable LCRV tester. Another company showed a telephone-size IC frequency counter.

Another electronics show is scheduled for April 1970 in Tokyo. **R-E**

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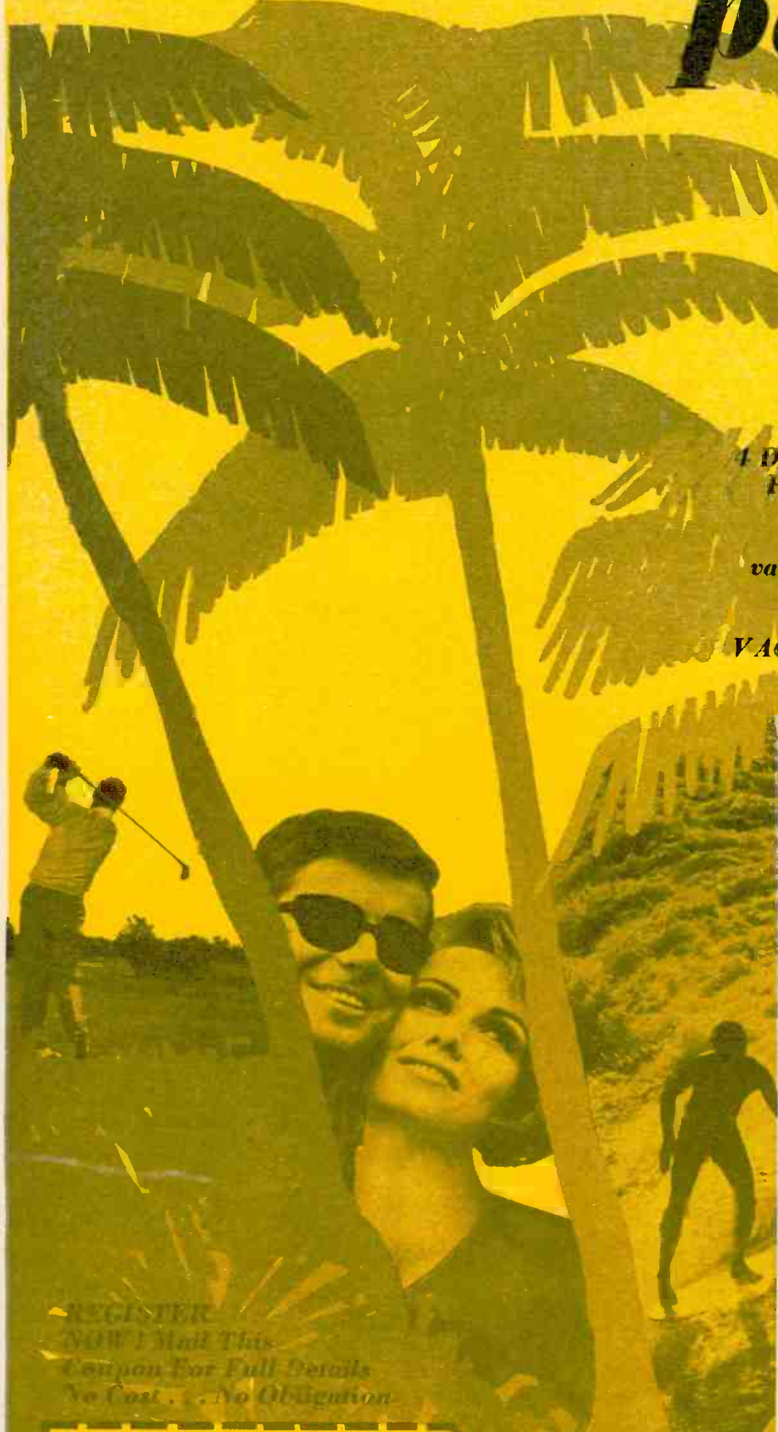

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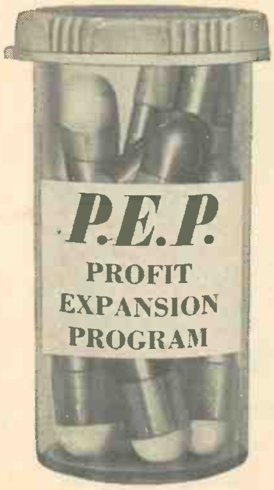


Circle 13 on reader service card

In the Shop . . . With Jack

By JACK DARR
SERVICE EDITOR

THE NEW LOCUS OF THE FOCUS

FOCUS VOLTAGE IS PRETTY IMPORTANT to color TV. Poor focus makes a good picture look fuzzy, and the owner beefs about it, with reason. However, if you can see clean, sharp *scanning-lines* all the way across the screen, don't bother with the focus voltage. That isn't the problem. The focus voltage supply only has to make the scanning lines show. Other smearing is in the video, and that sort of thing.

In all color CRT's, focus voltage should run about 4.5 kV, with 24 kV of high voltage. This should always be the *same percentage* of the high voltage. If the high voltage varies, the focus voltage should vary with it. The actual percentage is somewhere very near to 20%. Feeding the anode of the focus rectifier from the flyback tap connected to the horizontal output plate helps quite a bit. Variations in beam current change the loading here, and the focus voltage stays pretty well with the high voltage.

Lately, a different circuit has shown up in several sets. Since the focus voltage should be a percentage of the high voltage, why not take it off with one of the oldest circuits in electronics—a voltage divider? One reason why this wasn't used earlier was the lack of resistors that would stand up under this tremendous voltage. The basic circuit is in Fig. 1. The focus voltage is picked off at the low tap. So if high voltage changes, focus goes right along with it.

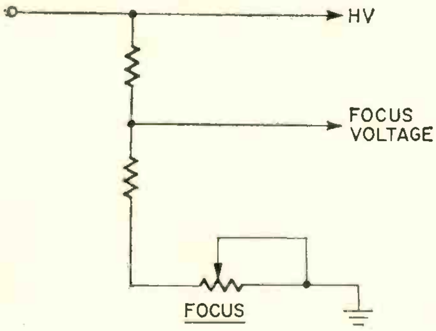


FIG. 1

The circuit, and resistance values, used in the GE G-1 color chassis, with a 15MP22 picture tube is in Fig. 2. The dropping resistor in this set is a three-section, plastic-encapsulated unit with three 80-megohm sections. It is mounted crosswise in the bottom of the flyback cage. For adjustment, a 20-megohm variable resistor is connected to the bottom of the big resistor. A fixed 47-megohm unit is the other part. The bottom of this section can be returned to B-boost, B + (280 volts) or ground as needed for minor corrections.

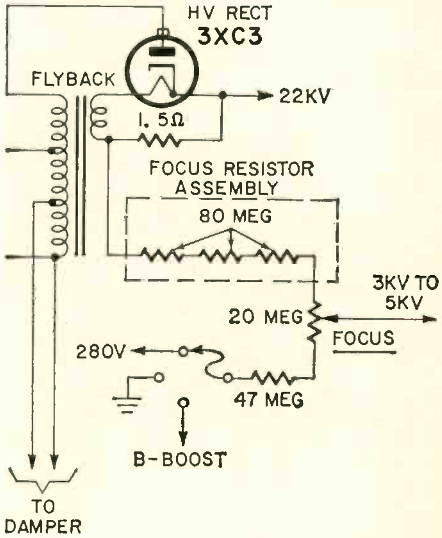


FIG. 2

In Motorola color chassis such as the TS-912, 914, 920, you'll find the big dropping resistor used with a 15-megohm variable for control, followed by 47 megohms and a fixed 15 megohms to ground. This final resistor may be shorted with a jumper if necessary to center the focus control slider (Fig. 3).

(continued on page 74)

THANK YOU JACK DARR

For ten years you've been delivering to the Readers of Radio-Electronics the most personalized help they can get. You answer their questions, present a monthly column crammed with vital service data and are always available for consultation on a service problem, or question. This month, as we set foot into the eleventh year of your reign, we look forward to your continued A-OK performance.

—The Editors

Voltage supply in your city can vary as much as 10%. And even a 2% variation causes a significant tape speed change in tape decks with induction motors and a difference in reproduced sound that is intolerable.

The Concord Mark II stereo tape deck completely ignores fluctuations in line voltage. It is driven by a hysteresis synchronous motor which locks onto the 60 cycle power line frequency and maintains constant speed (within 0.5%) regardless of voltage variation from 75 to 130 volts. So if you're about to buy a tape deck that doesn't have a hysteresis synchronous drive motor, you're liable to negate any other fine feature it might have.

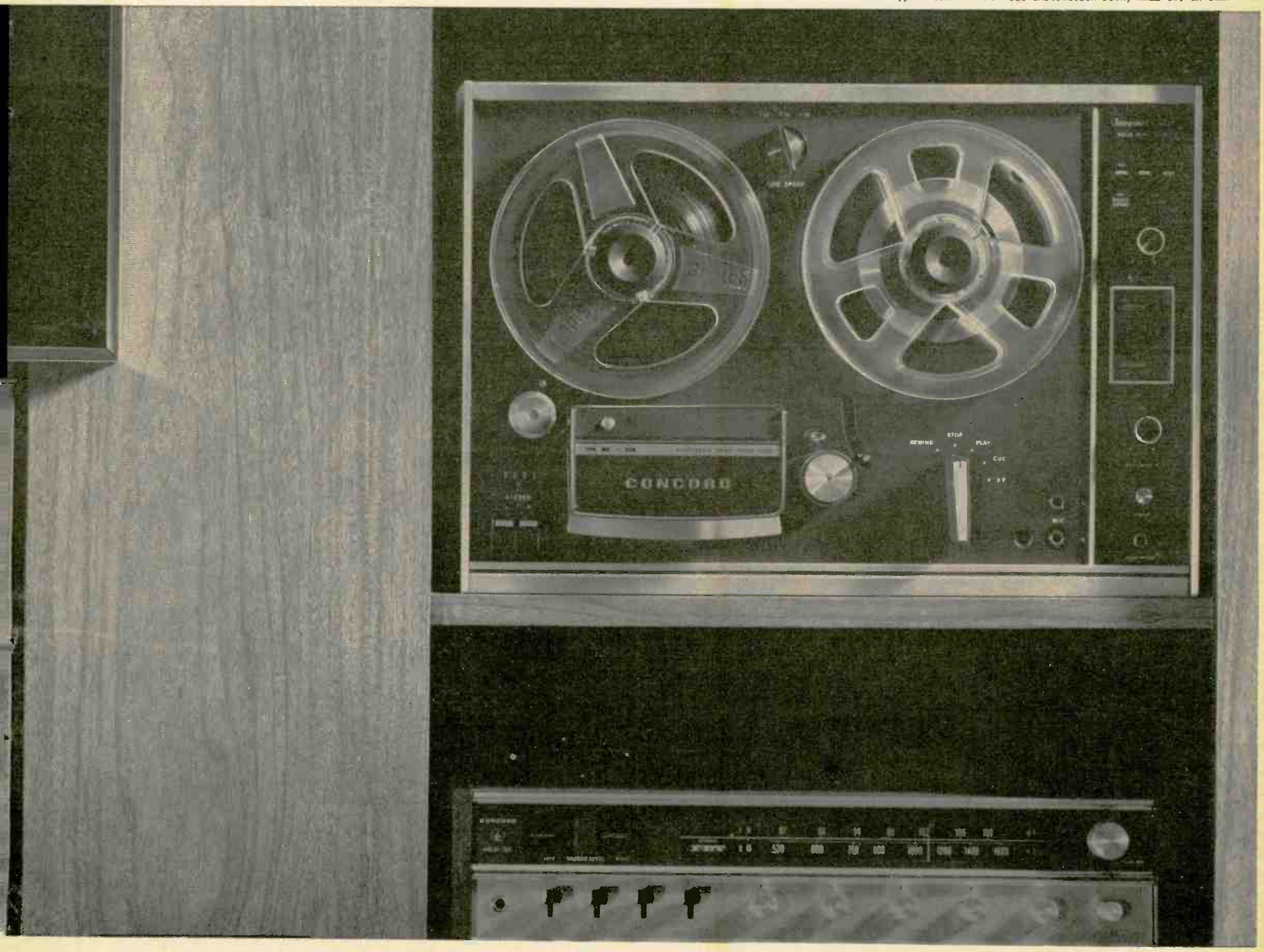
Don't get the idea the hysteresis motor is all the Concord Mark II has to offer. It also has just about every other professional feature. Three high-quality heads: ferrite erase head; wide gap Hi-Mu laminated recording head for optimum recorded signal and signal-to-noise ratio, narrow gap Hi-Mu laminated playback head for optimum reproduced frequency response. No compromise combination heads. The three heads and four preamplifiers also make possible tape monitoring while recording.

The tape transport mechanism assures a fast startup—you don't miss a note. Supply and takeup tape tension arms eliminate startup burble. A special flutter filter eliminates flutter due to tape scrape or cogging action. A cue control provides instantaneous stop and start operation. Other important conveniences: the flip-up head cover permits you to see the head gap position markings for professional editing; 3 speeds; automatic sound-on-sound with adjustable level controls; variable echo control for reverb recording; calibrated VU meters with individual record indicator lights; stereo headphone jack; electronically controlled dynamic muting for automatic suppression of tape hiss without affecting high frequency response. All this, for under $230.

The hysteresis drive Concord Mark III has all of the features of the Mark II plus pressure-sintered ferrite heads for extended frequency response and virtually no head wear. It sells for under $260.

The hysteresis drive Mark IV, the top-of-the-line Concord deck offers all of the performance and conveniences of the Mark II and III including wide gap record, narrow gap playback heads, tape source monitoring, sound-on-sound, echo recording. Plus, a dual capstan tape transport mechanism with electronic automatic reverse, no metal foil or signal required on the tape. Superior recording performance plus the convenience of automatic reverse and continuous play. A superb instrument with the finest performance money can buy, and it's under $330. Audition the new Concord Mark series, the tape decks with the hysteresis synchronous drive motor. For "all the facts" brochure, write: Concord Electronics Corp., 1935 Armacost Ave., Los Angeles, Calif. 90025. (Subsidiary, Ehrenreich Photo-Optical Industries, Inc.)

For copy of Concord Mark III Instruction book, mail 25¢ in coin



NEITHER AIR CONDITIONERS, TV SETS, WASHERS NOR ANY OTHER ELECTRICAL APPLIANCE CAN KEEP THE HYSTERESIS-DRIVE CONCORD MARK II FROM ITS PRECISELY APPOINTED SPEED.

Circle 15 on reader service card

In today's electronics boom the demand for men with technical education is far greater than the supply of graduate engineers. Thousands of real engineering jobs are being filled by men without engineering degrees—provided they are thoroughly trained in basic electronic theory and modern application. The pay is good, the future is bright . . . and the training can now be acquired at home—on your own time.

How to become a "Non-Degree Engineer"

THE ELECTRONICS BOOM has created a new breed of professional man—the non-degree engineer. Depending on the branch of electronics he's in, he may "ride herd" over a flock of computers, run a powerful TV transmitter, supervise a service or maintenance department, or work side by side with distinguished scientists on a new discovery.

But you do need to know more than soldering connections, testing circuits and replacing components. You need to really know the fundamentals of electronics.

How can you pick up this necessary knowledge? Many of today's non-degree engineers learned their electronics at home. In fact, some authorities feel that a home study course is the *best* way. *Popular Electronics* said:

"By its very nature, home study develops your ability to analyze and extract information as well as to strengthen your sense of responsibility and initiative."

Cleveland Method Makes It Easy

If you do decide to advance your career through home study, it's best to pick a school that *specializes* in the home study method. Electronics is complicated enough without trying to learn it from texts and lessons that were designed for the classroom instead of the home.

Cleveland Institute of Electronics concentrates on home study exclusively. Over the last 30 years it has developed tech-

NEW FOR YOU

For manufacturer's literature, circle No. 79 on Reader Service Card.

Harman-Kardon CAD-4 Stereo Tape Cassette Deck

WOULD YOU BELIEVE A CASSETTE DECK that is almost hi-fi? I didn't, until I tried this one. It's amazing! The main limitations turn out to be the quality of the precorded cassette material currently available.

We A-B'd a precorded cassette against the same company's recording of the same material on a top quality disc. The record did sound better. It had more highs and no tape hiss. (The hiss problem is a tough one to lick. You're looking at a very slow tape speed, 1⅞ ips. With current tape, you almost can't avoid it.)

However, when we taped from the disc we found we got somewhat better fidelity from the tape we made from the record than was on the pre-recorded tape.

Chromium dioxide tape may help this problem a bit, but don't expect it in the very near future. There are still several headaches to be solved.

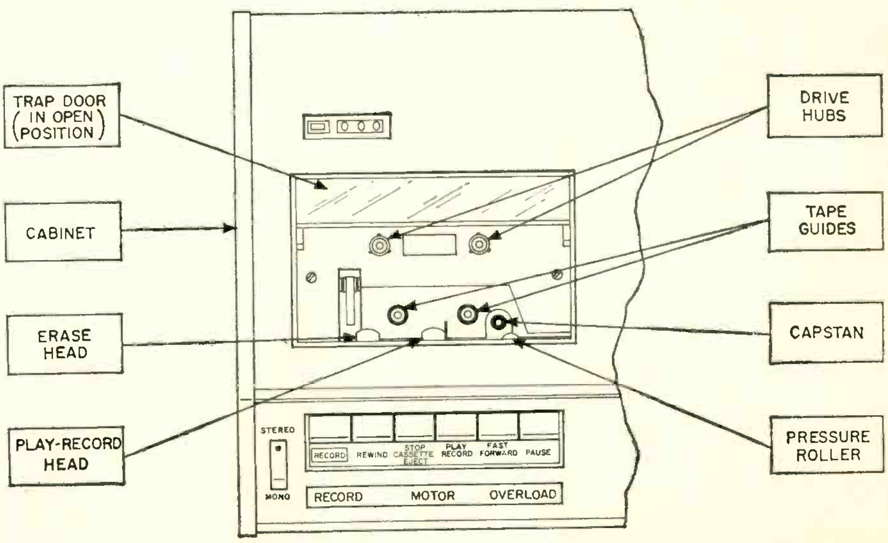
Having recently received some TDK C-60SD cassettes, we gave them a trial too. The tape is claimed to have a frequency response or 30 to 20,000 Hz. But in the deck there didn't seem to be much difference between it and the cassette tapes provided. Perhaps the new tape does offer the frequency response specified, but someone is going to have to build the cassette machine that can handle this range of frequencies before we can take advantage of the tape. Now back to the review.

Conclusions were that while this deck doesn't deliver 20-20,000 Hz response, it does show that high-quality recording on cassettes is possible and is getting there. I would have little hesitation in adding a deck of this quality to my system, but I would have to remember that it does have limitations. One other interesting point. The tape bias oscillator frequency can be adjusted. This is not a front-panel control, but could make a bit of difference in frequency response if carefully matched to the tape you use.—**Joe Shane**

SPECIFICATIONS

Frequency Response: ±2 dB, 30-12,500 Hz.
Harmonic Distortion: below 1.5%
Wow and Flutter: 0.25 mV rms at 1⅞ ips
Tape Speed: 1⅞ ips
Tape Speed Variation: within 2%
Signal-to-Noise Ratio: better than 49 dB
Cross Talk: better than 35 dB
Erasure: better than 55 dB
Bias Oscillator Frequency: 105 kHz ±5 kHz. No MX beats regardless of tuner used.
INPUT SENSITIVITY:
High Level; 200 mV, ±2 dB for zero VU
Low Level; 0.2 mV, ± 2 dB for zero VU
INPUT IMPEDANCE:
High Level; 200,000 ohms
Low Level; 2,500 ohms
Output Level: 0.8 V, rms, ±2 dB at maximum recording level.
Sizes: 12½ x 9 x 3¼ inches
Weight: 10 pounds

Key component layout inside the CAD-4 stereo tape cassette deck. Note that all controls are pushbuttons intended for ease of operation. When the user depresses the TAPE EJECT the trap door over the cassette opens and the cassette pops out.



Letters to R-E

ANTI-KRENTZ

Mr. Ed Krentz' positive attitude toward certification of all electronics technicians in the October, 1969, Correspondence Column, reveals a common weakness of all human beings, and that is to wrap up, sew up, and institutionalize anything that isn't nailed down.

The analogical models that Mr. Krentz utilizes to establish his case for such organization is also faulty and contains an opposing cutting edge. If our forefathers were so institutionally organized, I doubt that we would have to worry about light bulbs, radios, telephones, or for that matter the man on the moon. I doubt that the Thomas Edisons, Marconis, Alexander Graham Bells, or the Robert Goddards would have emerged within this type of organizational structure.

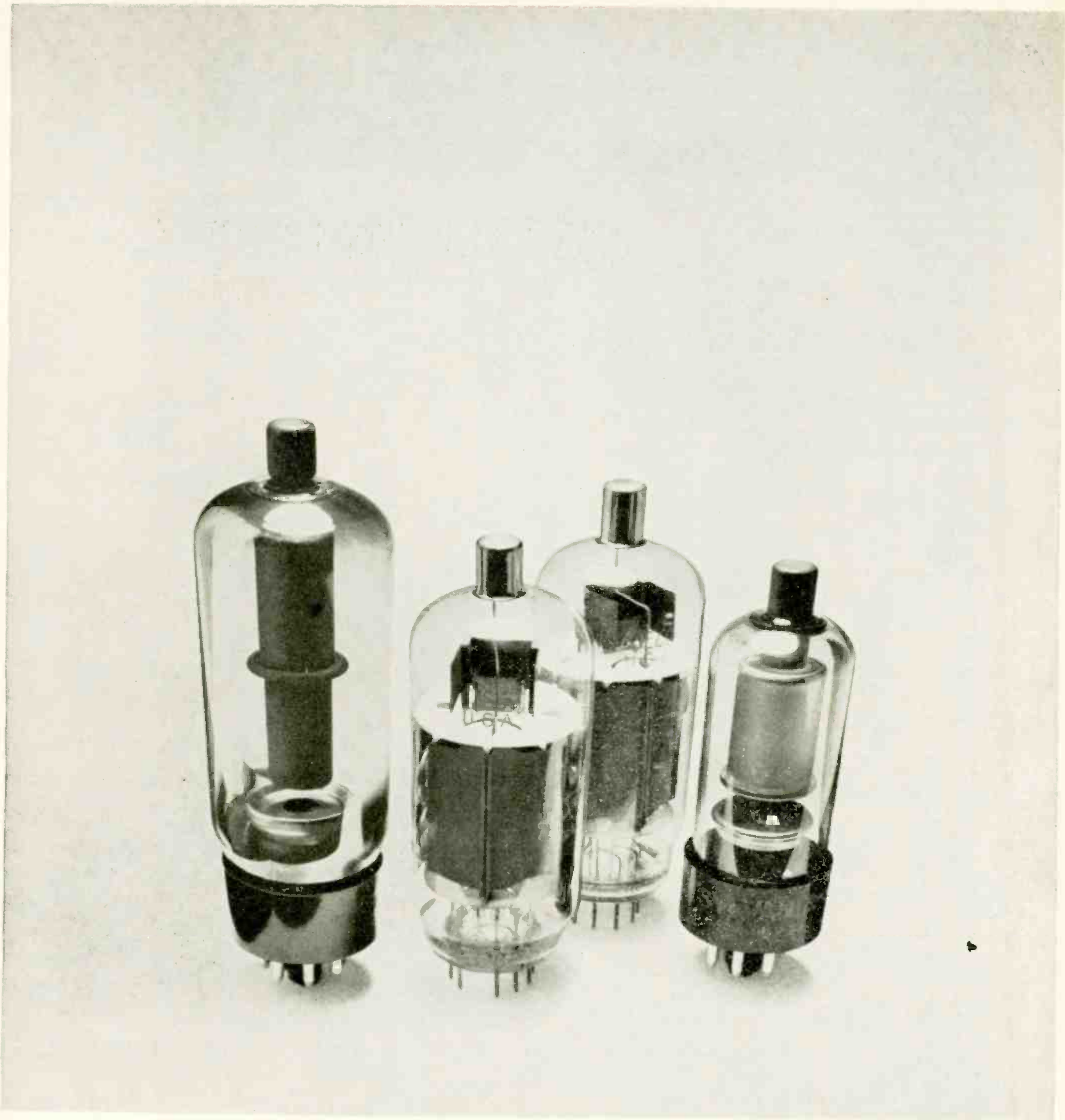
Mr. Krentz also appears to have a medical hangup. His medical analogical model has a limited comparison value. The cause and effect relationships between physicians, surgeons, and their patients are more direct and the consequence far greater. Mandatory membership in medical organizations can at least be understood for the purpose of policing and establishing a level of competence for the protection of human lives. This circumstance, while true for the medical profession, is not true for the electronics technician. If life is endangered by electronics, it is most often the fault of poor design and manufacturing, or faulty use of equipment, and there is an established legal recourse for this type of problem.

Mr. Krentz' basic premise of forced organizational membership can be applied to all facets of our lives, then finally we will need a master coordinating and directive organizational structure to handle all the subunits in to the final complete total corporate structure—"The Ant Hill."

ALBERT BASCO
5355 N. Luna Ave.
Chicago, Ill.

COLOR ORGAN CORRECTION

Although the author's original main schematic was correct (Fig. 2, "Stereo Color Organ," October 1969), our artist got carried away and drew an extra line. Delete the line from the cathode end of D22 (lower right) tying it to ground. Our thanks to Mr. Ray O. Couvillon of Houston, Texas, for pointing out the error. **R-E**



Our hot ones are the last to go.

The last thing you need is to be called back a day or two after you've replaced the sweep or high voltage tubes in somebody's color TV.

But, they're usually the first to go. Because they get so hot.

So we figured out how to cool them. Now, they last a lot longer.

Take our 6JE6C/6LQ6, for example. It's the horizontal deflection tube that takes such a beating when the set gets hot.

Well, we've given it special patented radiator fins that first absorb the heat and then radiate it out of the tube.

Now it runs cooler and lasts longer. Same for our 6JS6C.

Or take our 6BK4C/6EL4A. That's the shunt regulator that eliminates runaway high voltage. We gave this one a whole new anode and shield design to improve heat transfer and stability.

Now it also runs cooler and lasts longer.

Or take our 3A3B high voltage rectifier. This one's got leaded glass for added protection. And it lasts longer too.

So next time you have to replace any of the hot ones, just cool it. You'll both last longer.

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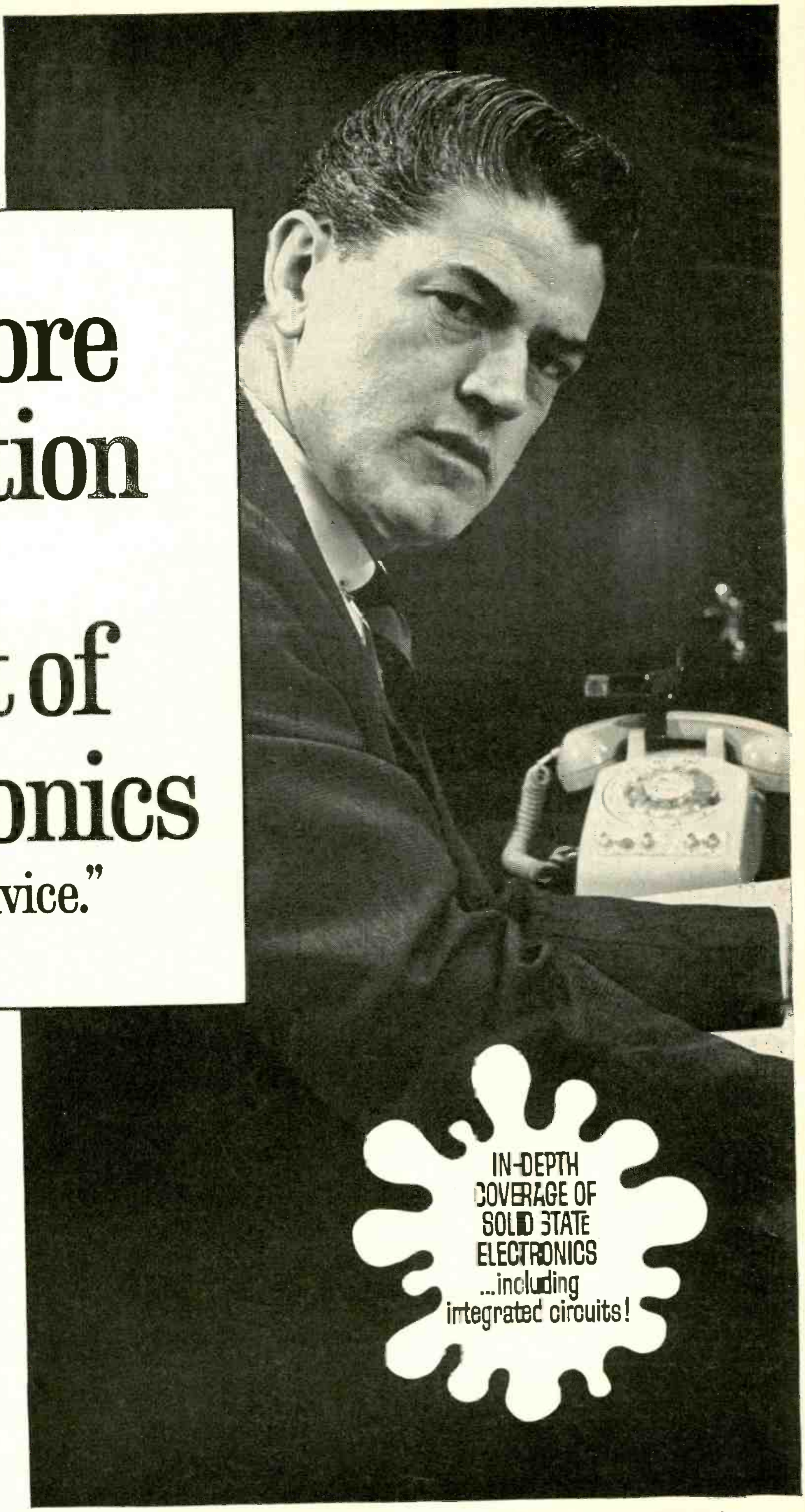
"Get more education or get out of electronics ...that's my advice."



Ask any man who really knows the electronics industry.

Opportunities are few for men without advanced technical education. If you stay on that level, you'll never make much money. And you'll be among the first to go in a layoff.

But, if you supplement your experience with more education in electronics, you can become a specialist. You'll enjoy good income and excellent security. You won't have to worry about automation or advances in technology putting you out of a job.

How can you get the additional education you must have to protect your future—and the future of those who depend on you? Going back to school isn't easy for a man with a job and family obligations.

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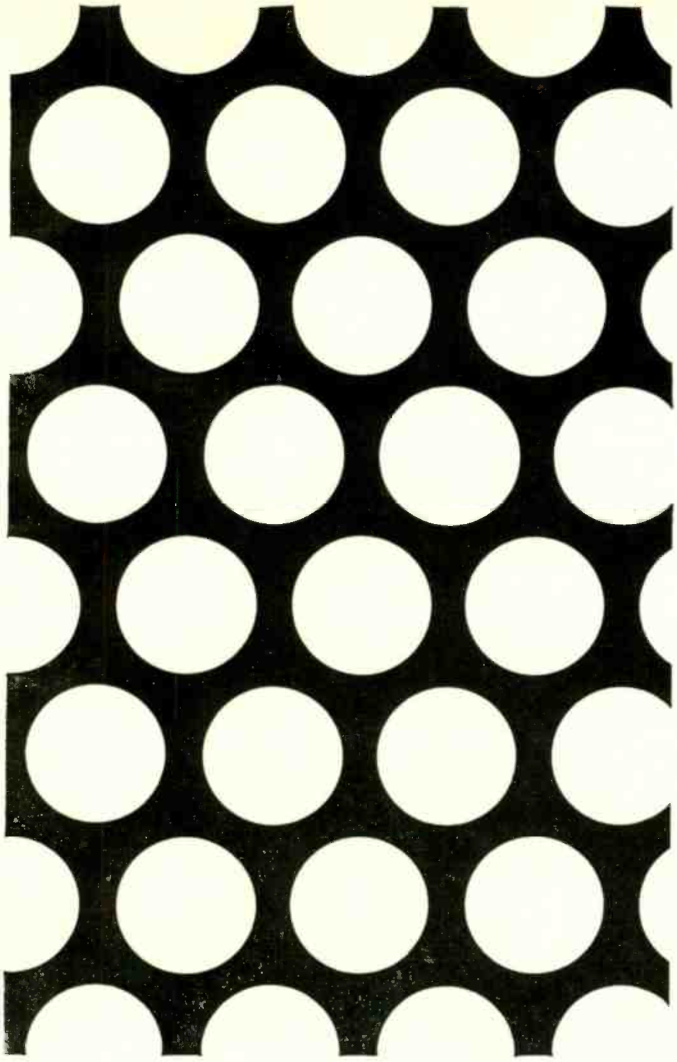


SPECIAL ISSUE

COLOR TV 1970

THE NEW COLOR TUBES!

by JOHN MASON

Super-bright tubes have brought color TV into the sunlight. Black surround, better rare-earth phosphors and improved electron guns make viewing better than ever

COLOR TV 1970: IT'S THE YEAR OF "BLACK SURROUND," "black honeycomb," europium-activated gadolinium and yttrium oxides, super-bright tubes and, not to be forgotten, the Trinitron. The color picture tube brightness war started in earnest six years ago when Sylvania introduced europium-activated red phosphors, claiming a 40% brightness increase. It's been escalating—to everyone's benefit—ever since.

RCA fired the first barrage for 1970 early. In midsummer last year they announced their 100% brighter Hi-Lite Matrix tube, featuring an opaque black masking surrounding each of its 1.2 million phosphor dots. Zenith, who had been working on a similar—but not identical—"black surround" principle since 1960, quickly brought its Chromacolor tube to the front line. Most picture tube manufacturers—G.E., Westinghouse, Motorola, Admiral, Sylvania—then rolled out "super-bright" tubes, some utilizing only new phosphors and others the new black surround.

Soaking up ambient light

Let's see what black surround tubes like Zenith's Chromacolor can do. If you've ever tried to watch color TV with bright sunlight streaming into the room, you know how poor the picture becomes. The image that reaches your eyes is "washed out."

Sunlight passes through the tinted glass on the front of the picture tube, bounces off the phosphor-coated viewing surface and heads toward you after again passing through the tinted glass. Picture contrast is sharply decreased since you're also viewing the phosphor-coated CRT surface illuminated by ambient light. Since external light must pass through the filter glass *twice*, manufacturers carefully balance filter density (transmissivity) against the brightness available from the red, blue and green phosphor triads for the best contrast and brightness.

Now Zenith and others have developed a technique for surrounding each phosphor dot with an opaque, jet-black material. About 50% of the screen area is covered with the material. By definition, this "black surround" does not reflect ambient light falling on it. Because external light is absorbed instead of reflected, there's no need for high-density, picture-dimming filters.

Zenith's switch to 80% transmission glass for Chromacolor from 42% in their conventional tubes is illustrated in the photos. With improved phosphors, this boosts brightness more than 100% over their conventional tubes and provides 25% more contrast.

And there's another advantage to the black-surround approach. In conventional tubes the entire screen area is coated with phosphor materials. Large numbers of stray electrons strike this "white surround" and reduce image detail. The black surround is unaffected by stray electrons; back reflected light from the tube's front surface is similarly neutralized.

The shadow-mask, electron-beam, triad arrangement for regular color tubes is shown in Fig. 1-a. The dots in each triad are tangent to one another, and the electron beam. its diameter fixed by the mask aperture, excites most of the dot area but leaves a circular guard band. This tolerance band is necessary for good white field color purity.

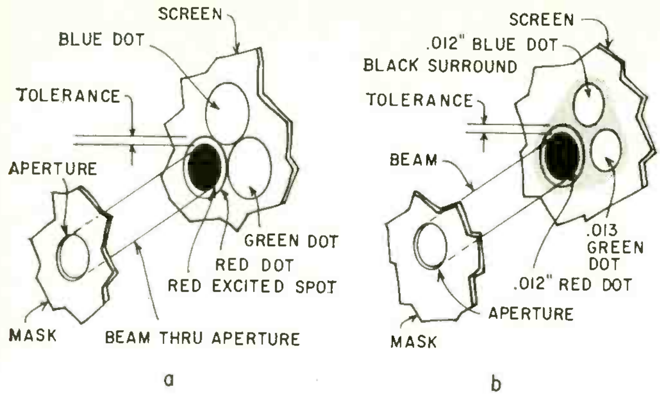


Fig. 1-*a*—Conventional phosphor-dot triad arrangement uses narrow electron beam and excites only part of phosphor dots. *b*—Wider beam excites entire dot area with black surround.

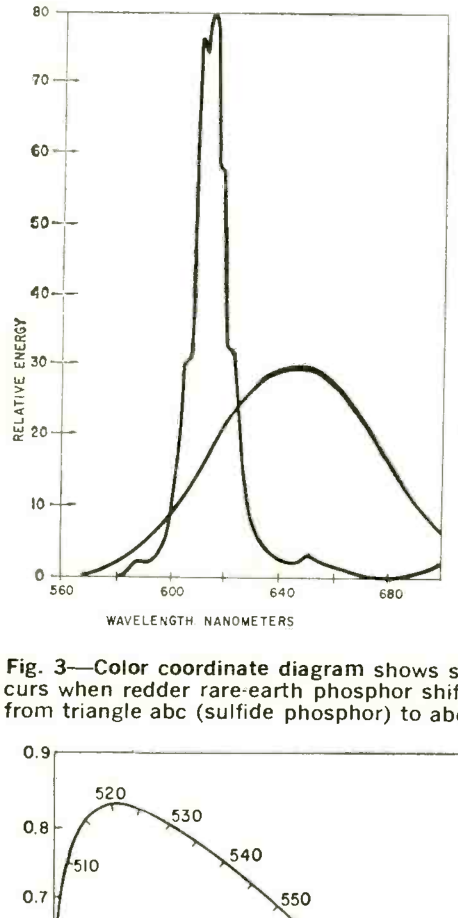
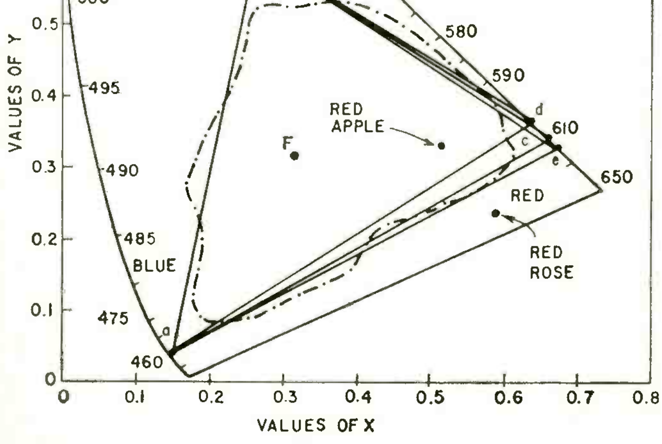


Fig. 2—Rare-earth red phosphor has high, peaked light emission, and appears redder because the eye also sees the "tail" on the broader sulfide phosphor curve. Eye is least sensitive in region under sulfide curve, and rare-earth appears brighter.

Fig. 3—Color coordinate diagram shows small shift that occurs when redder rare-earth phosphor shifts color triad area from triangle abc (sulfide phosphor) to abe (rare earth hue).



But in the Chromacolor tube (Fig. 1-b) the electron beam is *wider* than the phosphor dots, and the guard band spills onto the black surround without affecting the picture.

To accomplish this, Zenith starts with a shadow mask that has smaller apertures than standard masks. The mask is used to screen 1.35 million phosphor dots on the surface of the picture tube. Then the mask holes are enlarged to permit electron beams wider than the dots to pass through.

This electron beam "spillover" on the dots is useful. Now, instead of holding back the efficiency of some phosphors to keep beam currents equal, the dot diameters can be varied according to phosphor efficiency. Using some of the brightest phosphors available, Zenith deposits .012-inch red, .013-inch green and .012-inch blue dots. The dots and aperture holes in the mask are graded in diameter toward the edge of the screen.

Both RCA and Zenith are using new, higher-resolution electron guns in their black surround tubes. Zenith says the spot size in the Chromacolor is 25% better than earlier tubes, providing a sharper, clearer picture.

Admiral has developed a super-bright picture tube using what they call a "black honeycomb," and Westinghouse also has a black-surround tube. Neither manufacturer has released details.

Sylvania, who had a very bright tube going into the 1970 competition, decided not to go "super bright." Instead, they've improved their phosphors to boost brightness one-third, and claim 30% more contrast with a "sharper" picture. General Electric switched to a europium-activated gadolinium oxide in their '70 tubes, saying the new red phosphor is 20–70% brighter than those in use.

Improving rare-earth phosphors

Researchers have known for some time that rare-earth phosphors radiate light more efficiently. But the scarcity of rare-earth metals makes them expensive to produce commercially. G.E.'s new gadolinium oxide, for example, costs more than $150 a pound.

A glance at Fig. 2 shows why manufacturers are willing to pay 10–15 times the price of sulfide-type phosphors for rare earths. The high peaked curve represents light emitted from europium-activated yttrium orthovanadate, introduced as a red phosphor in 1964. The smaller, wider curve is that of silver-activated zinc cadmium sulfide, widely used as a red phosphor before the rare earths became commercially available.

Although the sulfide curve peaks more into the red (longer) wavelengths, the vanadate appears redder to the eye. Much of the sulfide curve is in the shorter wavelengths, and the eye sees a more "orangish" red. The vanadate phosphor appears *brighter* because most of the sulfide emission is in a region where the eye is least *sensitive*. (A curve indicating eye sensitivity would peak at 550 nanometers, the green portion of the spectrum.)

If you've made the change from sulfide-phosphor tubes to those with rare earths, you may be aware of another improvement. Red rare-earth phosphors are a white powder, while the sulfide type has a yellow-orange body color. When ambient room light falls on the rare-earth dots the light is reflected and only slightly dilutes the red hue. The sulfide phosphor, however, reflects yellow light that mixes with the red emission and shifts it toward orange-yellow. Consequently, early sets lost much of their red when viewed in ambient light.

Can you see more colors with the newest phosphors? The current debate is over which phosphors offer the best combination of hue and brightness. The europium-activated red phosphors generally peak at about 612 nm. What takes place when this wavelength is varied from one red phosphor to another can be seen in Fig. 3.

This is a standard color coordinate diagram, adopted in 1931 by the International Commission on Illumination.

The wavelengths of the pure spectral colors are specified in nanometers along the curved periphery. Using the proper x-y coordinates, various proportions of two or more colors can be combined by additive mixing to denote other colors.

For example, the coordinates of a Stehman Apple are: x, 0.514 and y, 0.330. The coordinates for a Best Times Rose are: x, 0.589 and y, 0.245. Most of the reflection colors that occur in nature and all known dyes and printing inks lie within the dot-dash contour.

Triangle abc is formed by the coordinates for the phosphors used for color picture tubes before the rare earths were introduced. With the proper currents to the red, green and blue CRT guns, all the colors enclosed in the triangle can be generated with a triad, as well as pure white at point F.

Eye sensitive to red changes

The color coordinates for yttrium vanadate indicate it appears as a pure spectral red to the eye, at 612 nm on the diagram. You can see that triangle abe for the vanadate encloses a wider range of color. Although the change is very small with the vanadate phosphor, the color changes occur in an area of the spectrum where the eye is quite sensitive to color differences. Thus the change from sulfide-type to rare-earth red phosphors brought a significant increase in the range of reds as well as more brightness for the newer tubes.

Another disadvantage of sulfide-type phosphors is their tendency to saturate with higher beam currents. For highlight areas on the screen, there is a shift toward the orange portion of the spectrum and the light output of the phosphor decreases. This causes whites to shift to green or blue when highlights are on the screen. Triangle abd shows the affect of saturation on the color triangle.

Not represented on the diagram are changes in brightness that occur with various phosphors. Colors—except for small changes in hue with red phosphors—have been standardized, and manufacturers are now trying to obtain the brightest rare-earth chemical combinations for their super-bright tubes.

Sony's Trinitron

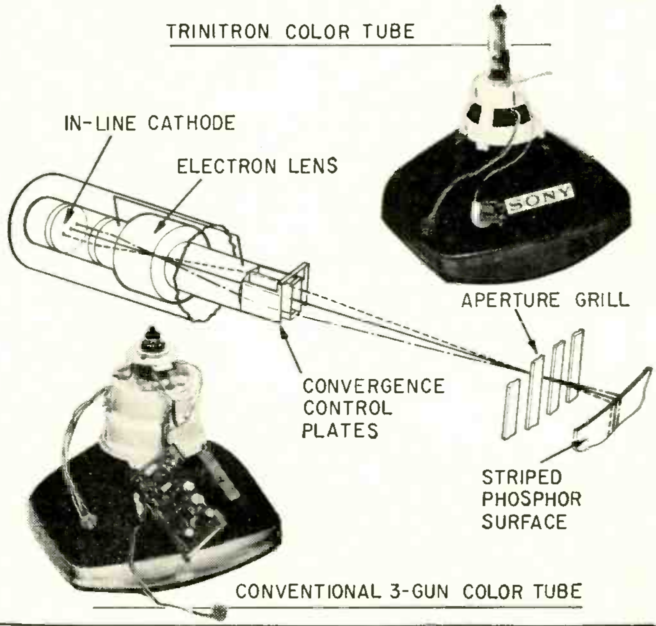
Until the super brights this year, American-made shadow-mask color tubes had at least one disadvantage in comparison with Japan's Trinitron tube. The shadow mask held back electrons reaching the phosphors, unlike the single-gun, aperture-grille construction of the Trinitron (Fig. 4).

Sales of 12-inch portable Trinitron sets are booming in this country. Sony reportedly plans to introduce a larger-screen version—perhaps this year.

The Trinitron utilizes a single electron gun and three in-line cathodes to direct an electron beam through the aperture grille onto separate red, green and blue phosphors stripes. Sony also likes to point out that their large, single electron lens is able to focus a sharper image than the three smaller lenses in shadow-mask tubes.

Which type of tube provides the best picture? There's only one way to really tell since color pictures are somewhat subjective: Visit today's sunlit showrooms and see them yourself. **R-E**

Color pictures come through 42% filter glass with Chromacolor tube 100% brighter than with 80% filter for regular tubes.



Single electron gun in Sony's Trinitron is directed through aperture grille onto red, green and blue stripes of phosphor.

COLOR TV 1970

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ADD TO YOUR COLOR TV

AUTOMATIC COLOR

Modernize your color set. Add R-E's version of the Magnavox

by STEVE LECKERTS

THIS YEAR COLOR TV SET MANUFACTURERS came up with a badly needed circuit—an automatic tint control. Now, we're going to show you how to add this circuit—the only one of its kind—to your own set.

First a little history. The circuit was developed by Magnavox and is used in their T940 color TV chassis. What we are doing here is presenting it as an add-on circuit for your set. You will find complete data on how to determine if this circuit will operate in your set and how to fit it into the existing circuitry.

If you come up with questions please write the author, in care of RADIO-ELECTRONICS. Do not write to Magnavox, they will be unable to assist you as they have not done any research into adding their circuit to sets made by other manufacturers.

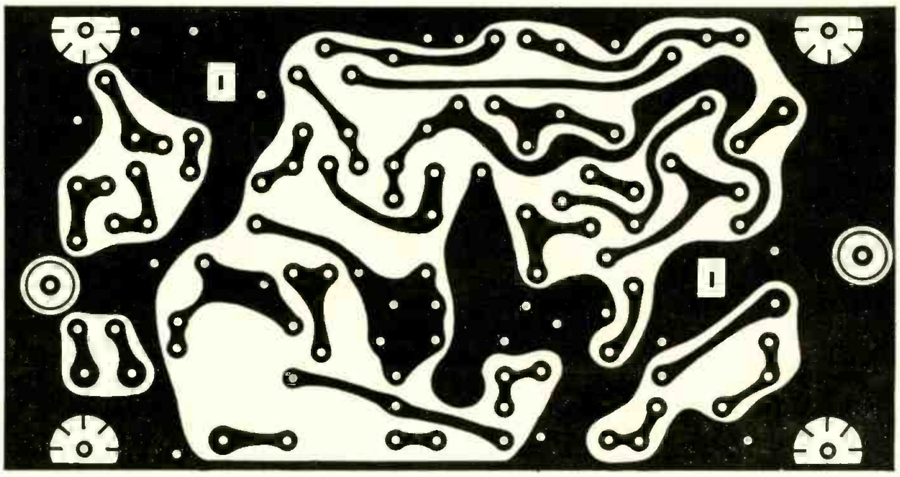
How it works

The circuit is intended to minimize the error in fleshtones which often occurs when you change stations or when program material changes. The problem is basically caused by the difference in phase relationship of the chroma and burst signals between stations and may even happen when a station switches cameras, or to tape, or to film.

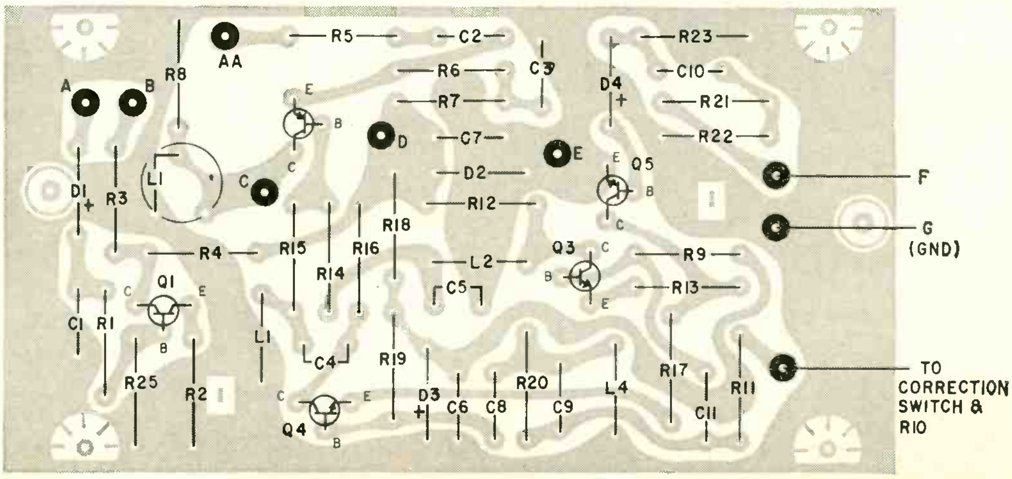
The Magnavox circuit senses phase errors in the chroma signal that occur around the fleshtone segment of the color spectrum and add whatever correction is required to the chroma signal to provide proper fleshtones on the screen of the color receiver.

The RED GATE and YELLOW GATE transistors (Q3 and Qy in the diagram) develop the needed correction. These two transistors sample the chroma information that is fed to their bases. Each gate is sensitive only to the chroma phases on either side of the proper fleshtone phase. A transistor switch completes the emitter circuit of each gate.

The combined correction signal from both gates is added to the original chroma signal by the chroma amplifier transistor. This stage is emitter driven by the same information that is applied to the gates. The base bias of the chroma amplifier is developed by the individual phase shift network in the collector circuit of each gate. These networks add the phase cor-



Foil side of circuit board. Use this pattern to make your board if you want to try adding circuit to your set.



For parts layout follow this diagram. To see where to connect the lettered terminals refer to the schematic on the facing page.

COLOR TV 1970

TINT CONTROL

Total Automatic Color circuit to your set

rection needed to cause the output from the RED GATE to develop a correction toward yellow, and the YELLOW GATE to develop a correction toward red. Thus the combined output of both gates mixes with the chroma signal being fed to the emitter of the chroma amplifier to produce a resultant at the chroma amplifier collector having the proper phase to produce good fleshtones on the screen.

Since chroma phases that don't produce red through yellow are negative going during the time that 3.58-MHz switch is on, the gates affect only fleshtones and are not sensitive to or affect any other portion of the color spectrum.

A tc correction converts all scene colors between yellowish orange and bright red to normal flesh tones.

PARTS LIST

All Resistors ½-watt 10% unless noted

R1—27,000 ohms
R2, R9—2,200 ohms
R3—1.5 megohms
R4—10,000 ohms
R5, R6, R21—330 ohms, 5%
R7—680 ohms
R8—1,500 ohms, 5%
R10, R11—560 ohms, 5%
R12, R16—1,000 ohms, 5%
R13—220 ohms, 5%
R14, R15—4,700 ohms, 5%
R17—270 ohms, 5%
R18—10,000 ohms, 5%
R19, R20—2,200 ohms, 5%
R22—820 ohms, 5%
R23—8,200 ohms
R24—potentiometer, 6,000 ohms

All capacitors ceramic, 500 V, 20% unless noted

C1—0.1 μF, 100 V, polystyrene
C2, C3—0.01 μF
C4, C5—20 pF, 5%, NPO
C6, C7, C8, C10, C11—0.01 μF
C9—43 pF, 5%, NPO
C12—47 pF, 5%, NPO

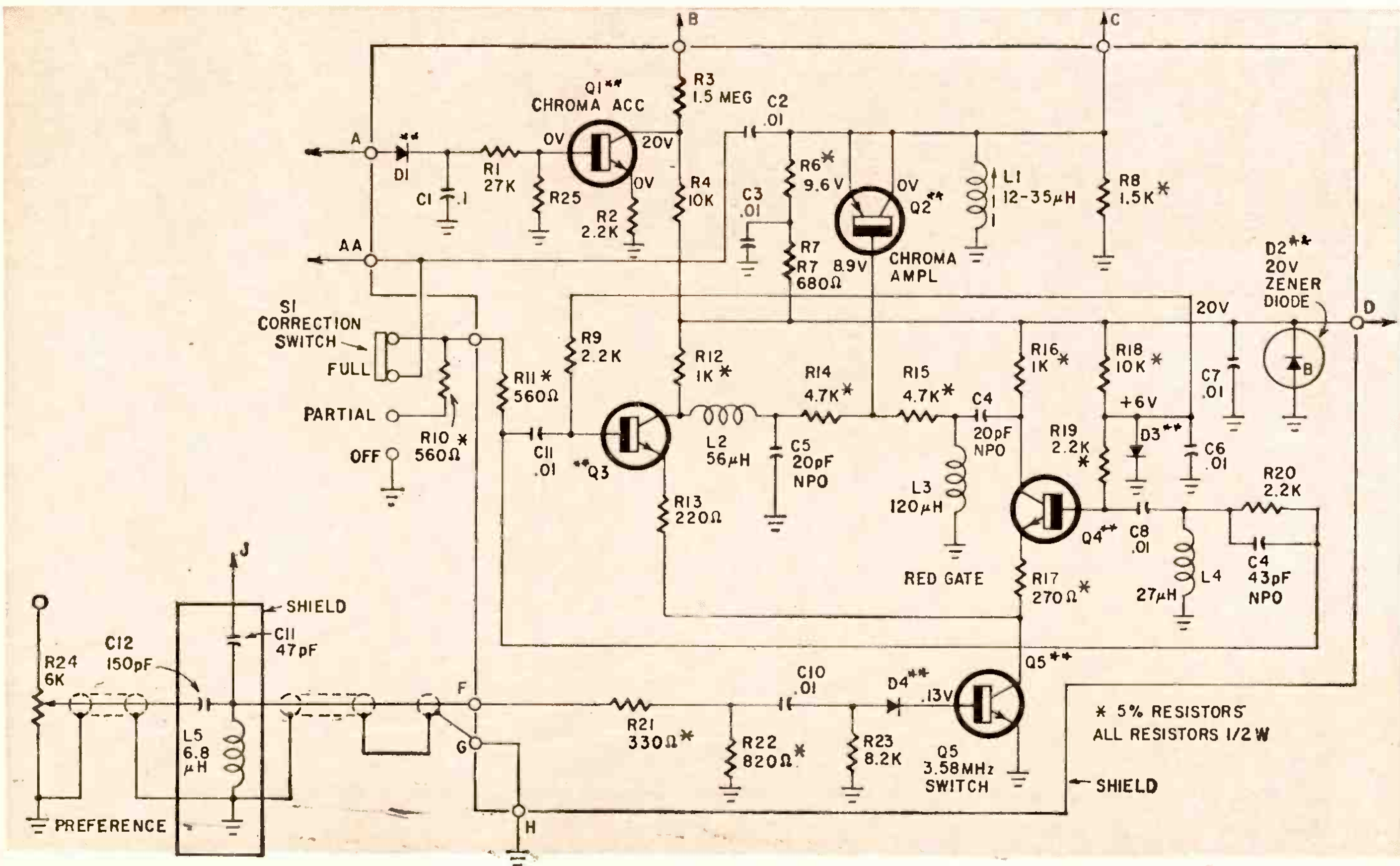
Coils

L1—12-35 μH peaking coil
L2—56 μH peaking coil
L3—120 μH peaking coil
L4—27 μH peaking coil
L5—6.8 μH choke

Semiconductors

D1, D2, D3—FD100
D2—Zener diode, 20 V, 400 mW, 5%
Q1—2N1711 or EN1711
Q2—2N4916
Q3, Q4—2N914 or EN914
Q5—2N5134
S1—single pole, 3 position, slide switch

Here's the circuit of the Automatic Color Tint control. Note that the semiconductors marked ** are identified in the parts list. The circuit is comparatively simple, and easy to duplicate.



The circuit can be installed with relative ease in both automatic-phase-control and injection-lock type color receivers.

Four connections must be made to the receiver. They are:

1) The oscillator output to the preference phase shift network through J.
2) Chroma signal from the receiver to the automatic tint control via A.
3) Output (C) from the chroma amplifier of the tint circuit to the receiver's color demodulator.
4) Power supply for the automatic tint control to D.

Let's begin by looking at what is involved to connect the automatic tint control circuit to a color set with a two tube color demodulator driven by the 3.58-MHz oscillator. These demodulators all require between 3 and 5 volts peak-to-peak oscillator drive. This level is conveniently available at the oscillator transformer and is exactly the range of voltage required to drive Q5 in the automatic tint control circuit, after filtering (phase shifting) of the preference network. In this circuit, the 3.58-MHz oscillator transformer terminal is bridged (simply tied on) to the input capacitor of the preference network C11. This preference network must insert the proper phase shift with respect to the chroma signal to assure proper circuit operation. The relative oscillator angle is determined by the phase lock system whether it be APC or injection. For most receivers this angle will be correct as for the examples given here.

However, if because of some receiver peculiarity, insertion of the tint control circuit results in obviously wrong flesh tones, the preference circuit can be easily modified. First, moderate changes in phase shift can be introduced by changing the LC component values. Second, the high-pass network can be made into a low-pass by interchanging the inductive and capacitive tuning elements (C12 and L5). By a combination of these two techniques a full 360-degree phase angle can be covered and every conceivable oscillator phase dealt with.

Next, the chroma amplifier on the automatic tint board must be inserted in series with the receiver's bandpass amplifier. Since the tint circuit is emitter fed it presents a low input impedance to the receiver. The most convenient place to make this connection is at the set's chroma control since a 500-ohm pot is almost universally used for this application.

In the circuit we are describing, there is approximately a 5-volt peak-to-peak signal at this point as it follows the bandpass amplifier. The wiper of the chroma control is disconnected and the wiper itself connected to point AA on the automatic tint control board.

The receiver's demodulator is fed from the output of the tint circuit point C. This point is connected to the color demodulator at the point where the wiper was disconnected.

The only other concern is the power supply, which is the most difficult part of the installation since it requires some calculations to make this connection without affecting the receiver's normal supply voltages. The automatic tint control draws about 20 mA and is regulated by a 20-volt Zener diode.

A dropping resistor from a higher-voltage supply designed for between 25 and 30 mA will assure reasonable current in the Zener diode, to be safely over the Zener knee and to keep the Zener dissipation below 250 milliwatts. The receiver associated with the circuit we have been describing is line operated and has a 280-volt voltage doubler supply. The 280-volts is dropped to 140-volts through a 3,900-ohm 10-watt wire-wound resistor. It is this 140-volt supply that we will drop to 20 volts. However, we will also have to parallel the set's 3,900-ohm resistor with another resistor to prevent the 140-volt supply being lowered by the additional loading of the tint circuit.

First we compute the value of the resistor to be connected between the receiver's 140-volt supply and point D of the automatic tint circuit. This resistor must drop 140 volts to 20 volts with a current of 27 mA.

$R_1 = (140 - 20)/.027 = 4,440$ ohms

There is a 10-watt power resistor available at 4500 ohms (IRC PW-5). Using this resistor the actual current will be:

$I = 120/4.5K = 26.7$ mA

and the power dissipated in R_1:

$P = V^2/R = (120)^2/4500 = 3.2$ watts

Next we compute the current in the receiver's dropping resistor.

$I = (280 - 140)/3.9K = 35.9$ mA

The current actually drawn is $35.9 + 26.7 = 62.6$ mA. While it may appear that we are greatly increasing the current drain from the receiver's supply components, it should be realized that this current is only part of the current of the 270-volt supply and so is a considerably lower percentage of the supply current than first imagined. The value of resistance needed to drop 280 volts to 140 volts with 62.6 mA of current is:

$R_p = (280 - 140)/.0626 = 2,236$ ohms. Since the receiver already has a 3,900-ohm resistor performing this function we must determine what resistor should be paralleled with 3,900 ohms to give 2,236 ohms. The parallel resistance of two resistors is equal to the product of the two resistors over their sum and we can make the required calculation as follows:

$R_p = R_2R_1/(R_2 + R_1)$

where R_2 is the resistor we are looking for and R_1 is the resistor in the set.

By some algebraic shuffling . . .

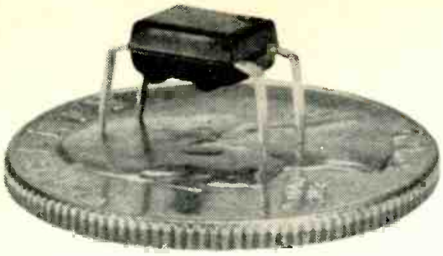
$R_2 = 3.9 \times 2.24/(3.9 - 2.24) =$ 5,140 ohms picking a 10-watt 5,000-ohm resistor, we check the power dissipation:

$P_3 = V^2/R = (280 - 140)^2/5000 = 3.92$ watts.

One other point is of interest concerning the chroma levels. In some sets the chroma control is located between the first and second bandpass amplifiers. The peak to peak chroma level is approximately 100 mV at this point. However, since we are breaking the circuit and reinserting the signal with slight amplification, and since we are able to adjust signal level with the control, the insertion of the tint circuit chroma amplifier at this point is functionally correct. We still retain the convenience of connecting to the low impedance chroma control in this way. **R-E**

TEST ADAPTER COLOR TIP

Tube-socket test adapters can be used with a scope and color generator to signal trace faulty color receivers without pulling the heavy chassis. Simply take out the tube in a particular stage that you wish to signal trace and insert the test adapter in its place, then insert the tube in the test adapter. There are numbered metal tabs that project out around the upper part of the test adapter to permit signal tracing or signal injection tests. You will have to obtain 7- and 9-pin miniature and octal-base test adapters to cover the field of most tubes that are used in color receivers.—*Robert Appel*



MICRO-MINI IC'S

IN THESE DAYS OF MINIATURIZATION, everything from automobiles to women's bathing suits seem to be growing smaller. But, who would have thought that miniaturization could be applied to the IC? Well, evidentally someone at Motorola Semiconductor Products did. They have just announced (at a Linear IC Seminar, in Garden City, N.Y.) a couple of micro-mini DIP (dual-in-line package) IC's that are only about one fourth the size of the 16-lead DIP and have only four *leads.*

Designed as a 250-mW audio amplifier, the MFC4000 reduces the component count by two transistors and two transformers when used as the audio power amplifier in portable radios, tape players and phonographs.

Current drain is exceptionally low. When operating from a 9-volt source, the current ranges from 3.5 mA (standby) to 60 mA at 250 mW output. Total harmonic distortion (THD) is less than 1% up to 75 mW and rises to about 4% at rated output. With a 6-volt supply, total harmonic distortion is around 2.2% from 3 to 10 mW, 4% at 50 mW and to 8% at 100 mW output.

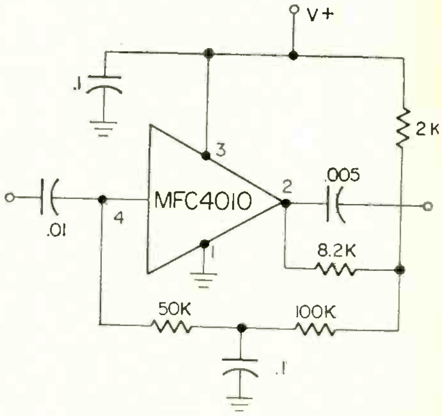
The other micro-mini IC is the MFC4010, a wide-band high-gain amplifier for AM i.f. and low-level audio applications. It has a minimum gain of 60 dB and low output noise (1.0 mV rms typical). These characteristics make the MFC4010 an excellent performer as a 455-kHz i.f. amplifier and as a mike preamplifier in cassette and portable recorders.

Frequency response is flat from 800 Hz to 500 KHz and is down 3 dB at 200 Hz and 1.1 MHz. Voltage gain is 68 dB with a 6-volt supply and about 75 dB with 9–12-volt supplies.

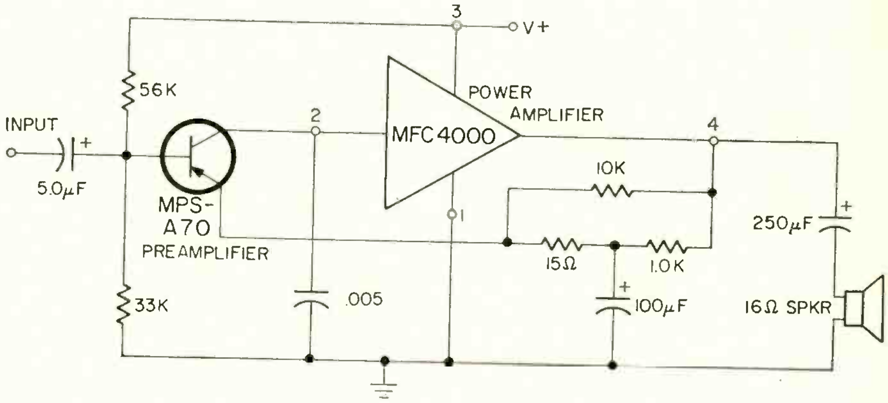
Current drain rises linearly from 3 mA at 6 volts to 9 mA at 18 volts. Typical circuit applications and data follow.—*Robert F. Scott* **R-E**

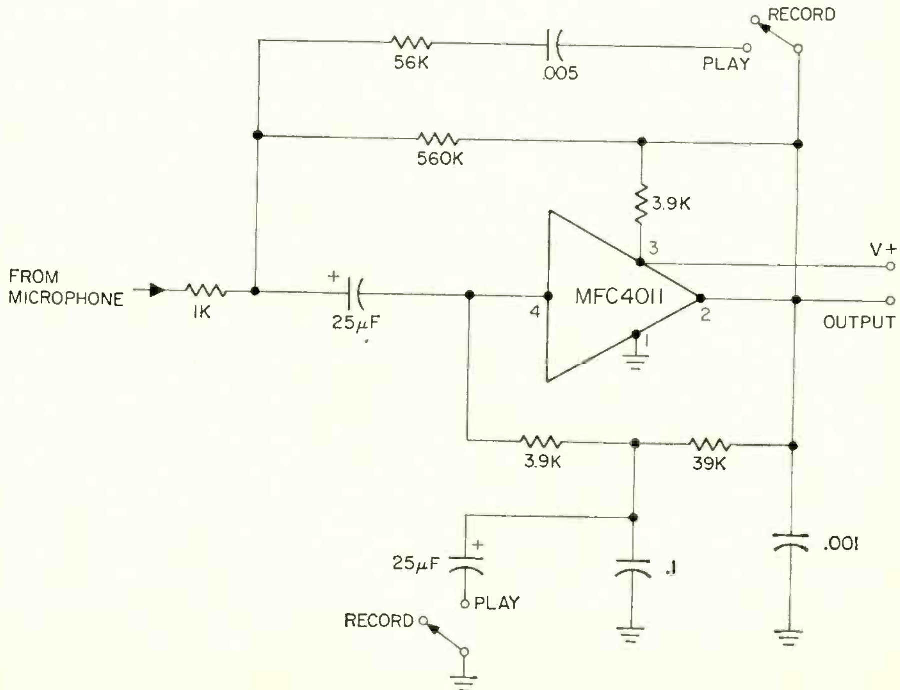
MFC4000 Specifications

Supply voltage (V+):	12 Vdc max
Power dissipation (soldered to circuit board and held in free air):	1.0W
Power dissipation (derated above 25°C):	10mW/°C
Operating temperature range:	−10 to +75°C
Zero-signal current drain (V+ = 9 Vdc, R_L = 16 ohms):	2.5 mA typical, 6.0 mA max
Sensitivity (P_{out} = 50 mW rms):	15 mV rms
Power output (THD less than 10%):	250 mW min, 350 mW typical
THD (P_{out} = 50 mW):	0.7% typical
(P_{out} = 50 mW, V = 6 Vdc):	4.5%



Above is circuit for using the new 4010 as a 455-kHz amplifier. Basic audio amplifier shown **below** uses the 4-lead micro-mini 4000 IC. On the **bottom**, is the 4010 (labeled wrong) used as a record/play preamp for cassette or tape recorders.





MFC4010 Specifications

Power supply voltage:	18 Vdc max
Power dissipation (free air):	0.5 W
Power dissipation (derated above 25°C):	5.0 mW/°C
Operating temperature range	−10 to +75°C
Voltage gain (at 1 kHz):	60 dB min, 70 dB typical
Output noise voltage (bandwidth 20 Hz to 20 kHz):	1 mV rms

COLOR TV 1970

NEW! Color TV Circuits

There's an ac line regulator, a snap-in module for color amplifier and demodulator, a new composite video amplifier and noise immune sync circuits in the 1970 sets

By ROBERT L. GOODMAN

EXPANDED AND INNOVATIVE USE OF solid-state circuits again highlight the new color receivers introduced for 1970. The availability and lower costs of transistors and other semiconductors are being put to good use by most manufacturers to improve picture quality in their 1970 sets. Here's a few of the circuits you'll be dealing with.

Quasar ac-line regulator

The regulated 105-volt ac power supply in Motorola's Quasar sets prolongs component and picture-tube life while giving viewers a stable, clearer picture. The regulator delivers a constant CRT filament and B+ voltage regardless of line variations. As shown in Fig. 1, the power transformer and two 50-watt resistors are in series across the ac line.

A high ac-line condition is sensed by the regulator panel, which switches the two 50-watt resistors in series to dissipate the additional line voltage. This maintains 105 volts ac to the power transformer primary. With ac line voltage at 105 volts, the regulator senses a low-voltage condition and electronically shorts out the 50-watt resistors, thus holding 105 volts on the transformer primary.

The voltage regulator, therefore, can provide a voltage drop between the input and the regulated output, following Kirchhoff's law for a series circuit: the sum of the circuit voltage drops is equal to the applied voltage.

Regulator operation for high ac-line voltage occurs when the unfiltered B+ to regulator control R5 *rises* (Fig. 2). Transistor Q1 *reduces* conduction and C3 now takes *longer* to charge (compared to a low B+ condition). When C3's charge reaches 28 volts, diac D3 fires, gating on triac TR1, which shorts out R15 and R16. The triac remains on until the ac across its main terminals goes to zero. When this occurs, the cycle repeats itself.

Because TR1 fired *late*, its duty cycle is *short* and resistors R15 and R16 are in the circuit *longer* during each alternation. This counteracts the original *rise* in ac line voltage. Then Q2 is pulsed on at the beginning of each ac alternation to establish a zero reference. For low line voltage, this sequence is followed with the converse of the steps italicized above.

As described, the B+ is used as a "sensor" for the triac switching operation. When line voltage increases or decreases, the unfiltered B+ is used to control an RC timing circuit consisting of C3 and transistor Q1 used as a variable resistor. The unfiltered B+ is connected to its base. The conductivity (resistance) of Q1 determines how long C3 takes to charge to 26 volts and close the switch. The emitter is held at 36 volts by Zener diode D2 when the B+ goes up. This reduces Q1's forward bias and lowers the charging current. When B+ goes down, the base becomes less positive and increases the forward bias, resulting in more current. When C3 charges to 26 volts, diac D3 conducts and discharges through the pulse transformer. This current produces a secondary pulse that turns on the triac.

Here's why synchronized firing of the triac is needed. If line conditions are such that the timer requires 100° to reach 26 volts and fire the triac,

Fig. 1

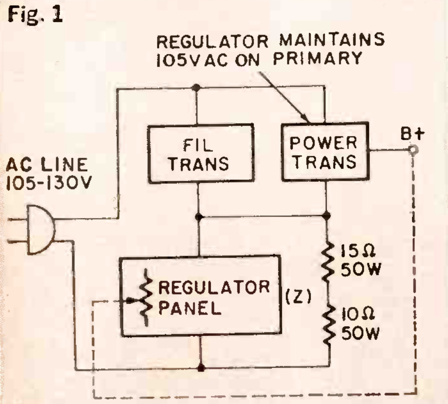


Fig. 2

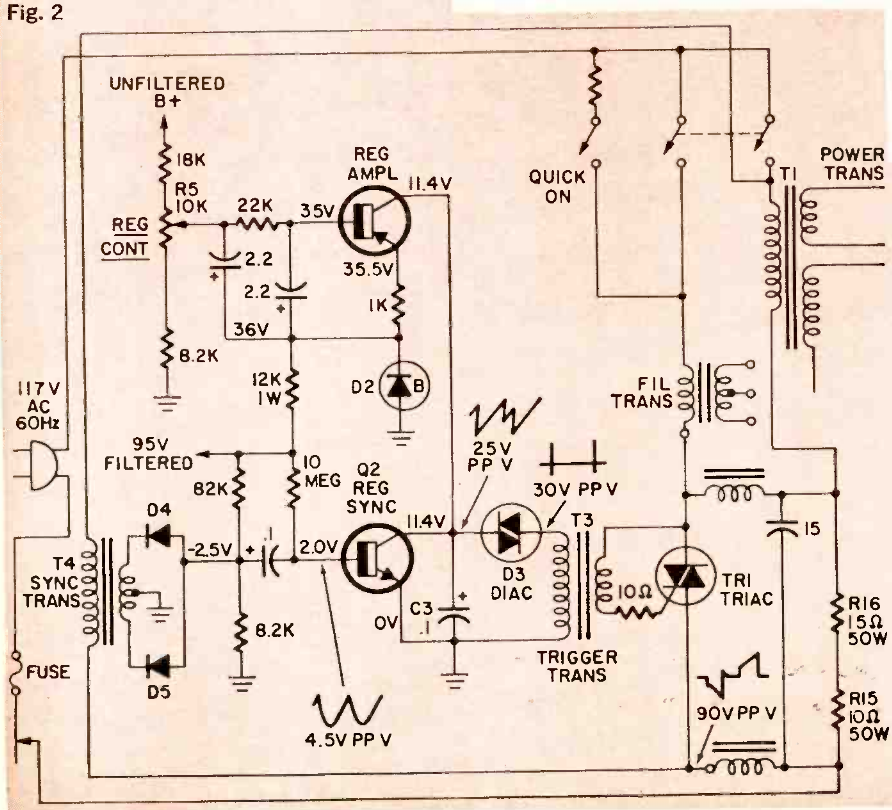
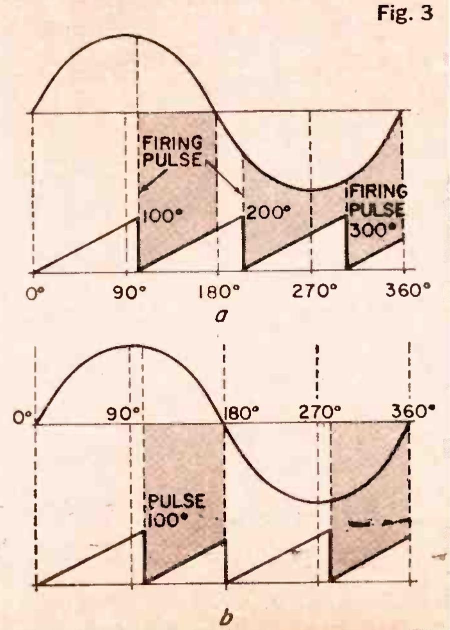


Fig. 3



the timer starts again and reaches a second firing point at 200° (see Fig. 3-a).

During the second alternation the triac turns on at 200°, 20° into the second alternation. However, the following firings are haphazard and will produce unbalanced dc primary currents and pop the circuit breaker. Some type of sync is needed.

At the start of each ac alternation the timer must be restarted to turn on the triac at the same point in every cycle. The timer can be restarted by discharging C3. Hence at 0°, 180°, 360°, etc., the capacitor must be discharged. (see Fig. 3-b).

With npn transistor Q2 across C3, the base must go *positive* at 0°, 180°, 360°, etc., to drive the transistor into conduction and discharge the capacitor. At all other times the base is negative and Q2 is nonconductive. Full-wave rectification is used to develop a negative output waveform to cause Q2 to conduct. However, this negative waveform is coupled through a capacitor to the base of Q2. A positive pulse then occurs at 0°, 180°, and 360°.

Zenith's Dura-module

A snap-in, solid-state Dura-Module used in Zenith's 14A9C51 color TV chassis contains the color amplifier and a demodulator IC.

The module circuitry is shown within the dashed line in Fig. 4. Connections to the module (U6, T5, A5, etc.) correspond to the vertical and horizontal letter and number columns printed on the module. This identification technique permits quick locations from the schematic to a point on the module and vice versa.

The heavy lines in Fig. 4 show the signal path from the first color amplifier to the IC demodulator. This color signal enters at A5, is amplified by second color amplifier Q701 and exits to the COLOR COMMANDER control and CHROMA LEVEL controls through connection A7. The COLOR COMMANDER control is an additional color level control ganged with the contrast control that varies both color and contrast level. The main color level control (in series with the color level section of the COLOR COMMANDER) is adjusted for the proper amount

Fig. 4

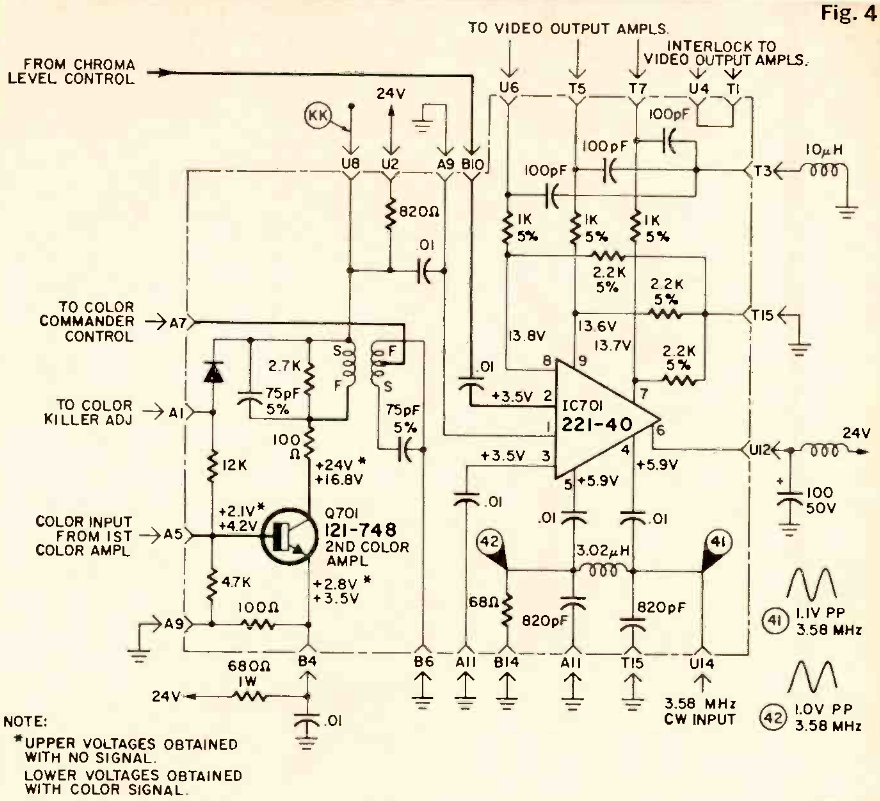
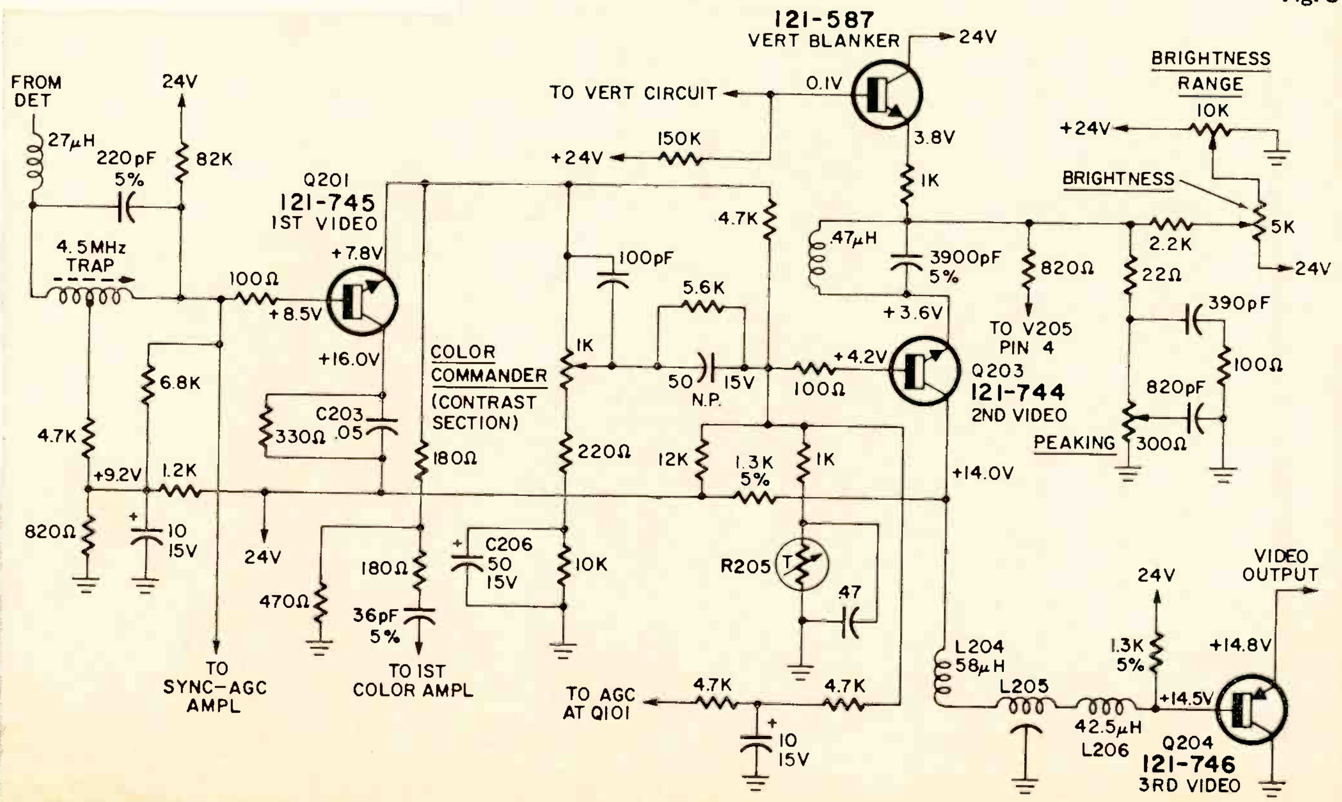


Fig. 5



of color signal required for proper tracking with contrast. Once the color level is set, the COLOR COMMANDER control is adjusted for contrast and color level during color programs and contrast during b-w programs.

The color signal re-enters the module at B10 and couples to the demodulator. Following demodulation in the IC, color difference signals exit the module at U6, T5, and T7 to the video output amplifiers.

Video (Y) amplifier

The Zenith 12A12C52 chassis now uses three transistor stages to process the composite video (Y) signals (Fig. 5). Composite video is coupled through a 4.5-MHz trap to the base of the first video amplifier Q201, an emitter follower.

The composite video (Y) signal is further coupled through a 50-μF nonpolarized capacitor (shunted by a 5.6K resistor) to the base of second video amplifier Q203. Dc coupling between the first and second video amplifiers is accomplished by the 4.7K and 5.6K resistors. Capacitor C206 (shunted by a 10K resistor) and the 5.6K resistor (arm of the contrast control) provide proper black-level tracking with adjustment of the COLOR COMMANDER (contrast) control.

Thermistor R205 with a 1K resistor provide brightness stability during the first few minutes of receiver warmup. This stability is desirable since the color amplifiers require a few minutes to stabilize at operating temperature.

Composite video information (positive-going) is also coupled from the colleector of Q203 through peaking coils L204 and L206 and delay line L205 to base of Q204, the third video amplifier (emitter follower). The composite video emitter output is injected into the emitter circuits of the three color video output amplifiers. Transistor Q204 is actually the emitter ground-return circuit of these three amplifiers.

Because all video amplifier stages are direct- or dc-coupled, any failure in the first video stage will be directly reflected into the cathode of the CRT. If one stage opens, the screen will be dark. And if a stage became shorted, the screen would be very bright and you may lose brightness control action.

The purpose of the phase-splitter stage shown in Fig. 6 is to change and control the phase of the chroma signal (provide proper color hue for the set viewer).

Chroma information is fed to Q103 through color control R110, and the output is tapped from both the collector and emitter. This information is applied to a phase-shifting network (R123 and C118.)

This phase-shifting action can be seen in Figs. 7a, b, c, where the collector and emitter signal voltages are represented by generators delivering to the network voltages of equal amplitude but opposite phase. In Fig. 7a emitter voltage V_e is in phase with the input signal voltage; collector voltage V_c is 180° out of phase with the input signal voltage (thus 180° out of phase with the emitter signal voltage).

The emitter signal is shifted 90° by capacitor C; therefore, the emitter signal at point A appears 90° out of phase with both V_c and V_e. This 90° voltage shift is represented by V_s (V_{SHIFT}). Of course, a certain amount of the in-phase collector signal (V_c) is added to V_s at point A. This amount is determined by the adjustment of tint control R.

(continued on page 87)

Fig. 6

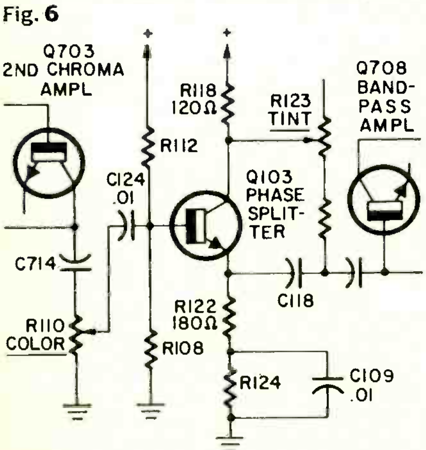


Fig. 7

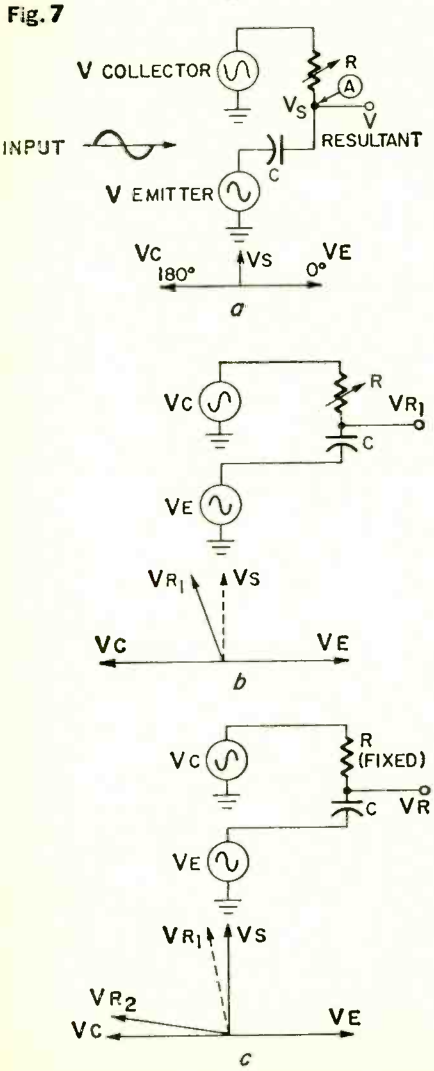
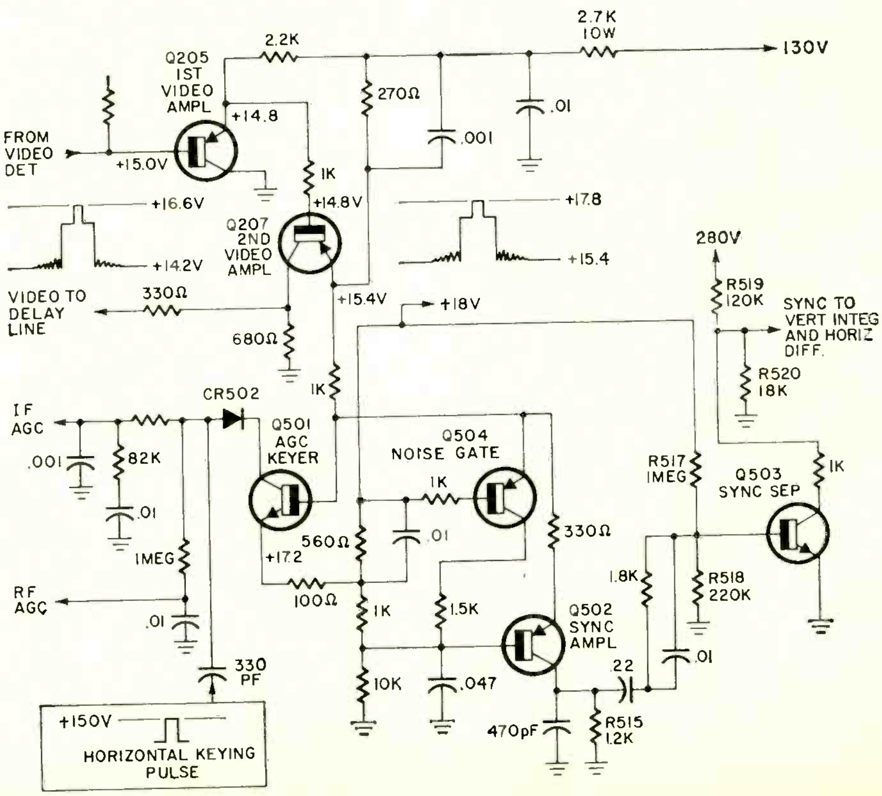


Fig. 8



MATCHING RESISTORS
to close tolerances

by E. D. CLARK

IN MANY CIRCUIT APPLICATIONS, TWO or more resistors must be closely matched while the actual value used may be 10% or more off the specified value. Matched pairs of resistors are made but are often difficult to obtain. Here is a simple circuit I have used to match ordinary resistors to well within 1% tolerance.

Fig. 1 shows a simple bridge consisting of R1, R2, R3 and R4. Resistors R3 and R4 can be interchanged (by S2) so current unbalance can be compared. Switch S2 may consist of a toggle, knife or momentary d.p.d.t. switch. S1 may be a toggle or normally closed push-button switch. The meter is an old 0–1-mA, 50-ohm movement in a vom. Any similar meter is suitable. The meter (M) is connected (as shown in dashed lines) across points X—X when checking resistors up to 100 ohms or so.

The dc amplifier in Fig. 2 is used when matching resistors up to 500,000 ohms. The transistor is in a common-emitter circuit with R7 limiting current through the meter. Resistors R6 and R8, in conjunction with the resistors being checked, form a voltage divider that provides base bias for the transistor. The amplifier is connected across the bridge at X—X. The 4.5-volt battery in the bridge supply is suitable for resistors up to at least 10,000 ohms. With a 150-volt supply, resistors up to around 500,000 ohms can be compared.

The theory of operation is that when R3 equals R4, throwing R2 from one position to the other does not change the meter deflection. Also, when R1 equals R2, the meter will not deflect when used direct and will not deflect from the reference point when the amplifier is used.

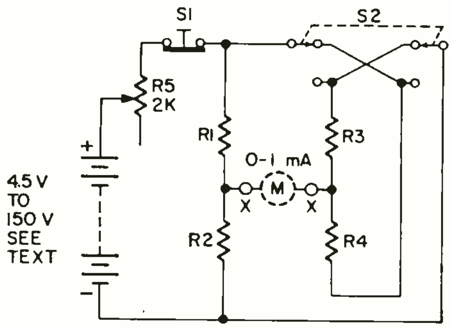


Fig. 1

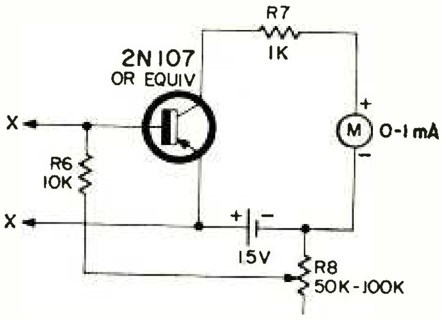


Fig. 2

Using the bridge

Connect up R1, R2, R3 and R4 (100 ohms, 10%, for example). Set R5 for maximum resistance and connect the battery and meter. If the meter reads upscale, reverse the position of S2. If the deflection is still upscale, leave S2 in the position for maximum upscale reading. (It is advisable to open S1 before operating S2. The reason is that if the S2 contacts do not break or make at exactly the same instant, a current surge of considerably higher than full scale flows through the meter.)

If the meter deflects upscale in one position of S2 and backwards in the other, note the upscale reading and then reverse the battery or meter polarity and take another reading. Leave everything in the position that gives the greatest deflection.

Now, temporarily connect a much higher resistor across R3 and then R4 and note the change in meter reading. The resistor that causes an *increase* in reading is the *lower* one and is the one to be modified to raise its value to match the other.

Remove a part of the resistor body by grinding or filing. Note the decrease in meter reading as material is removed. Check frequently for balance by operating S2. When throwing S2 causes no change in meter reading, R3 and R4 are matched.

If you want to match R1 and R2, locate the lower value as explained above and modify it until the meter reads *zero*. If all four resistors are to be matched, interchange R1 and R3 or R2 and R4 and repeat the procedure.

The basic bridge is quite sensitive. For example, three 100-ohm resistors and one 99-ohm resistor will show a meter reading of around 75 μA—about 3½ divisions on the 1-mA scale. As a test, I used the bridge described here to match pairs of 100-, 1,000- and 10,000-ohm resistors. When checked on a precision resistance bridge, the 100-ohm pair checked out as 107.5 and 107.6 ohms; the 1K pair measured 1,118 and 1,119 ohms and the 10K pair came in at 11,124 and 11,126 ohms.

When using the amplifier, connect the meter as in Fig. 2. With S1 open, adjust R8 for a center-scale reading. (When checking higher-value resistors, it may be necessary to increase the value of R6 before the meter can be centered. Now, procede to match the resistors as described earlier. When matching is fairly close, R5 can be adjusted to apply full voltage to the bridge resistors.

An easy way to handle R1, R2 R3 and R4 is to mount them in a Jones-type barrier terminal strip.

Modifying resistors

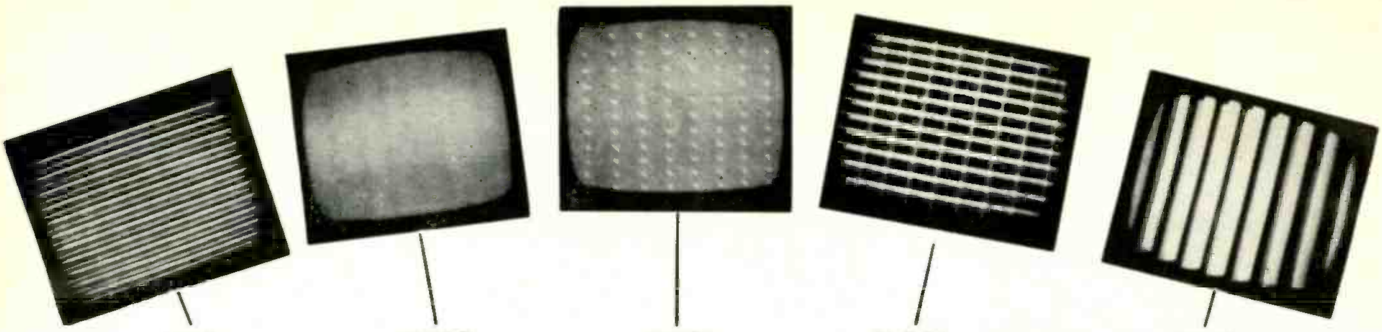
There is nothing new about changing the value of composition resistors such as Ohmite Little Devils but I've found that grinding part of the resistor body away seems to work better than filing or scraping as the latter methods seems to cause erratic changes in resistance. I leave the resistor being modified in the test circuit and watch the meter as I grind away the material.

One word of caution: Heat generated by grinding will cause a temporary additional increase in resistance. So, when nearing the desired value, let the resistor cool to ambient temperature before rechecking. This method allows the matching of three other resistors to one with a higher value. The latter may be a 1% precision unit if desired. Seal out dirt and moisture with a coating of service cement or epoxy cement.

Matching by selection

It may surprise you to know that you can sometimes get two or three 1% pairs from a random group of ten resistors of the same value and make. When matching by selection, the resistors being compared are within 1% if balance can be obtained by shunting either one with a resistor 100 times its value. While ordinary carbon resistors do not have the stability and low-noise characteristics of deposited-carbon and metal-film types, they are useful in such applications as split-load phase splitters and grid resistors in push-pull amplifiers.

Two resistors may also be matched by shunting the larger with an additional resistor that will bring its value down to the level of the smaller one. **R-E**



COLOR TV 1970

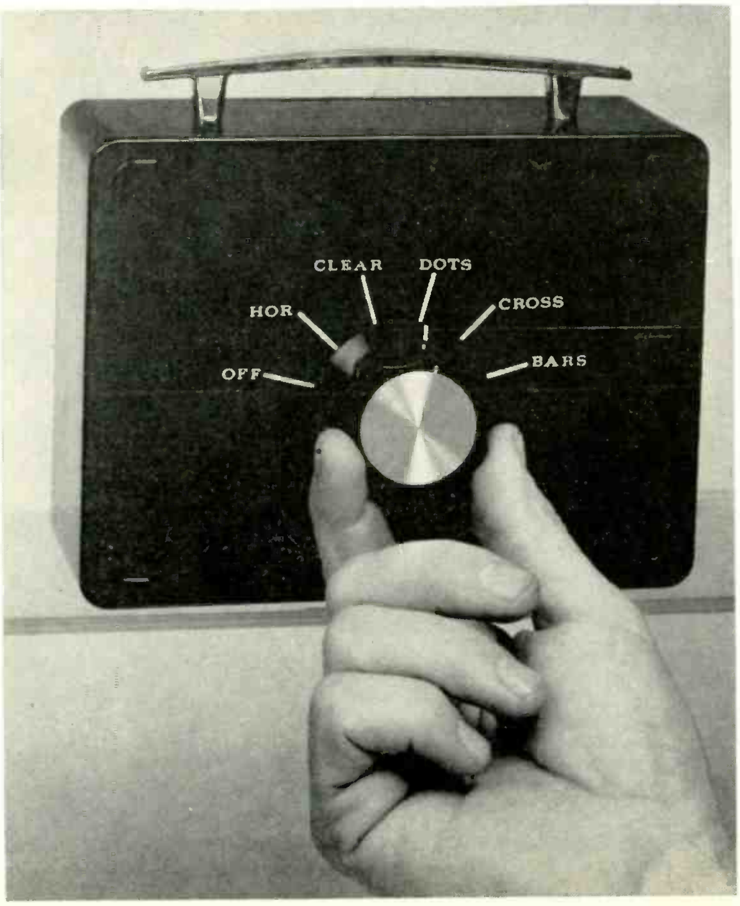
BUILD R-E's IC color pattern generator

With IC's you can make a really special color pattern generator. The only front panel control is the pattern selector switch.

By RAYMOND G. KOSTANTY

WHAT FEATURES DO YOU LOOK FOR IN a color bar-pattern generator? Outstanding stability, ease of operation, a variety of patterns, generous use of the most modern semiconductors and integrated circuits, instant warmup, low cost, compactness and light weight? If so, this generator, which has all these features, is for you.

A single selector knob turns the unit on and delivers any of the following patterns: horizontal lines, vertical lines, dots, crosshatch, color bars. A color amplitude control can be added. Rf output is slug-tuned to channel 3, 4 or 5.



Circuit operation

The pattern generator is dependent upon three basic building blocks: the inverter, the NOR gate and the J-K flip-flop.

The simplest element is the inverter. Its symbol and truth table are in Fig. 1-a.

In digital circuits, the signals into and out of an element are classified as HIGH or LOW. In the truth tables, HIGH is represented by the symbol 1 (one) and LOW is represented by 0 (zero). With the IC's used in this pattern generator, any voltage into or out of the basic elements greater than +0.70 volts is defined as a 1, and any voltage less than this is defined as 0.

Returning to the truth table in Fig. 1-a, we find that a 0 appears on the output of an inverter when its input is 1 and vice versa.

The operation of the NOR gates is explained in Fig. 1-b. If either or both inputs are 1, the output is 0.

The small circle at the output of the symbol can be thought of as meaning an inversion. Thus, a NOR gate is an OR gate followed by an inversion.

When an AND or OR function is needed, it can be produced as shown in Figs. 1-c and 1-d.

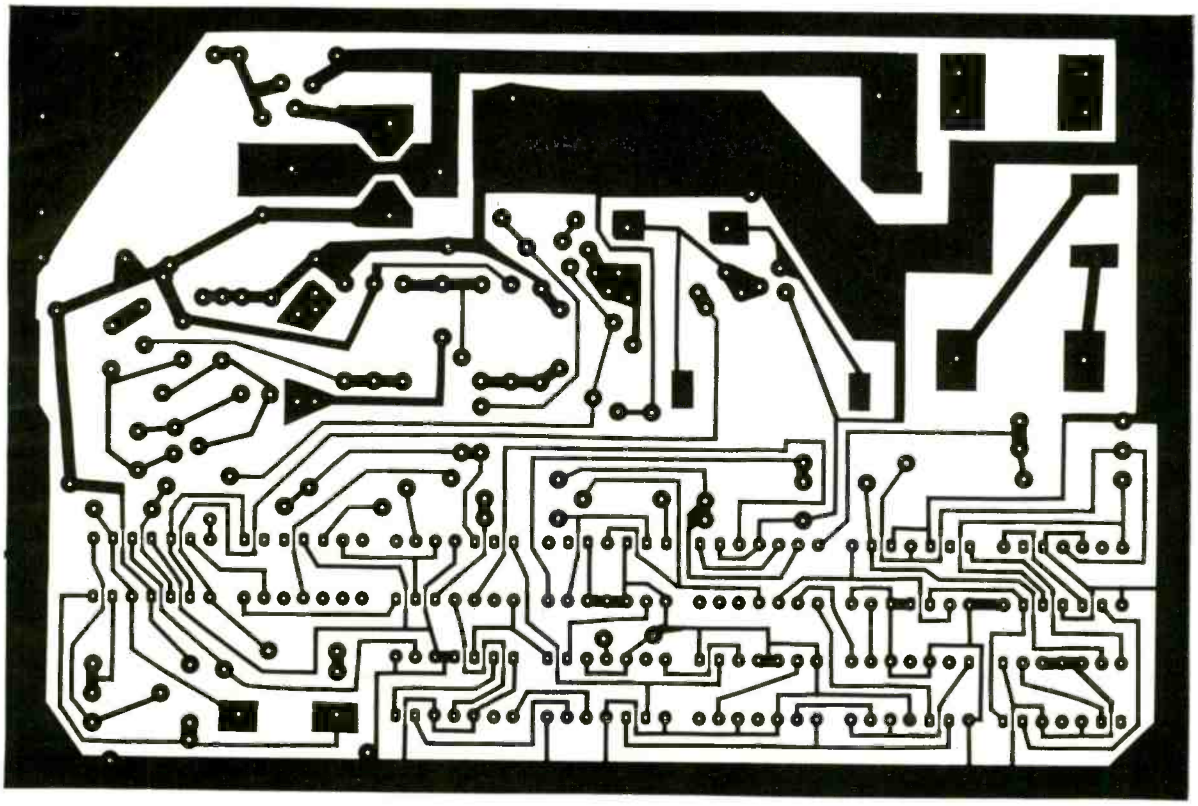
The J-K is the most versatile flip-flop available and is widely used in frequency dividers, counters and shift registers. Its symbol is in Fig. 2.

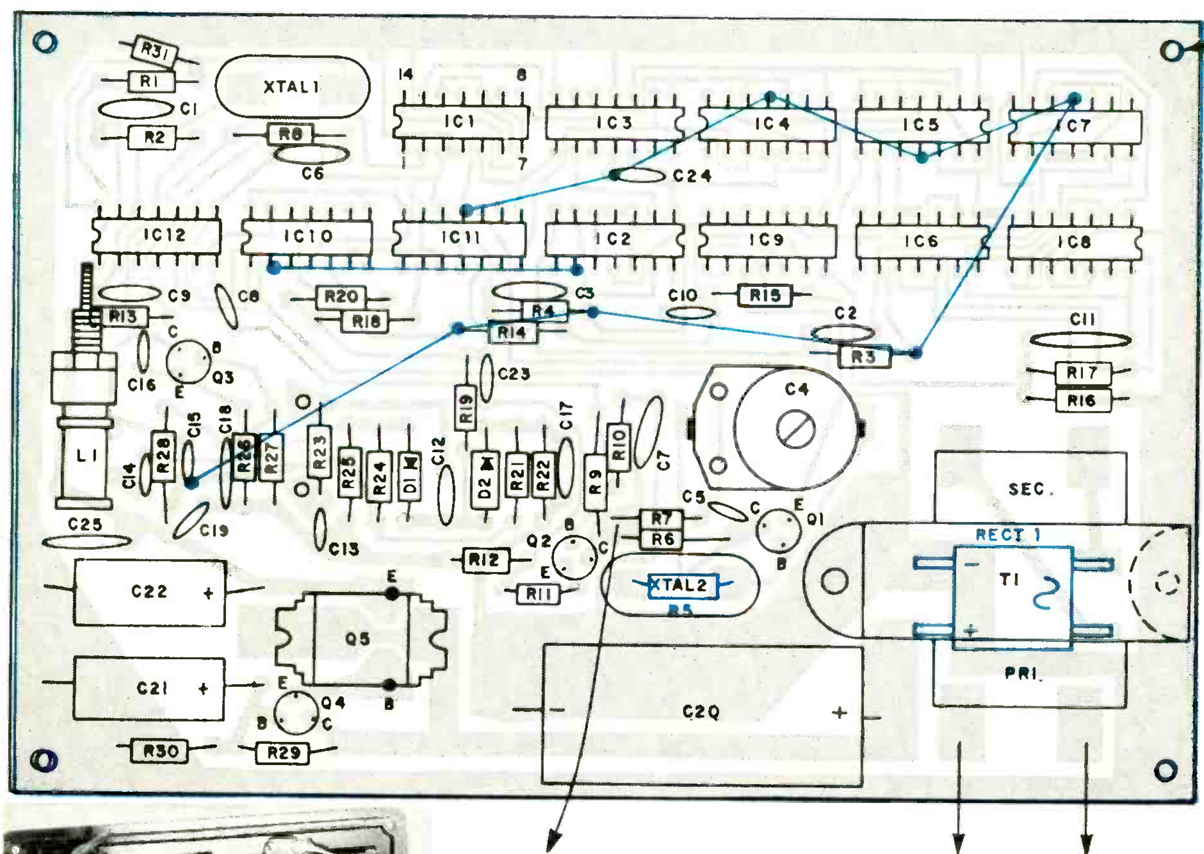
It has three inputs—J, K and C_1 (frequently referred to as S, C and T, respectively), and two outputs—Q and $\overline{Q}$ (frequently referred to as the 1 and 0 outputs, respectively).

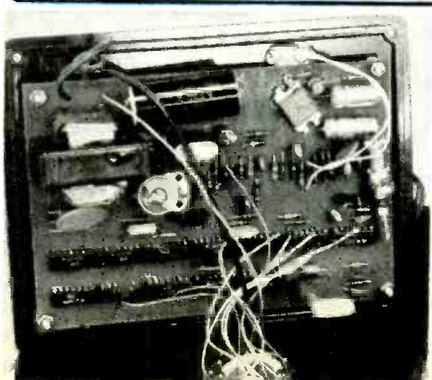
The J-K flip-flop is a clocked device; that is, the outputs change only after a negative-going signal (clock) is applied to its C_1 input. The state of the outputs after the clock pulse is determined by the state of the inputs and outputs just prior to the clock pulse.

For example, if J is 0 and K is 1 before the pulse, then Q is 0 and $\overline{Q}$ is 1 after the clock pulse has arrived. (The $\overline{Q}$ output is always opposite the Q output.)

If both the J and







Everything but the selector switch goes on this circuit board. The top diagram is the foil side of the board. The bottom diagram is the components side. Wiring and components in color are mounted on the foil side of the board. Interior of the completed unit is shown at the left.

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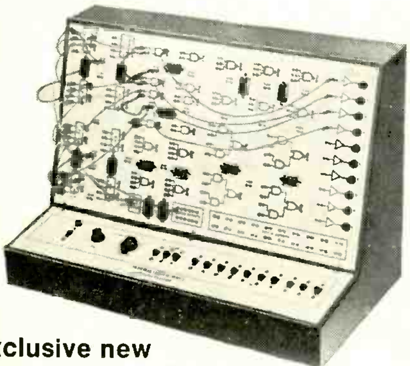

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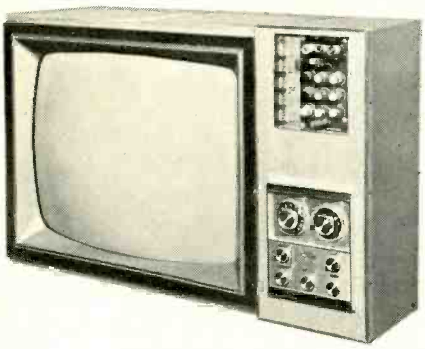

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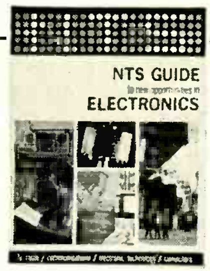

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K inputs are 0, every time a clock is applied, the outputs change (toggle). If the clock signal is a square wave, the output is a square wave of half the clock frequency, since the flip-flop can change state only just after the clock has gone from 1 to 0.

The outputs can be made to memorize their last states or prevented from changing by making both J and K HIGH.

A fourth input, the direct clear, C_d, when HIGH will force the O output to be 0 regardless of the J, K or C_1 states. It is not used in this particular circuit application.

The circuits

The various frequencies in the generator and all components are shown on the full schematic in Fig. 4.

A 189-KHz crystal-controlled square-wave generator is the heart of the divider chain. Its output is divided down to 15.75 kHz for horizontal lines and 60 Hz for vertical sync.

It's in the divider chain that the J-K flip-flop really shines. Since each divider block counts each pulse put into it (rather than ignoring most of them as unijunction dividers do), an entirely jump-proof divider results. As a result there aren't any horizontal or vertical hold controls to fiddle with in this generator—it doesn't need them.

This type of divider is also insensitive to supply voltage variations and temperature extremes. Even if a large power-line transient should get into the divider chain, it would fall back into sync within 1/60 second.

If all the flip-flops were used in their simplest divide-by-two mode, we could cascade 9 flip-flops to get a 512-line raster which might require readjusting the TV's hold controls.

To produce the desired 525-line raster, dividing blocks of 2, 3, 5 and 7 are used. The 3, 5 and 7 division is obtained by a variety of feedback arrangements.

For those of you more interested in the divider blocks, Fig. 3 shows timing diagrams for the 3 divider and for one of the two types of 5 dividers used here. Peak-to-peak amplitudes at all points in the divider chain are about 1.5 volts.

For example, in Fig. 4, the horizontal blanking pedestal is formed by taking the 15.7-KHz signal from IC2-a, differentiating it with C3 and R4, and "squaring up" the resulting waveform with IC11-b and IC11-c.

IC2-b forms the horizontal lines in such a manner that they start and end during the blanking interval.

The crosshatch pattern is generated by allowing either the horizontal *or* vertical lines to generate the video signal. IC10-a performs the OR function in the circuit.

Dots are formed by allowing a video signal to pass only at the intersection of the horizontal *and* vertical lines. IC12-e, IC10-d and the inversion inside IC2-b form the AND gate as shown in Fig. 1-d.

A 3.56-MHz oscillator generates the chroma signal. A 189-kHz gates the chroma signal on and off via R8

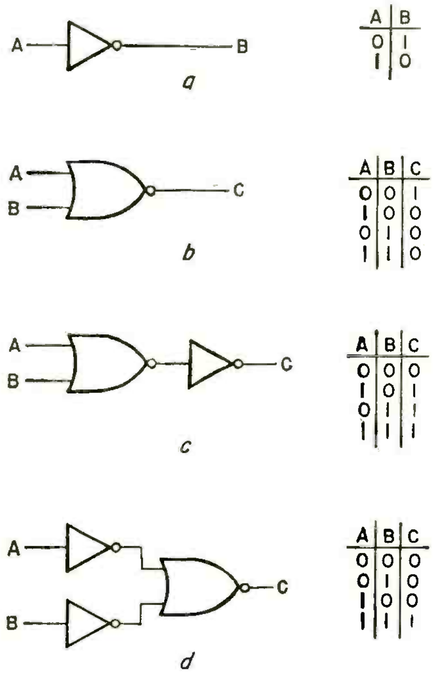


Fig. 1—Logic elements make the generator work. It uses inverters (a), NOR gates (b), AND gates (c), OR gates (d).

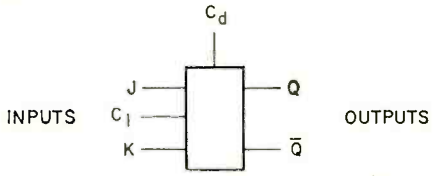


Fig. 2—Basic J-K flip-flop is a major component in the circuit of this pattern generator.

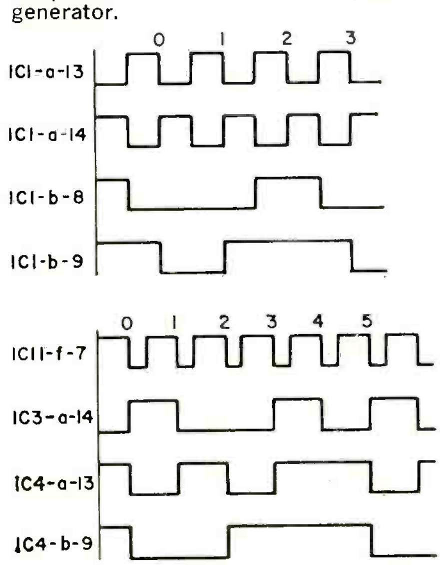


Fig. 3—For 525-line raster dividing blocks of 2, 3, 5, and 7 are used. Here are timing diagrams for 3 and 5 dividers.

and C6 to produce the 12 color bursts. (Only 10 are visible because one occurs during blanking and one occurs during the burst period.) IC12-f performs the gating and amplifies as well. C8, R9 and R10 reject the 189-kHz signal but pass the 3.56-MHz signal. Q2 is an emitter follower isolation stage.

The brightness component of the color bar signal is obtained by passing a 189-kHz square wave through S1-A-6 and IC10-b simultaneously with the chroma signal.

IC10-b serves three purposes: it inverts, it prevents modulation during the blanking period via the connection from IC11-c-3, and it brings the amplitude of the various patterns to a constant level so the contrast on the TV screen is the same for all generator patterns.

Q3, L1, C15 and associated components form a common-base rf oscillator circuit.

D1, D2, R21, R22, R24 and R25 form a modulator whose linearity is much better than that of the ordinary one-diode modulator. C14 couples rf to the modulator and R19 couples video to it. Chroma input is via C23. Modulated rf output is across R23.

How to build it

A printed circuit board is a must. Make your own from the pattern on page 45 or order one from the address given in the parts list. Drill according to the parts layout, using a pin vise manually or a hand drill.

When possible, use the specified manufacturers' parts. These were chosen for small size and low cost. C4 should be a high-quality unit to obtain maximum chroma oscillator stability. Similarly, the coil form for L1 should have a locking nut on it to prevent frequency shifting due to vibration. After winding L1, apply several coats of coil dope to secure the wire to the form.

Note that the circuit board is designed for ¼-watt resistors.

Mount the components as shown. Don't clip the leads on the soldered components until the jumpers on the foil side of the board have been added. The color overprint shows the location of the jumpers R5 and Rect. 1.

To mount the transformer, notch the PC board with a small knife and file about 1/16 inch for the width of the mounting strap. Bend one of the mounting lugs straight down, fit it into the notch, and then continue to bend it around to the foil side. Solder the lug to the foil beneath it after pretinning both the lug and foil.

The other lug is mounted with a (*continued on page 94*)

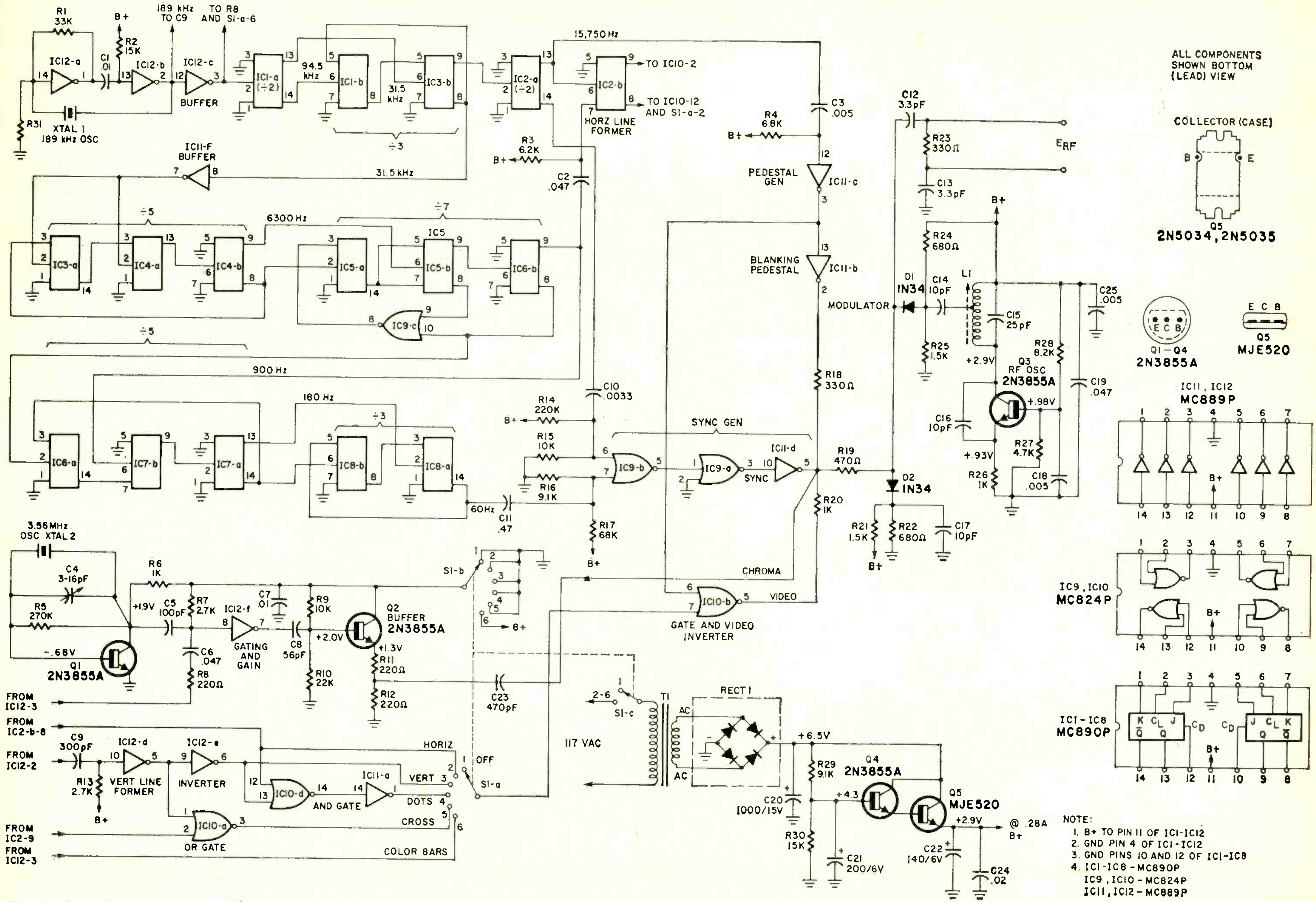


Fig. 4—Complete circuit of the IC color pattern generator. Complex as it may seem, the entire unit can be built for about $50.

GET A BETTER COLOR PICTURE

Don't let distorted pictures caused by sweep distortion spoil your viewing pleasure. Here's how to fix them—fast!

COLOR TV 1970

by **MATTHEW MANDL**
CONTRIBUTING EDITOR

ANY TROUBLES WHICH DISTURB THE waveshape of either the vertical or horizontal sweep signal cause scan distortion. Symptoms include poor vertical or horizontal linearity, severe bending at sides and scan curvature at screen edges (pincushion effects). Such defects have common origins in both color and black-and-white sets, but present greater problems in color because of convergence factors and more complex sweep circuitry.

Pincushion correction

Bending of the scan lines at the outer edges of the raster has always been a problem with large-screen tubes. In b-w sets small magnets are suspended along the tube sides (usually by extension wires or rods from the yoke). These are adjusted so their magnetic fields bend the electron beam slightly and correct the pincushioning.

In color sets three beams must be aligned properly for purity and convergence. Pincushion magnets cannot be used since they would disturb such settings. Instead, special circuits are used which sample vertical and horizontal signals and form parabolic waveforms. These are injected into the sweep system for correction of pincushion effects caused by the wide-angle sweep in large-screen tubes. Because active signals are used (instead of passive magnetic fields) this type of correction is often referred to as *dynamic pincushion correction* and may be indicated on schematics by the letters DPC.

Typical pincushioning is illustrated in Fig. 1, where a rectangular display shows edge curvature. During the initial setup procedures for a color set, pincushioning should be corrected before convergence adjustments are made. If DPC circuits become defective, convergence will also suffer, but good convergence will be restored

Fig. 1—Pincushioning is concave curvature in the raster edges. It is due to tube-screen geometry and is a fairly common trouble on large-screen TV sets.

when the DPC system is restored to its proper function.

Various types of pincushion correction circuits are used in large-screen color sets. The type depends on whether only the top and bottom of the raster need adjustment, or only the sides. If both require it, more elaborate circuitry is used. Screen size, deflection angle and scan circuitry all have a bearing on final requirements. Some sets use only transformers and RC circuits, while others use a tube for proper waveshaping.

One of the more basic types of pincushion correction is shown in Fig. 2, used in the Silvertone 528.72500 color chassis. Here, two transformers have their primaries in series with the horizontal coil leads. A horizontal sweep signal is produced in the secondaries and shaped by the phase coil and RC network. This signal is applied to the vertical deflection coils and to the vertical sweep signals obtained from the vertical output stage. The correction signals affect the rate of scan at the start and end of the sweep, and can be adjusted by the pot and phase coil for straightening the edges.

When the top and bottom pincushion adjustments are made, vertical linearity should also be checked and readjusted if necessary. Improper vertical linearity will cause a bulging of horizontal lines at the raster edge, while pincushioning will produce a concave effect, as shown in Fig. 1. A bar generator should be used to test the vertical and horizontal scans, using a cross-hatch pattern so both can be kept under observation during adjustments.

A corrector circuit using a tube is shown in Fig. 3 and is found in the Zenith 23XC36 chassis. Here, half of a 6KT8 is used for pincushion correction, with the other half as the second color amplifier. If correction fails initially, try a new 6KT8. Next check for proper grid and plate voltages as indicated on the schematic. A scope test at the plate should show a parabolic waveform having 230 volts p-p at a 60-Hz rate. Note the two isolating capacitors for the horizontal signal injection are rated at 1 kV. Check these for leakage and open and shorted conditions.

Some receivers have more elaborate pincushion correction circuitry, necessitating a more thorough check of components when circuit defects occur. In the Magnavox T920 series chassis, for instance, a dual-triode 12AX7 is used for pincushion correction signal amplification. In the Magnavox T922 color sets, a separate pincushion board is used, with the output signal from a dual-triode 6FQ7.

Other troubles may contribute to sweep distortion when linearity and pincushion adjustments fail to produce results. Shorted turns in the yoke can produce pincushioning, and sweep linearity can be disturbed by defective capacitors, resistors or thermistors within the yoke housing. Also, if a defective yoke has been replaced by one not matched properly to the sweep output system, sweep distortion will result.

Insufficient or excessive drive to the horizontal output tube is another common cause for sweep distortion, with weak tubes in the horizontal oscillator and output sections a usual contributing factor.

In a number of receivers the blue shaping coil in the convergence section is slug-tuned as shown in Fig. 4. Often this control is brought out on the convergence board, but actually *is not part of the convergence setup procedure*. Thus, when making convergence adjustments, do not tamper with this setting because it will cause horizontal sweep distortion and overload the horizontal convergence components. If adjustments are necessary, refer to the service notes for the receiver for the special procedures necessary.

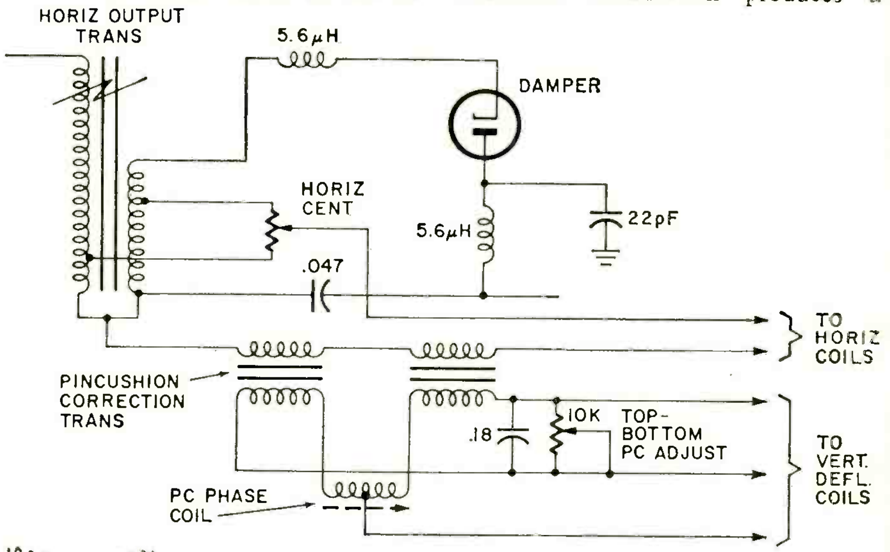
Distortion from hum

When hum enters the sweep system it will modulate the scan signal and periodically decrease and increase sweep amplitude. Consequently, the raster edge curve may depend on the amount of hum entering the system.

When 60-Hz hum enters the sweep circuitry it will produce a single change in width as shown in Fig. 5, and a dark horizontal area appears (hum bar). The usual cause is cathode–heater leakage in the rf, i.f. or video amplifier tube sections.

With a slight leakage the hum bar may hardly be visible, but a slight curvature may appear, resembling a pincushion effect. Thus, if pincushion adjustments fail to restore linearity, check tubes for cathode–heater leakage. If the leakage is prior to sound takeoff, some hum will appear in the speaker.

With a full-wave power supply, a hum signal may affect sweep due to filter capacitor troubles in the low-voltage supply, as shown in Fig. 6. Full-wave rectification produces a



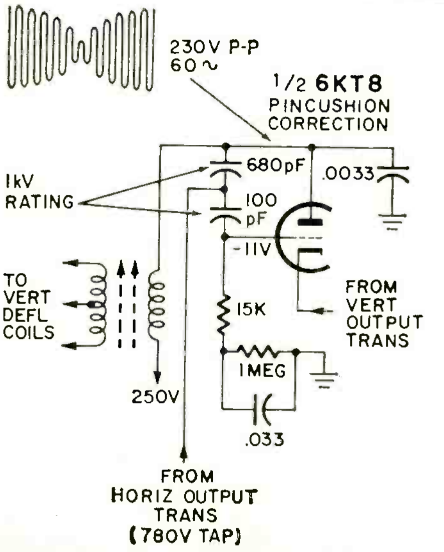
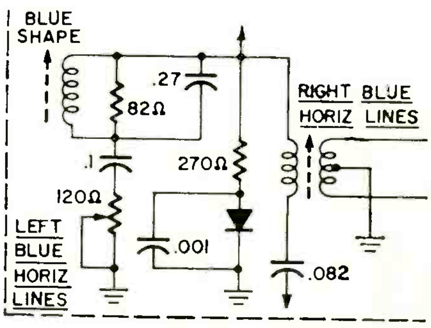


Fig. 2—Pincushioning correction circuit used in some Silvertone TV chassis.
Fig. 3—Pincushion correction (left) is provided by a triode in Zenith circuits.
Fig. 4—Avoid blue-shape control (below) when converging. It can cause distortion.



120-Hz signal which will cause two changes in width and a double hum-bar effect. Even with a slight 120-Hz interference (without noticeable hum bars) the double change in width is a clue that pincushioning troubles are not the culprit. With a 120-Hz signal affecting sweep, bending will be present with or without a picture. If the 120-Hz hum is present in the voltage to the rf or i.f. amplifiers only, the hum bars will disappear when a tube is pulled in the i.f. amplifier preceding the detector (in parallel-heater receivers).

In most color sets the low-voltage supply has separate taps and filter sections for various portions of the receiver. Thus, a defective filter capacitor in the supply section feeding the horizontal deflection circuits will cause picture pulling, but without hum bars. With the hum entering stages between the tuner and video amplifiers, however, hum bars are usually visible in addition to the double change in width.

The symptoms shown in Fig. 6 will vary with the amount of hum signal present. In one instance severe pulling was present only for the first few minutes after the set was turned on. The set was a Westinghouse V-2476-1 chassis. Hum bars were only faintly visible, indicating the trouble was in the low-voltage supply feeding the horizontal sweep system. Because of common power supply circuitry, however, some hum voltage was leaking into the video sections and producing faint bars.

The power supply circuit for this receiver is shown in Fig. 7. It uses the voltage-doubling principle, with each of the 160-μF capacitors receiving a separate rectified charge, and delivering double the voltage because they are in series across the output of the B-plus power supply in this chassis.

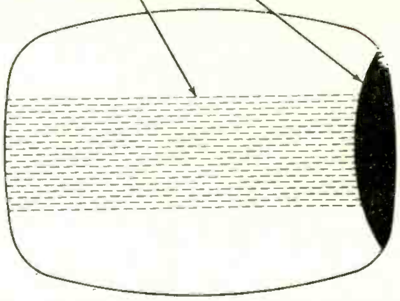


Fig. 5—Single curve at raster side is caused by stray 60-Hz signal pickup.

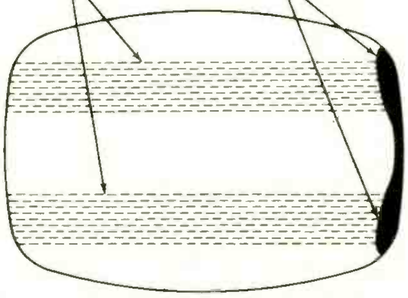


Fig. 6—Two hum bars and curves are due to 120-Hz pick up from full-wave supply.

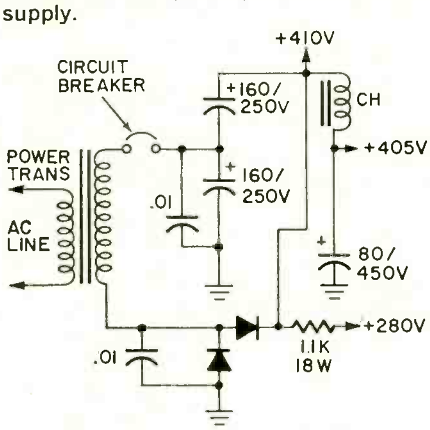


Fig. 7—A full-wave voltage doubler used in the power supply of many TV sets.

The upper 160-μF capacitor (next to the filter choke) felt warm to the touch and had a slightly scorched smell. Evidently a partial short or leakage was present when the set was first turned on and before the tube heaters permitted full conduction loading. During warmup the reduced load raised the voltage in the supply and caused the trouble in the filter capacitor. When the heaters came up to normal temperature and the loading effect was in full force, the normal operating voltage was insufficient to cause the temporary breakdown.

A replacement of the suspected capacitor cured the trouble. In this instance, however, a 300-volt capacitor was installed as an added safety feature. Since one of the two doubling capacitors became defective, the other 160-μF, 250-volt capacitor might also give trouble. Thus, this capacitor was also replaced with a 300-volt type. While these two capacitors don't have to be perfectly matched, their ratings should be fairly close to provide for an equal distribution of voltage across them. If one capacitor is too far off, the unequal voltage drops across the two may place a voltage across one that exceeds its rating, causing a short life.

Since chassis removal in a color set is time-consuming, some service technicians take the added precaution of replacing the silicon rectifiers as a matter of routine when replacing filter capacitors. Defects in the low-voltage supply often overload the rectifiers and shorten their life. Thus, while their replacement adds to the service bill, it reduces the chances of a callback and may save the customer an additional service charge in the near future. **R-E**

TOOLS FOR ELECTRONICS

by TOM HASKETT

This issue, starting on the facing page, is the fifth part of our new series of articles on tools for electronics. It starts our description of wrenches. Next month we will continue the series with the next section of the article on wrenches and how to use them. 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.

ALL ABOUT WRENCHES

The tool used to turn a hexagonal or square bolthead or nut is called a **wrench.** There are many kinds of wrenches, for several good reasons. A wide variety of different sizes are needed to work the numerous sizes of nuts and bolts. Then too, some types of wrenches are most effective where you've got lots of work space. Others are needed in tight quarters.

Some wrenches are faster and easier to use than others, but cost more. Usually, it's how much you're going to use a wrench that determines how much you spend on it. You buy a simple and inexpensive wrench if you don't plan to have much use for it. But if you'll be turning a lot of nuts and bolts, it will be worth your while to invest in more specialized and higher quality wrenches.

Since you can work nutdrivers much faster than most right-angle wrenches, you might wonder why you need wrenches at all. Sometimes you have to work a nut or bolt in such tight quarters that a nutdriver can't be used. And nutdrivers are made to handle nuts only up to about ¾". For larger nuts and bolts, you must use right-angle wrenches.

Basically, there are two types of wrenches. One kind has **fixed jaws.** These will turn only one specific size bolt or nut. The other kind of wrench has **one fixed** and **one adjustable** jaw, and will accommodate several sizes of bolts and nuts. Within the category of fixed-jaw wrenches, there are several types.

The open-end wrench

Typical **open-end, double-head wrenches** are shown in Fig. 1. (Single-head versions are made, but aren't as useful as the double-

Fig. 1—The usual open-end wrench is double-ended, has parallel jaws, and each head is set at a 15-degree angle with respect to the plane of the handle. Craftsman model 4455, six-piece open end wrench set is shown

with angles of 22½°, 30°, 45°, 60°, 75°, 80°, and 90°. Other models are made with thin **heads**, to work in close quarters.

The box wrench

This wrench is so named because the working end completely surrounds or **boxes** the bolthead or nut, as you can see in Fig. 3. In most

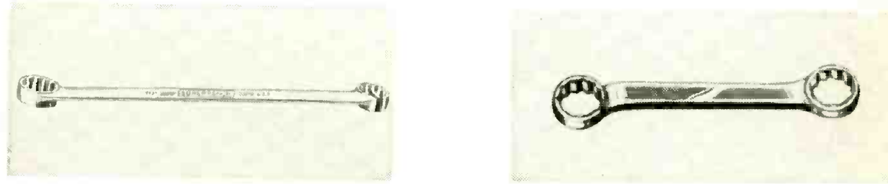


Fig. 3—Box wrenches have two completely enclosed ends. Heads usually have 12 points, though some have only 6. Left is Williams 7727. Right is Husky H-6723.

standard-size box wrenches, (which are double-head types) the head contains 12 **points,** or notches, arranged in a circle. Since a hex nut has only 6 points, a 12-point wrench head lets you take as little as 1/12 of a turn (30° arc) if necessary in close quarters. Some small box wrenches, however, have only 6 points which restricts the minimum arc to 60°.

The box wrench is a safer tool than the open-end wrench, since it won't slip off the work.

While box wrenches are occasionally made with straight heads and handles, most have **offset heads** which are convenient for working nuts in tight quarters. In Fig. 3 you see a box wrench with 15° offset heads. In Fig. 4 you see the type with 45° offset heads. In this double-

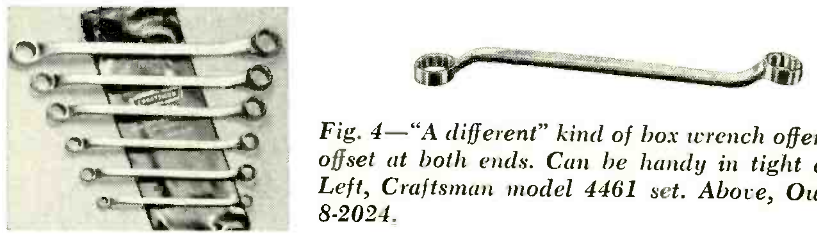


Fig. 4—"A different" kind of box wrench offers a 45° offset at both ends. Can be handy in tight corners. Left, Craftsman model 4461 set. Above, Owatonna 8-2024.

offset type, the heads are parallel to the handle, but not in line with it. The handle is bent up to each head. A few wrenches are made with 10° offset heads.

head type unless you're on a production line and have to handle only one size bolt all day.) The jaws are parallel, and each head is set at a 15° angle with respect to the plane of the handle. This angle gives more torque than a straight head would, and gives you an advantage in working the wrench in close quarters.

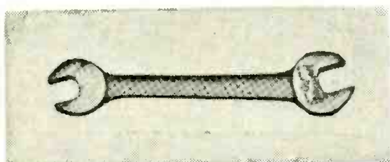
An open-end wrench size is identified by the two fractions, which denote the width, in inches, between each set of its jaws. If the wrench in Fig. 1 has a 5/16″ head at one end, and a ⅜″ at the other; it's known as a **5/16 x ⅜ wrench.** These sizes are stamped on the sides of the wrench. The jaw widths are actually from 0.005″ to 0.015″ larger than the nominal size, so the wrench will easily slip on to boltheads or nuts of that size. Wrenches of this type are generally available with jaws from ¼″ to about 1⅝″, in steps of 1/16″, 1/32″, or 1/64″.

Overall wrench length is determined by jaw size. A ¼″ x 5/16″ wrench is generally 4″ long, a ⅝″ x ¾″ wrench about 7⅞″ long, and so on. You need more leverage to turn larger nuts, and the longer handle gives you that greater leverage.

European-made equipment uses nuts and bolts measured in millimeters. At least five companies (Armstrong, Crescent, Proto, Upland, and Williams) make **metric-size open-end wrenches,** covering generally the range from 8 to 18 millimeters or so.

Probably more useful for chassis work are **miniature** open-end wrenches. Two typical versions—the **double-head** and **handle-and-blade sets** are in Fig. 2. The type at (a) is generally available with jaw widths from 13/16″ to 15/32″, and that at (b) from 5″64″ to 5″32″.

There are several variations to the standard open-end wrenches shown in Figs. 1 and 2. Models are available with straight heads, and



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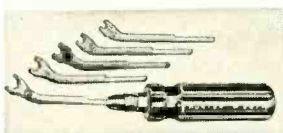


b

Fig. 2—Miniature open-end wrenches are used for chassis work. Both double-head and handle-and-blade types are available. At far left is Moody model OE-5. Top right is Armstrong H-8. Bottom right is Hunter 24T.

Sometimes you have to work a nut around a corner. For such jobs, the **obstruction** box wrench is a handy device, as shown in Fig. 5. Each

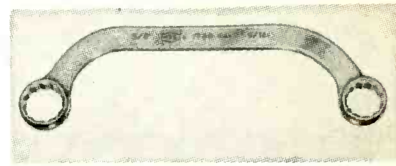


Fig. 5—Obstruction box wrenches are used when you have to work a nut around a corner. Shape somethimes gets them the "half-moon" label. Left, Proto 9501-3. Right, P&C 1730.

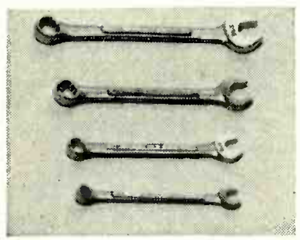
head is offset and the two are 1/16″ different in size. The wrench is sometimes called a **half-moon.**

Box wrenches are generally available in the same sizes as open-end types. As mentioned before, there are two heads; one is usually 1/16″ larger than the other. Sizes generally range from ⅜″ to 1-11/16″, and from 3/16″ to 11/32″ for miniature types. As with open-end wrenches, handle length increases with jaw size, for greater torque. You can also get wrenches with shorter or longer handles. And thin-head wrenches are also made.

Combination open-end and box wrench

The advantage of the box wrench is that it doesn't slip off a nut, and is therefore safe for loosening a tight nut. But the box wrench is slow when running a nut off the bolt, since you have to pull it up and reseat it each time you take a swing. It's faster to use an open-end wrench to run a nut out.

The obvious compromise is the **combination wrench** shown in Fig. 6, which has a box at one end and an open end at the other. Both heads



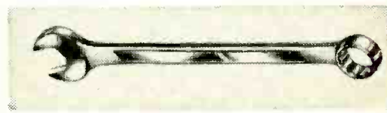


Fig. 6—Combination wrench has an open-end and a box end. Both are the same size. The open end is set at 15° and the box end is offset 15°. Wrenches at left are Craftsman. Above, Husky model CC-12.

are the same size. The open end is set at a 15° angle, and the box is offset at a 15° angle.

Ratchet box wrench

Someone once observed the wasted effort needed to remove a wrench and reseat it when turning a nut in a tight space. The result was the **ratchet wrench**; a typical version is shown in Fig. 7. It has two

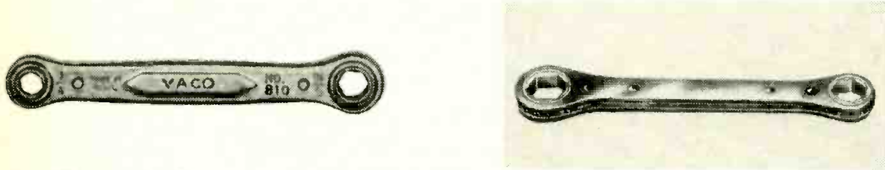


Fig. 7—Rachet box wrench eliminates the need to remove a wrench and reseat it when turning a nut in a tight space. Left is the Vaco No. 810. Right is Owatonna model RB-810.

12-point heads, one ⅛″ larger than the other. Jaw sizes range from ¼″ to ⅞″. The wrench turns the nut in one direction, but slips back for another bite in the other, an action called **ratcheting.** The ratchet wrench is not usually reversible; you have to remove it and turn it over to reverse direction. But this is no problem, since you are either putting a nut on or taking it off, not both at the same time.

Socket wrench

The nutdriver, a handy little tool, is just one type of socket wrench. Another type is shown in Fig. 8. The **socket** is boxlike and

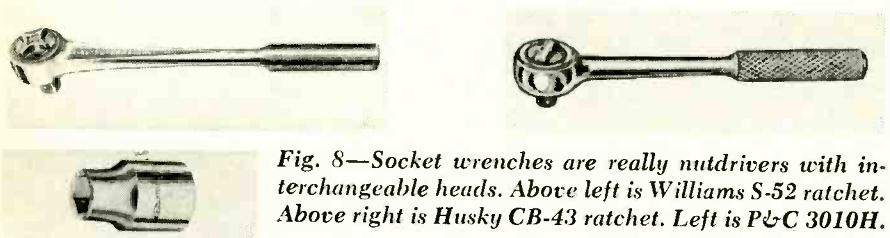


Fig. 8—Socket wrenches are really nutdrivers with interchangeable heads. Above left is Williams S-52 ratchet. Above right is Husky CB-43 ratchet. Left is P&C 3010H.

detachable, and the **handle** usually has a reversible ratchet mechanism. The socket is locked onto the handle by means of a square shaft on the handle and a square recess on the socket. A spring-loaded ball or the male end fits a matching hole inside the well on the socket. The socket wrench is the fastest type of wrench to use, since the ratchet handle permits the socket to remain on the nut or bolt, and you don't have to remove the handle for turning.

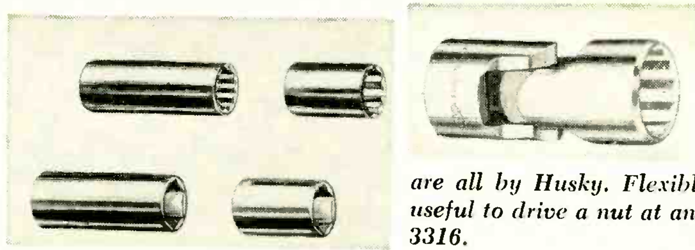


Fig. 10—Sockets come in all styles. Long on far left; short in the center are all by Husky. Flexible socket above is useful to drive a nut at an angle. It's a P&C 3316.

Handle types

There are quite a few types of handles with which to drive sockets. The standard handle in Fig. 8 comes in round, flat, and long versions. Some have rubber grips for comfort. The **flexible hinge** (Fig. 11) is

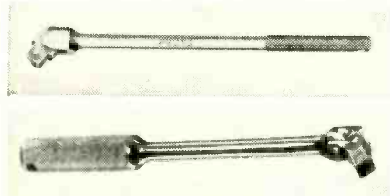


Fig. 11—Socket wrench drive handles come in several types. These are the most common ones. Top is Proto 9501-1. Bottom is Owatonna H-275.

useful for angle work. More efficient is the **ratcheting flexible hinge** (Fig. 12). The **sliding T** (Fig. 13) is useful where much torque is needed,

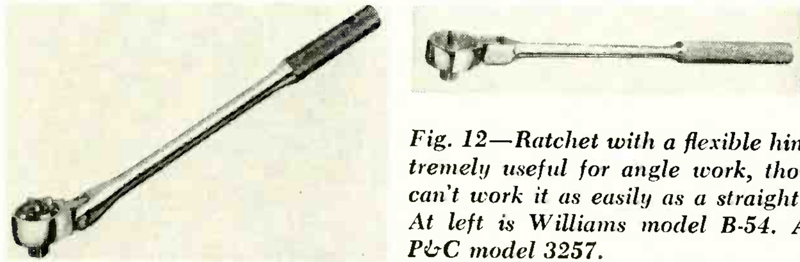


Fig. 12—Ratchet with a flexible hinge is extremely useful for angle work, though you can't work it as easily as a straight ratchet. At left is Williams model B-54. Above is P&C model 3257.

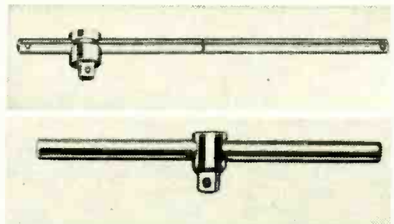


Fig. 13—Sliding-T drive is a great torque amplifier. You can work it with both hands. Top is Proto model 5285. Bottom is Husky CS-70.

as you can work it with both hands. Since the crossbar slides, you can work it from side to side to turn a nut in close quarters. The **speeder**

Socket types

There are several sizes and kinds of sockets. The mating device is called a **drive shaft,** and its size depends somewhat on the socket and nut size. That is, a socket having a larger drive shaft is used for larger nuts, for more strength. There are generally five series, covering sizes as follows:

Series	Drive-shaft size	Socket-size range
Miniature	1/4"	3/16" to 9/16"
Light duty	3/8"	1/4" to 7/8"
Standard	1/2"	5/16" to 1 1/4"
Heavy duty	3/4"	7/8" to 2 1/4"
Extra-heavy duty	1"	1 1/16" to 3 1/8"

Metric sizes are also available.

Some sockets are made to handle square nuts, others hexagonal. The four socket types generally available are shown in Fig. 9. The

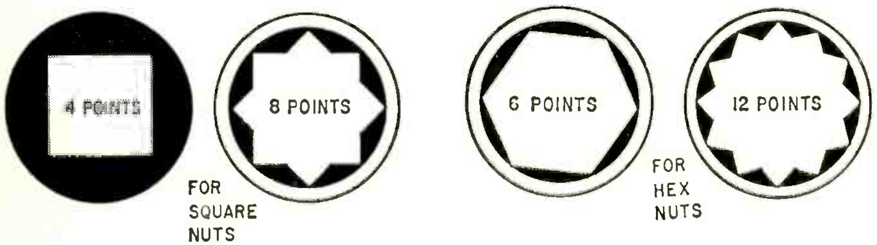


Fig. 9—Typical socket types. Four- and eight-point for square nuts. Six- and twelve-point for hex nuts.

4- and **8-point** sockets are made for square nuts, while the **6**- and **12-point** sockets are made for hexagonals. Generally, smaller sockets are available in all four styles, while larger ones are made only in the 12-point style. The 8- and 12-point sockets are more efficient than the other two, since you get more bites per degrees of handle swing, on a nut in tight quarters.

Fig. 10 compares the standard-length socket with the other types generally available. The **deep** style is useful for working nuts far down over protruding bolt ends. The **flexible** socket is used for working nuts at an angle.

(Fig. 14) as its name suggests, speeds up the work, because you hold

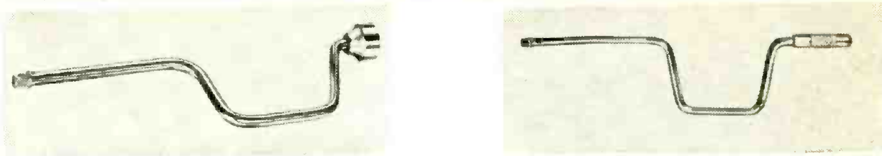


***Fig. 14**—Speeder is a crank to speed-up the work. Looks and operates very much like a carpenter's brace and bit. At the left is the **Owatonna H-283**. At the right is **Husky CB-85**.*

the top with one hand and work the middle rapidly in a circle with the other—like a carpenter's brace and bit.

The **spinner** or **screwdriver handle** (Fig. 15) works just like a nut-driver. Stubby models are also available. And Stevens Walden has a

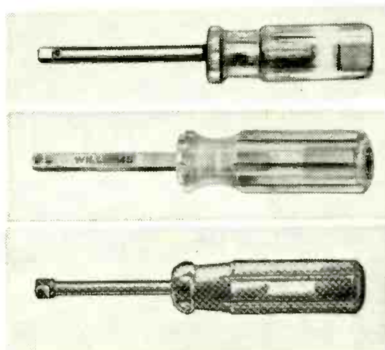
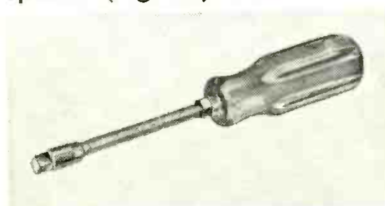


***Fig. 15**—Spinner screwdriver handle works just like a nutdriver with replaceable tips. Top is **Husky CM-64**. Center, **Williams M-106**. Bottom is **Armstrong model NM-106**.*

ratchet driver shaped like a screwdriver (type 4056). The **flexible spinner** (Fig. 16) has a shaft made of coiled spring steel, and will work



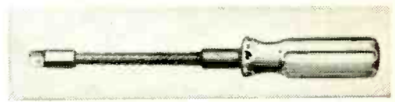


***Fig. 16**—Flexible spring shaft drivers almost work around corners. Top left unit is **Proto model 4764**. Above is **Husky model CM-38**.*

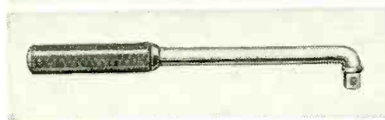


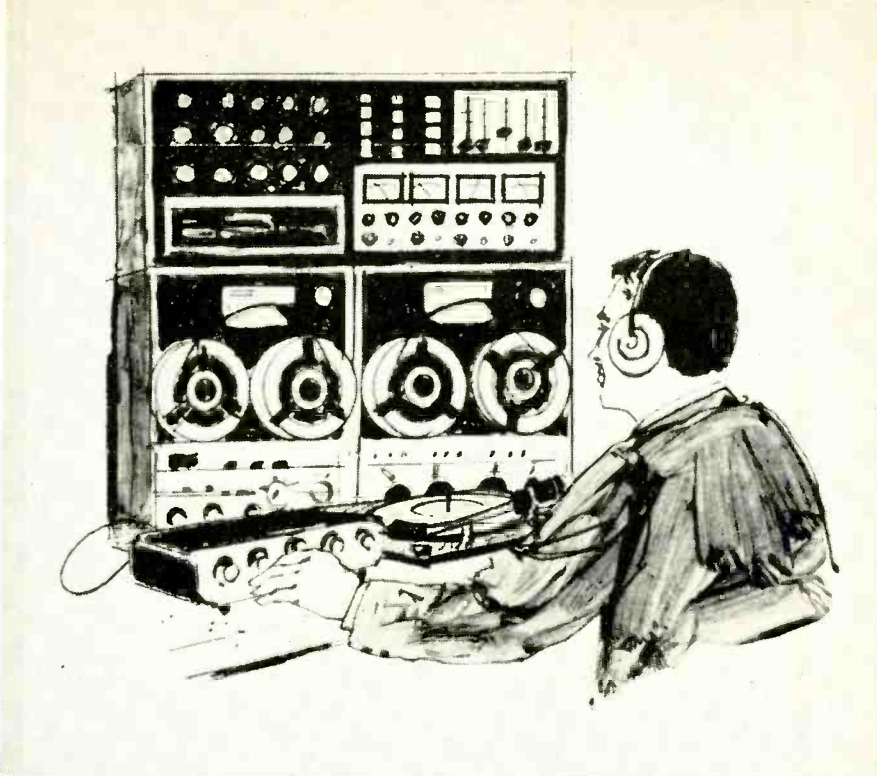
***Fig. 17**—L-handle or offset socket handles are used wherever you have to work around a corner. Here is the **Williams model B-30**.*

nuts at odd angles. The **L** or **offset** handle (Fig. 17) is used where you have to work around a corner or in tight spaces.

by **CLYDE SCHULTZ***

TAPE RECORDERS ARE FOR FUN, BOTH for the recordist and his audience. With small recorders or large, mono or stereo, one way to get more enjoyment from your recorder is to add a relatively inexpensive accessory—a microphone mixer.

With a mixer you can apply to your own recording all the tricks used by the pros. You can record sound-on-sound, fade voice and music, record voice over music, or mix program sources from several locations. At a party you can record conversations from several "candid" microphones, or record sing-alongs with enough mikes to get everyone into the action. With the family, record the kids singing along with their favorite records. Even have fun alone "disc-jockeying" your favorite records on tape.



MIXING SOUND FOR FUN

Increase the versatility of your tape recorder by adding a microphone mixer

Passive & resistive mixers

The basic operation of a mixer isn't at all difficult—in fact, you can make a simple mixer by taking a junction box and mounting three jacks on it. Wiring these jacks in such a way that two input jacks are connected in parallel to a common output jack gives us a simple passive mixer that does not amplify the input signal.

"But," you ask, "If mixers are so simple, why do they get so expensive?" The easiest way to answer this question is to take the simple mixer we have just "built" and see what it would take to turn it into a professional instrument.

The first change is to add a potentiometer to control input levels and provide a pleasing balance of sound at the mixer output. Without these controls one of the input signals could drown out the other.

With this addition, our homemade mixer would have the features of the least expensive mixer on the market, the resistive type (Fig. 1). These small resistive mixers mix inputs from two high-impedance sources to provide a monaural output. They use no power, they're portable and easy to use.

The simplicity of the resistive-type mixer makes it great for those impromptu recording sessions with the kids. Just plug the mixer into your tape recorder, connect two mikes to the mixer inputs, and you're ready to record. One microphone can be placed in front of a music source, such as a radio or phono, while your child uses the other to sing along. By using the monitor output on your tape recorder, you can get grandpa and grandchild on tape with a fair share of the volume for each.

*Switchcraft Inc.

The versatility of this type of mixer would make it a recordist's delight if it were not for two minor drawbacks. One is the fact that with resistance mixers, the voltage level of the output is always lower than the level of the input. The other drawback will cause a problem only if you have a stereo recorder: these small mixers have a monaural output. To solve these problems let's go back to our homemade mixer.

For stereo capability we have to add another output to give us left and right output channels. Then, to provide a mixing capability, we must add two more inputs, connecting them to the new output in the same way the previous connections were made. Add a switch to direct the two sets of inputs to one of the outputs for mono operation when we want it, and we have what corresponds to the next price level in mixers, a passive stereo/

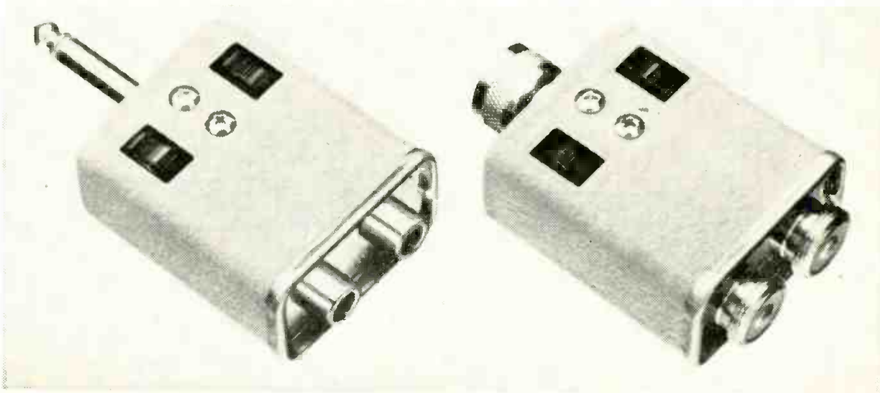
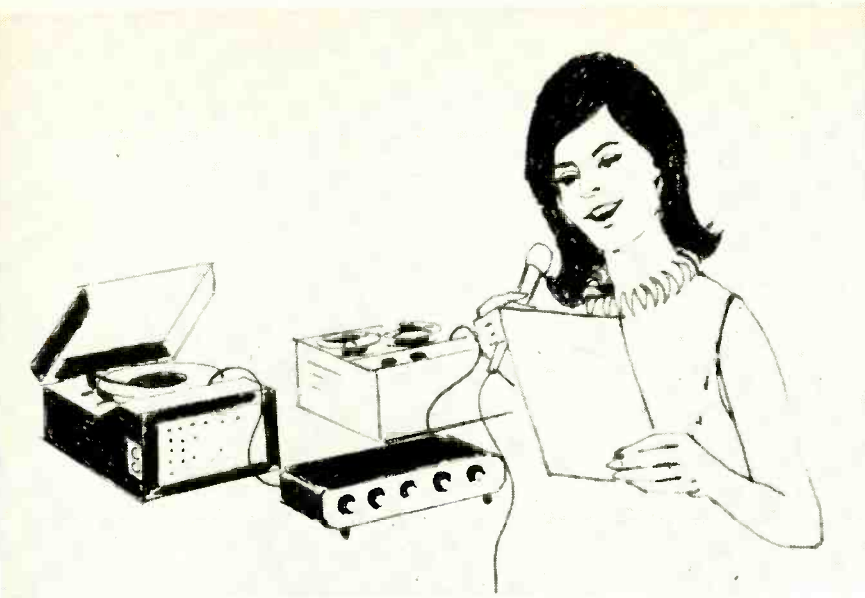


Fig. 1—Low-cost resistive mixers combine two inputs for a monaural output.



mono mixer arrangement.

A stereo/monaural passive mixer can provide for four or more high-impedance sources. Again, because it is passive, no power supply is needed. This type might mix four different sound sources, two on each stereo channel, or all four on one monaural channel. With it you can mix music, voice or other sources and control the level of each channel with an individual volume control.

This type of mixer is useful for recording group sessions. At a party you can position one mike for a music source and still have three left for the "chorus." Adjusting the volume can be done through the monitor output of the tape recorder. However, when using a mixer of this type you'll have to increase the recording level. This brings us to our second problem, losses.

Losses involved with a passive mixer can be due to a number of factors. First, the passive mixer uses simple resistive circuits to mix the incoming signal. This results in a voltage drop across the mixer and a subsequent drop in the input signal level. Another factor is the connecting cable between mixer and input source. Generally, longer connecting cables cause a greater signal loss.

Adding an amplifier

To solve these problems, we can add a transistorized amplifier circuit to the mixer. This changes the "passive" designation of our mixer to "active," and boosts the input signal. The amount of amplification depends on what you plan to use the mixer for. You can provide enough amplification to compensate for losses and possibly provide a slight gain, or build in enough gain so the unit could be used as a preamplifier for low-level inputs.

Mixer amplifiers solve the problems inherent to passive mixers. They have no loss (in fact, some provide considerable gain) and, by separating outputs, can be used to feed two separate signals into both the right and left stereo channels of any amplifier or recorder (Fig. 2).

With this type of instrument you can match most of the tricks used by professionals and come up with some top-rate home recordings. For example, you can "stereoize" old mono records by taking your phono output and running it to two filters, one bass and one treble, then running the leads to the mixer. The mixer then provides preamplification and balance control for the stereo tape.

However, in using a phono with the mixer, you're liable to encounter the need for another feature some mixers have, some don't—phono equalization. This is a built-in circuit that compensates for the special recording characteristics used in most modern recordings; equalization will also balance the special response characteristics of magnetic phono cartridges.

Another factor that can affect an "active" mixer's usefulness is its power supply. If portability is important, the best bet is a battery-operated mixer. On the other hand, if the mixer will always be used where commercial power is available, a "plug-in" type is preferable. The choice depends solely on mixer use.

A useful mixer feature is a master gain control—a volume control wired so you can vary the overall output of the mixer without touching individual gain controls. This control lets you do program fades easily, without adjusting several knobs.

Another feature available in some models is automatic impedance matching to match the impedance of your inputs (mikes, phonos, etc.) to the input on your tape recorder. Without built-in impedance matching you'd have to buy a separate transformer to match each of your sources to your tape recorder. Fig. 3 shows a mixer that has all these features for the serious recordist.

Mixers can be especially useful for recording sounds that can't be taped at home. For example, a friend recently discovered an old player piano in an abandoned garage. After getting the piano working, he found that by some wild chance the acoustics of the garage were perfect for the piano. He decided to make a recording of the piano right in the garage, using several mikes in different sections of the "auditorium." Because he used professional-quality equipment to make the recording, he now has a top-notch rendering of the music produced in this somewhat unique set of circumstances. **R-E**

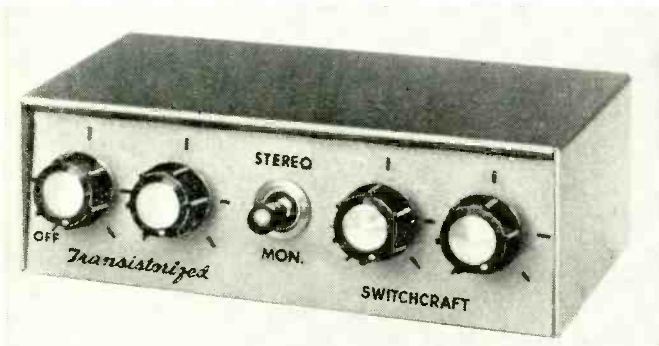


Fig. 2—Stereo mixer with solid-state amplifier eliminates loss problem, and can blend signals for left and right channels.

Fig. 3—Master gain control on this model lets you vary overall gain of outputs. Mixer also has automatic impedance matching.

Shunt High-Voltage Regulator

with hold-down safety circuit

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
	Raster narrow, out of focus	key-point-B grid-pin-5	No help	R2 R3 R4
	Raster very narrow, dark, out of focus	cathode-pin-1	No help	R3, R4 R5, R7
	Out of focus, width only slightly narrow	grid-pin-5 (turn R6)	No help	R4 C2
	Raster dark, out of focus, width only slightly narrow	grid-pin-5 key-point-B	No help	R5

Use this guide to help you find which key voltage or waveform to check first.
Study the screen and watch voltages as you turn the HV ADJ control.
Most helpful clues are at the points indicated.

Make voltage checks as indicated for screen symptoms.
Use Voltage Guide to analyze results.
For quick check, test or substitute parts shown as most likely cause.

THE CIRCUITS

THE SIMPLE SHUNT STAGE WAS ONCE THE ONLY TYPE used to regulate high voltage in color receivers, and still appears in some new models. Nowadays, a hold-down circuit is added to most chassis that have shunt regulators.

The triode tube, connected across the line from the high-voltage rectifier cathode to the color-CRT second anode, is a variable load. The CRT beams offer more or less load, depending on brightness content of the picture. The regulator tube draws more current when the CRT load is light (picture dark) and less when the CRT load is heavier (picture bright). That keeps current constant through the high-voltage rectifier, limiting any high voltage ups and downs.

Think of this system as three separate circuits. One is the regulator stage. It consists of the tube, R4, R5, R6, C2, and R7. The dashed lines show how it would be wired without the hold-down circuit.

The second is the protective biasing circuit for the horizontal output stage. It comprises C1, D1, R2, and R1. Finally, there is the hold-down safety circuit that consists of R3 and D2.

These three circuits do interact, but they're easier to understand separately.

SIGNAL BEHAVIOR

The only signal involved is WF1, the flyback pulse fed by C1 to bias diode D1. It's a positive-going pulse of short duration. But, ac-coupled to the diode, it can be considered a long-duration, negative-going pulse, too. It is rectified easily into 130 volts of negative dc.

Capacitor C2 shunts away any horizontal-pulse "hash" that might get to the regulator grid from the boost B-plus line.

DC DISTRIBUTION

Stage operation is mainly dc. The current load that regulates high voltage flows through D2, R7, and the tube (cathode to plate). Regulator current is controlled by bias between grid-pin-5 and cathode-pin-1.

During normal operation, D2 conducts and makes a direct connection to the B-plus source. The 350 volts goes to cathode-pin-1 through R7.

Voltage at grid-pin-5 is from divider R4–R5-R6, which is connected from boost B-plus to ground. Resistor R6 determines total resistance from grid to ground and sets the bias point. By affecting regulator conduction, R6 adjusts the high voltage value. Notice that true bias—usually 10 to 15 volts—is the difference between the two

DC VOLTAGES AS GUIDES

voltage change	to zero	very low	low	slightly low	slightly high	high
Crt second anode Normal 20 kV Is developed for high-energy flyback pulses in hv rectifier; value depends on total current drawn through hv rectifier		R2 low R3 open R4 low R5 high R7 open	R2 low R4 open R4 slightly low R5 slightly high C2 leaky	R4 very low		D2 open
Cathode-pin-1 Normal 350 V Source is B-plus, thus is steady; usually taken from vertical output/centering circuit		R4 high	R2 low R3 open R4 high R5 low R7 open			
Grid-pin-5 Normal 335 V Comes from boosted B-plus, thus varies with loading in horizontal output stage; R6 alters voltage, too.		R4 high	R2 low R3 open R5 low R7 open	R3 high		
Key-point-A Normal —45 V Is net of voltage from grid-leak action in horizontal output stage and voltage fed from bias and hold-down circuits			R3 low, shorted R5 open		R2 slightly low	R2 low R3 open, high R4 high R7 open
Key-point-B Normal —43 V Is net of voltages from bias and hold-down circuits; is also influenced slightly by grid-leak bias from horizontal output stage	R2 high[1] R3 low[1] C1 leaky[1], open[1] D1 leaky, open[1]	R2 high R3 low R5 high, open C1 slightly leaky,	R2 slightly high R4 low R5 slightly high C2 leaky		R5 low D2 open	R2 low R4 high R7 open
Key-point-C Normal —130 V Is developed by D1, rectifying flyback sample pulse fed in by C1	C1 open D1 open[1], short	R2 low R5 high, open C1 leaky D1 leaky	R2 low R3 open, low R4 low R5 high R7 open C1 leaky D1 leaky	C2 leaky	R2 high R5 low D2 open	

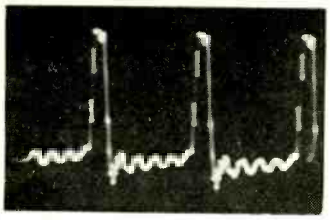
[1]Zero or positive

Use this guide to help you pinpoint the faulty part.
Measure the six key voltages with a vtvm.
For each, move across to the column that describes the change you find.
Notice which parts the chart says might cause that change.

Finally, notice which parts are repeated in whatever combination of voltage changes you find.

Test those parts individually for the defect described.
For more guides to narrow down the faulty part, see Screen Symptoms Guide.

WAVEFORMS AS GUIDES



WF1 Normal 75V p-p

Taken at anode of D1, at junction with R2. Comes from same flyback source, usually, as agc keying and horizontal-afc sampling pulse. Amplitude differs widely from chassis to chassis; dictates different values for C1 and R2, and for the −130 volts at key-point-C. Is little help in spotting trouble in regulator or hold-down circuits—note how few guides in chart below.

V p-p low	V p-p high	V p-p Zero	No significant shape changes, except as caused outside regulator/bias/hold-down stage
R2 low	C1 leaky	C1 open D1 shorted	

Use this guide to help pin down fault possibilities, although the Voltages Guide *is much more helpful.*
Use direct probe of the scope. If amplitude or shape is wrong, check source of pulse as well as parts listed in chart above.
Scope sweep should be set at H or at about 5 kHz.

voltages on cathode-pin-1 and grid-pin-5.

Meanwhile, bias for the receiver's horizontal output stage is developed by D1 rectifying the pulse fed to it. A strong negative voltage appears at the anode of D1. This negative dc is led toward the horizontal output grid by R2.

Before it gets there, however, it meets a positive dc brought from the regulator cathode circuit by R3. The difference between the positive and negative voltages is the net dc fed to the output stage by R1. The output stage develops grid-leak bias of its own, but the normal 45-volt bias (key-point-A) is influenced by the net voltage from the bias and hold-down circuits.

Hold-down is not tricky to understand. If the regulator fails, which might let high voltage rise to an unsafe level, current through the tube and R1 virtually quits. The anode of D2 becomes much less positive because the diode no longer conducts. At key-point-B, with less positive voltage coming through R3, negative voltage from D1 dominates. The voltage fed to the output grid by R1 becomes more negative and horizontal sweep output is reduced. Less flyback energy in the high-voltage rectifier means less dc high voltage.

This hold-down circuit is so effective, it keeps high voltage from rising more than 2 or 3 kV above normal. All circuit faults, with the exception of an open D2, cause *reduced* high voltage.

SIGNAL AND CONTROL EFFECTS

Station signal strength has no effect on voltages in this stage. You may see small voltage changes between bright and dark scenes, brought about by the changing CRT beam current.

Varying R6 alters the voltage at grid-pin-5 and raises or lowers the high voltage. At full resistance, voltage at grid-pin-5 may be as high as 340 volts; at low resistance, grid-pin-5 may have only 325 volts. High voltage, which is nominally 20 kV in this set, can be varied between 18 and 23 kV by R6.

QUICK TROUBLESHOOTING

A quick check of WF1 with an oscilloscope establishes whether it is okay. If not, the trouble is C1, D1, or R1—or it's elsewhere in the set.

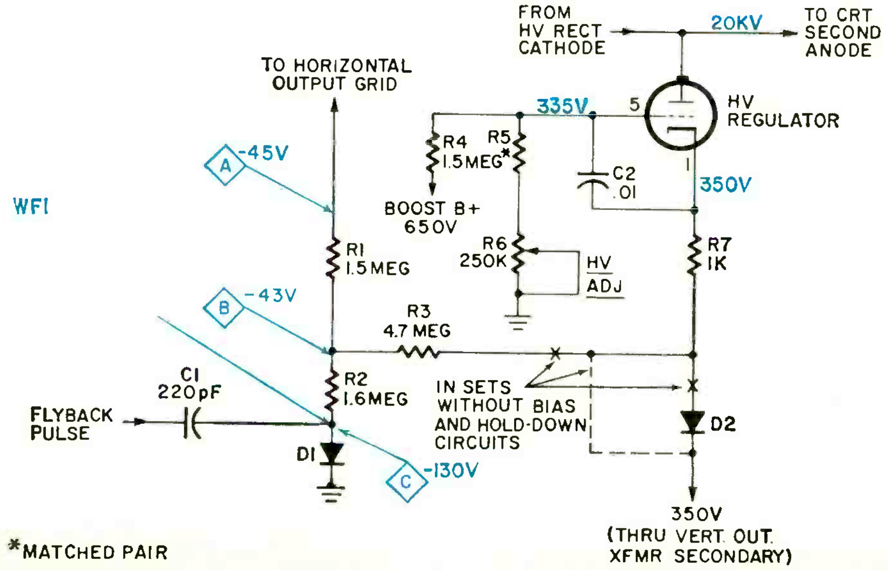
Then, with a dc voltmeter, test the regulator. Measure boost B-plus, then the regular B-plus applied to the D2 cathode. Clip the voltmeter to grid-pin-5 and twist the high-voltage adjust control up and down. It should vary the voltage at least 10 volts. If not, R6 or C2 is probably bad.

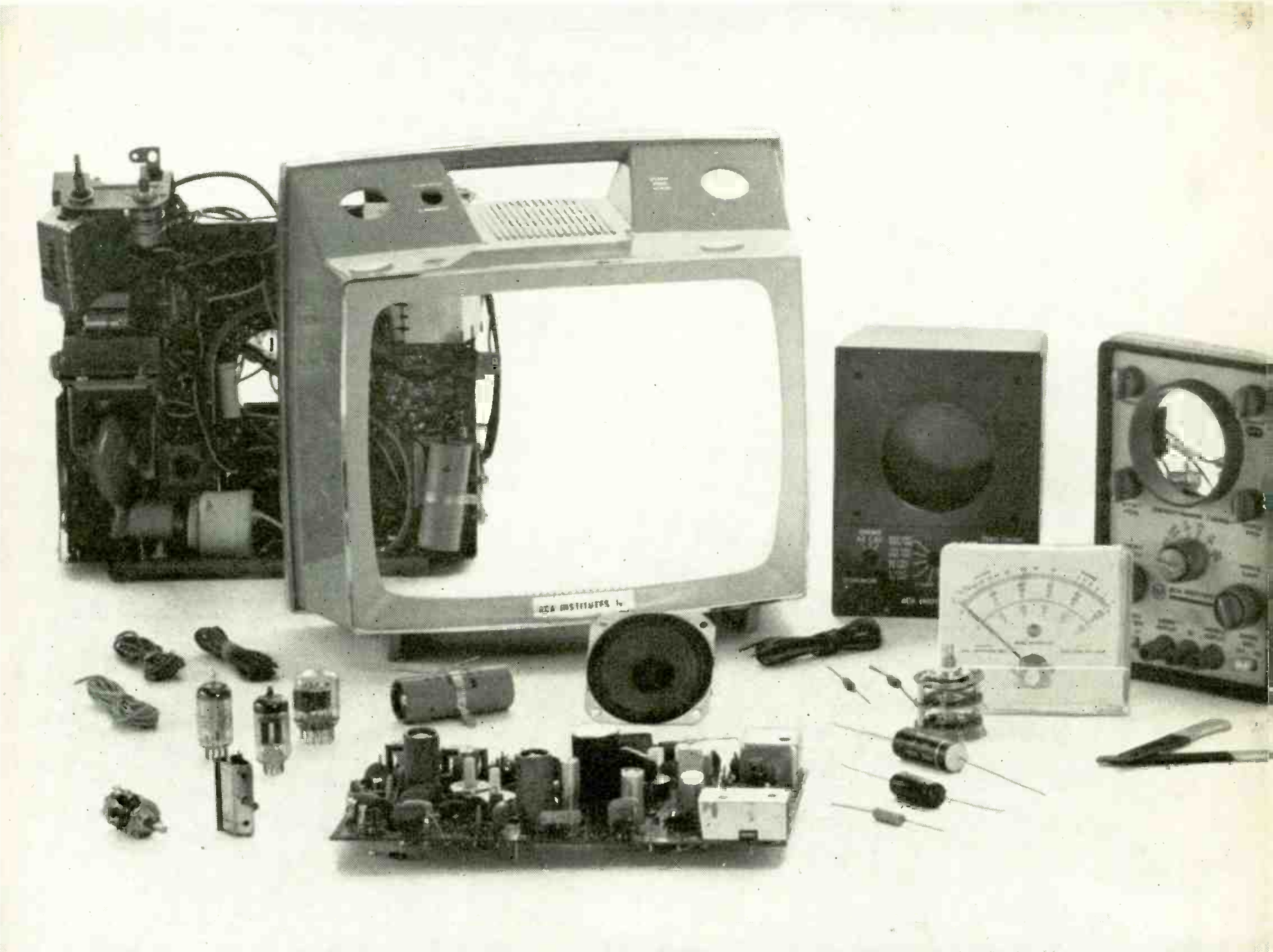
Then, in sets with the hold-down circuit, check the negative voltage developed across D1, at key-point-C. Then measure key-point-B; if voltage there is low or positive, there's too much positive dc coming through R3 or too little negative coming through R2.

Finally, check key-point-A. Not enough negative voltage there might be caused by trouble outside the regulator and hold-down stage—weak drive, for example.

Check the diodes without disconnecting them. Just turn the set off and measure each diode with an ohmmeter. The forward reading should be less than 10 ohms; the reverse, near infinity.

R-E





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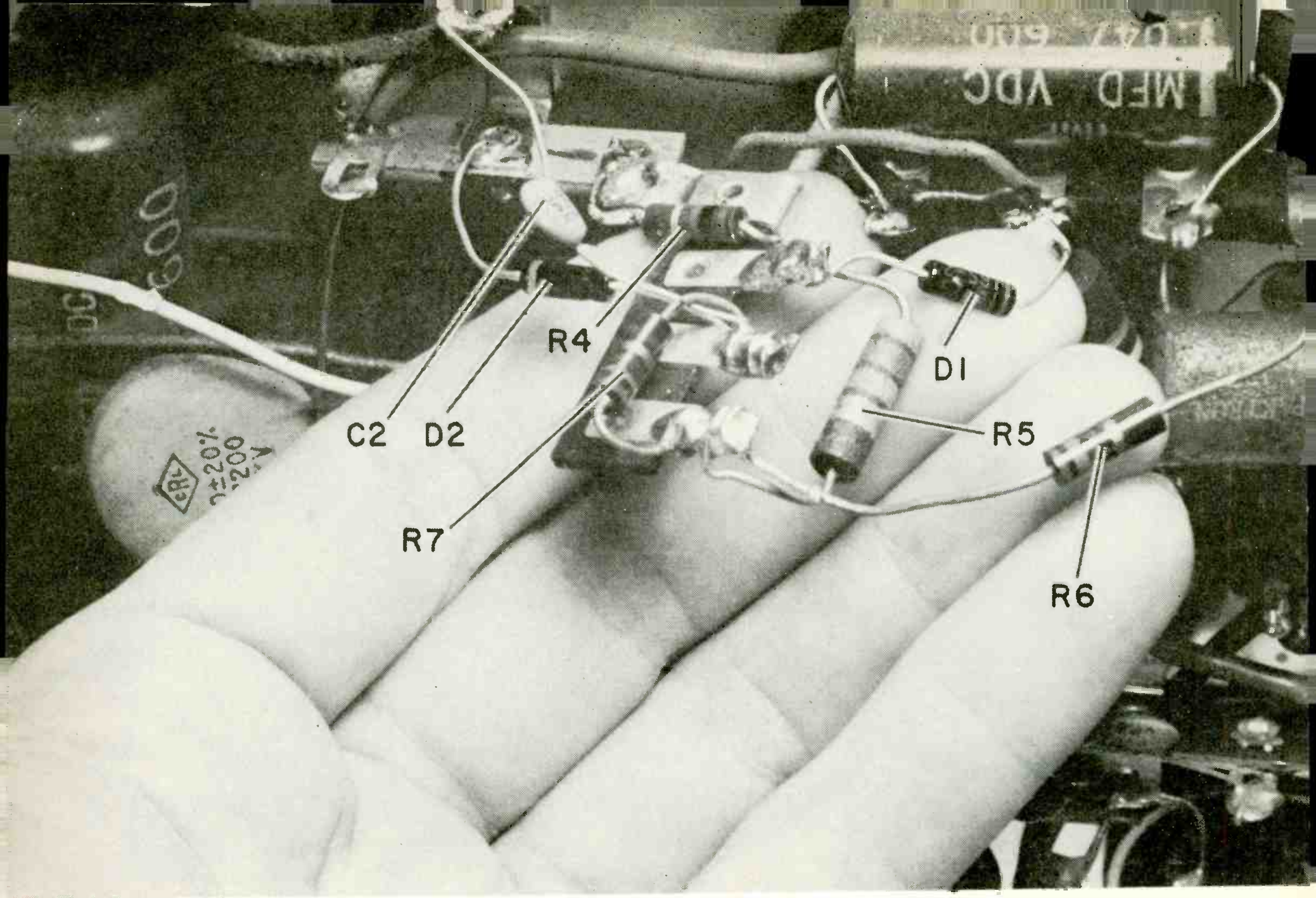


COLOR TV 1970

ADD TO YOUR SET Anti X-Ray Circuit

A few components added to shunt regulator in older color chassis prevents excessive high-voltage levels

by ALAN JAMES

KNOW ANYONE WHO'S STILL WORRIED about X-rays from a color set? There's little foundation for that worry (*see Looking Ahead, page 2, this issue*). But if the fear persists, there's something you can do about it.

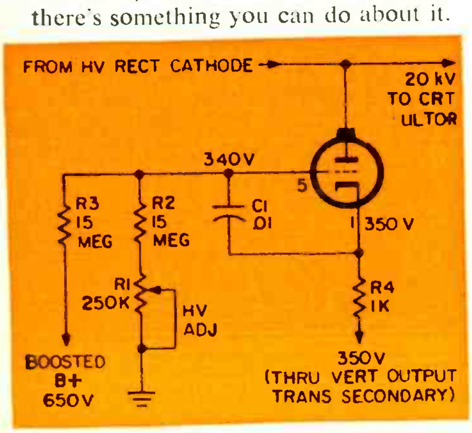


Fig. 1—**Basic triode regulator** acts as a variable load across the high-voltage line to the CRT second anode.

You can install protective hold-down circuits in those millions of chassis still around with shunt-type high-voltage regulators.

An improperly adjusted high-voltage regulator can cause x-radiation above the 0.5 mR/hr maximum standard set by The Bureau of Radiological Health (BRH). Yet, the BRH has assured the public that even several times that amount does no harm, either physically or genetically, to humans. But some people say: Why even take the chance? Eliminate the main possible cause—too much high voltage.

Set manufacturers have redesigned many of their chassis. More than half the 1970 receivers no longer use a shunt-type high-voltage regulator. Those that do usually have a hold-down circuit added. It prevents high voltage from exceeding a safe value, even if the regulator goes bad. In fact, with a properly designed hold-down circuit, the regulator can't even be misadjusted by a careless technician or a screwdriver-happy owner.

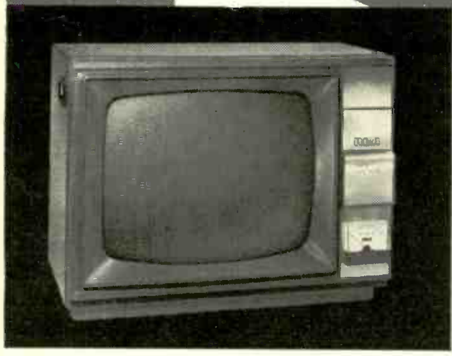
Here is a simple and inexpensive design you can add to almost any shunt regulator. With this add-on circuit in place: (1) no one can turn the high voltage too high; (2) a regulator fault activates the hold-down circuit, limiting high voltage; and (3) a defect in the hold-down circuit shrinks the picture or makes it fuzzy, giving notice of trouble.

Reviewing a shunt regulator

A schematic of the shunt regulator usually used in modern color sets is in Fig. 1. Normal conduction for the tube is set by voltage divider R1-R2-R3, connected across boosted B-plus. Potentiometer R1 sets the voltage drop across R3, and what's left is applied to the grid.

The cathode gets a positive voltage from B-plus (usually from the vertical-output-and-centering circuit)

ICTJ*



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IN THE SHOP
(continued from page 16)

These aren't ordinary resistors. They are rated at 2 watts, but since they have such a tremendous voltage across them, they are very special in-

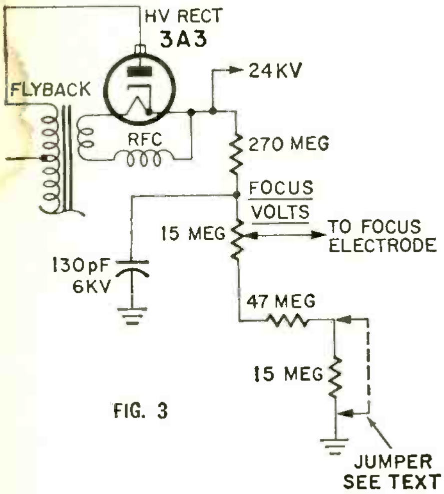

FIG. 3

deed. If one of these burns up, *DON'T REPLACE IT WITH A HALF-WATT CARBON!*

The special resistor used in the Motorola chassis contains *thirty-four* 4.7-megohm units, sealed in epoxy. You'll find this one in the TS-914 chassis and from there on (Fig. 4). The top (HV) part is 132 megohms, and the lower part 28 megohms. From the bottom, it goes to a 10-megohm variable resistor for control. In most of these chassis, you'll find 22 megohms from the control slider to ground.

The big resistors, both the special high-voltage and the encapsulated types, *can* change value. They do open occasionally. When you can read normal high voltage "at the top", but the focus voltage is either too low or too high, and out of range of the focus-control variation, you'll probably have to install a new resistor.

Ordinarily you won't have to read the focus voltage to tell when it's off. The well-calibrated eyeball will show you the scanning lines if they're sharp and visible all the way across the screen. Focus voltage isn't hard to

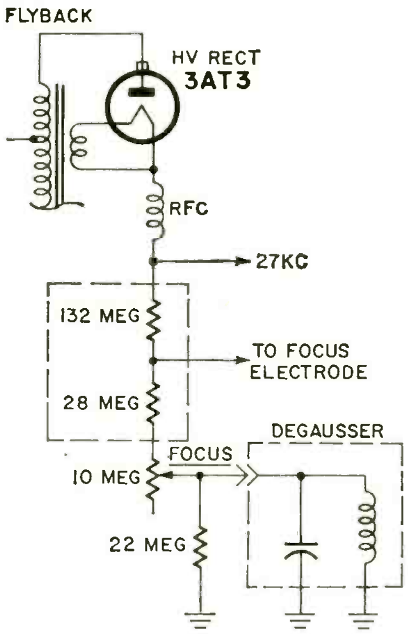

FIG. 4

read, however. Many vom's have a 5,000-volt dc range, and can be used to check focus voltage with your regular high-voltage probe.

The scanning lines ought to be the final test, though. Normal variation over the range of the focus control should be about 1,000 volts. This will usually be from 4,000 to 5,000 volts, or very near to it. If it will do that, it's probably OK.

If you can't get focus with the focus voltage at 5,000 volts and still going up, check the *high voltage* (on any circuit, not just the voltage-divider type!) You'll probably find it running away too high.

In some Motorolas, you'll find the focus voltage returns to ground through the degausser. If these chassis are operated on a test-jig, etc., ground the wiper-arm of the focus control, or the raster will be out of focus (see Fig. 4). **R-E**

EQUIPMENT REPORT

B & K "Dyna-Flex Probe"

I've always been a good prospect for anything that'll save me time, so I enjoyed using the B & K "Dyna-Flex Probe". Unless you're one of the fortunate-type technicians who has three hands, this will be very helpful. (Did you ever try to make three wee test clips, hold all at the same time, on a PC board with only little blobs on each terminal?)

This is a probe; it has three wires going straight through the good sized handle, and terminating in three *very* sharp, spring-loaded, ball-jointed tips. The tips are color-coded, so that you can tell which lead goes to each pin. The leads have miniature test-clips; these can be used to hook the probe to the leads of your transistor tester, vtvm, tvom, etc., or to hook up resistors, capacitors or even transistors for substitution on a PC board.

To make in-circuit transistor tests with the Dyna-Flex probe, just check the base arrangement of the transistors. For instance, E-B-C counter-clockwise. Now, hook the probe's leads to the clips of your transistor tester to get the same arrangement, and away you go.

Two of the pins, the yellow and blue wires, are longer; so, set one of these on the collector, then move the probe-body over until the other is over the emitter solder-blob, and push. This leaves the third (base) pin open until the others are connected. Now, just lean the probe body over a little, lining up the green pin with the base dot, push, and there you are. You can easily hold it in place with one hand, while you set up the transistor tester and operate it with the other. The exceedingly sharp tips of the pins will dig right into a solder-joint, through resist, varnish, etc.

You can hook up only the two long pins to the vtvm, etc., and take that handy base-emitter voltage reading on all of the transistors in a stereo amplifier, TV i.f. strip, etc., in a very little time; much less than standard test prods or clips. The ball joints on the pins make them easy to set up; just jab one into one joint, then move the probe over until you can reach the other. You don't have to space them or set them beforehand.

The wires are coded yellow and blue for collector and emitter (in most basings) and green for base, which is about as near as we get to a standard color coding for transistor bases. Your transistor tester probably has different colored wires, but it's no trick to hook them up. **R-E**

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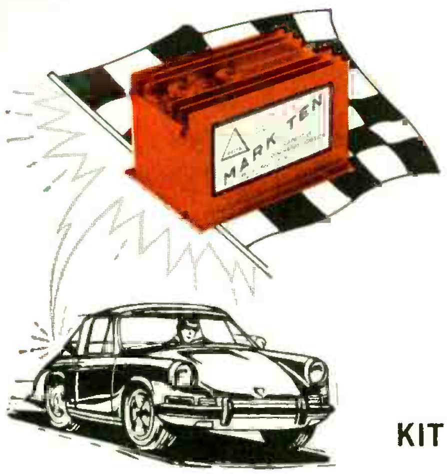

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IN KIT FORM: Feedback network with pre-selected components to eliminate all final calibration. **Ready to use when assembled!**

Only $59.95 ppd.

NEW DELTA FEATURES:

- ▲ Mirror scale 200 A D'Arsonval meter
- ▲ Integrated circuit (IC) operational amplifier for extreme accuracy
- ▲ FET input stage with current regulator
- ▲ Two stage transistor current regulator and Zener diode on OHMS for absolute stability and accuracy
- ▲ Voltage clippers for protection of input stage
- ▲ Fully temperature compensated for low low zero drift
- ▲ Ten turns ZERO and OHMS adjust potentiometers
- ▲ Epoxy glass circuit boards and metal case
- ▲ Enclosed switches
- ▲ Uses readily available type AA cells
- ▲ Uses standard test leads for maximum flexibility and ease of measurement
- ▲ 10 Megohms input impedance

DELTA COMPUTACH®

Delta, pioneers in CD ignition who produced the fabulous MARK TEN®, now offer a precise computer-tachometer which obsoletes any type tachometer on the market today! You achieve unbelievable accuracy in RPM readings due to the advanced, solid-state electronic matched components used in the computer, coupled with the finest precision meter in the world. Works on all 2, 3, 4, and 6 cylinder 2 cycle and with 4-6-8 cylinder—4 cycle 12 volt engines.

- ▲ 0-8000 RPM range
- ▲ Perfect linearity — zero paralax
- ▲ Adjustable set pointer
- ▲ Wide angle needle sweep
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- ▲ All-angle ball & socket mounting
- ▲ Use it with ANY ignition system
- ▲ Meter: 3⅛" dia. X 3⅜" deep
- ▲ Calibration kit included, no test eqpt. needed.

*An exclusive computer-tachometer for precise RPM measurement in easy-to-build Kit form! **$29.95 ppd.**

KIT FORM ONLY

Write today for complete literature packet

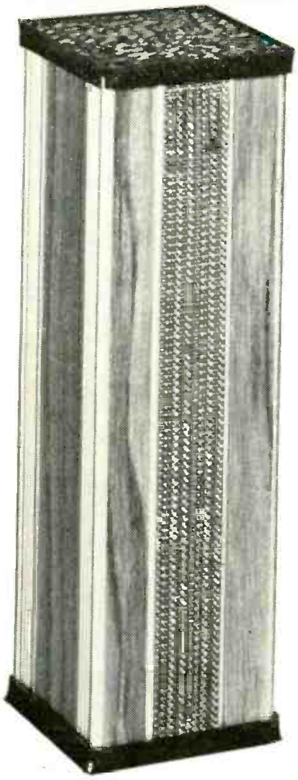
DELTA: Please send me literature immediately.
I am enclosing $________ for items checked.
☐ Mark Ten SCR (☐ Kit ☐ Assembled)
☐ Model 3000 FET VOM (☐ Kit ☐ Assembled)
☐ Computach (Kit only)
Please ship immediately.
Name________________
Address________________
City/State________________Zip______
*My car is (Model)________________(Year)______

DP 9-6

DELTA PRODUCTS, INC.

P.O. BOX 1147 • GRAND JUNCTION, COLORADO 81501

TWO NEW BELL RINGERS FROM DELTA



DELTALERT

Ultra Sonic Silent Sentry System

The all new economical-to-use DELTALERT, is more than a total motion detection and intrusion alert system. Use it as a convenience item to turn on lights, ring bells, alarms or monitor any area, indoors or out. Merely plug the system into any wall socket and plug the light, bell or alarm into the back of the unit. DELTALERT's **Extra Feature** variable sensitivity control and adjustable timing features provide you the most advanced sentry system on the market. Unit comes in handsome walnut finish, complete with 110-130V drop cord.

SPECIFICATIONS:

▲ Ultrasonic Frequency: 35 KHZ
▲ Area Coverage: 10-30 feet (depending on environmental conditions such as shape of area)
▲ Controls: On-Off Switch; Built in Timer; Variable Sensitivity Control
▲ Output: 110-130V at 1 Amp.
▲ Power Requirements: 110-130V, 60 HzAC

ONLY **$59.95** ppd.
For Complete Unit, Ready to Use

HIGH VOLT ANALYST

Complete Auto Analyzer

Delta brings you a new concept in automotive tune-up — The High Volt Analyst. A unique and **complete** auto analyzer, it provides all the primary advantages of a scope and yet is **completely portable.**

SPECIFICATIONS:

▲ Accuracy — Tachometer ± 2% of full scale (all ranges) • Dwell Meter ± 1% (both ranges) • OHMS Scale ± 5% • Low Voltage ± 2% of full scale • High Voltage ± 5% of full scale
▲ General — Fully protected meter circuit* • Size: 6½W x 8H x 3½D • Weight: 3¾ lbs.
▲ Ranges — DC Volts 0-15V, 15KV and 45KV • OHMS: 0-1 Meg. (10K center scale) • Dwell: 4, 6 and 8 cylinders • Tachometer: 0-1500 RPM, 6000 RPM

*Batteries (8 Type AA cells) included. Comes complete with standard lead set, a special probe, and high tension lead.

$79.95 ppd. Assembled

$59.95 ppd kit form

DELTA: Please send me literature immediately.
I am enclosing $________ for items checked.
☐ DELTALERT
☐ High Volt Analyst, Assembled
☐ High Volt Analyst, Kit form
Please ship immediately.
Name________________
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DELTA

DELTA PRODUCTS, INC.
P.O. BOX 1147 • GRAND JUNCTION, COLORADO 81501

Circle 27 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.

Hum Bar in Picture

I've got a good one for you. This is a big color set, tall antenna with booster, and it's got a terrible humbar in the picture. Yet when I get it to my shop, there's no humbar at all! All tubes OK, no intermittent filters or heater–cathode leakage, etc. Take it home, humbar is back! What's going on?—P. Q., Little Rock, Ark.

What's the *one* thing you didn't take to the shop with you? The *antenna!* I know the average antenna doesn't cause hum bars, but this one has an *antenna booster*. In these things, the 24-volt ac supply goes up the twin lead, and is rectified and converted to dc at the booster.

This is true of both tube and transistor types. They use half-wave rectifiers and big electrolytic filter capacitors. Take this booster down, and chances are you'll find the filter electrolytic open. This is 60 Hz, so you get one hum bar.

Slow meter zeroing

When I use the ac-volts scale on my WV-98C RCA Voltohmyst the needle returns to zero very slowly. Its normal on all other functions. Does this indicate something wrong in this meter?—W. B., Far Rockaway, N. Y.

If the instrument is accurate on its ac-volts ranges, which it should be if dc volts are okay, the meter is good. The same meter circuits are used on both ac and dc, the only difference being the addition of the 6AL5 rectifier diode for ac readings.

There is one possibility. I've found several 6AL5 diodes that have "grid leakage"—at least that's what it reads on a grid-emission tube tester! It's not, of course, but is probably a little mount contamination in the tube structure. This can upset FM discriminators or ratio detectors circuits, and could be the cause of the slow return.

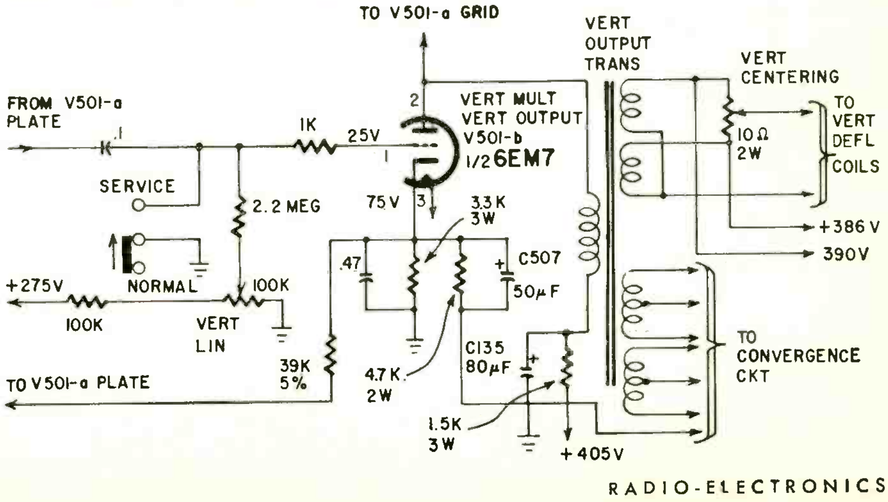
In the typical double-diode circuit, one half is hooked up as the rectifier proper, while the other is reversed to counteract contact potential. If either has developed leakage, it could make the meter needle slow to come back, without necessarily affecting the accuracy of the instrument. Try a new 6AL5, or check this one on a grid-emission tester.

Vertical Convergence Trouble

I've got an RCA CTC11 color chassis with more troubles than you can shake a stick at—all at once. I've got vertical problems such as nonlinearity, convergence trouble and some others. Most of them are intermittent. Tubes OK; now what?—K. W., Miami, Fla.

Most likely cause is one of the electrolytic capacitors in the vertical circuit. The combination of vertical and convergence troubles would point to something like C507, the 50-μF capacitor on the 6EM7 vertical output cathode. This is not only a cathode bypass but works as a part of the vertical pulse feed to the convergence circuits at the same time.

Check C6, but don't overlook C135, the 80-μF electrolytic in the +405-volt line to the vertical output plate. It can cause some odd symptoms, too. **R-E**



NEW PRODUCTS

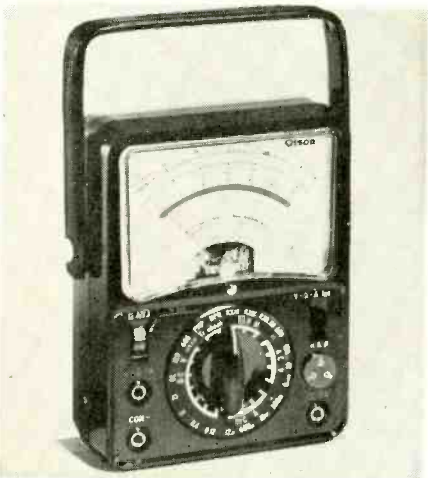
More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card at the left and circle the numbers of the new products on which you would like further information. Detach and mail the postage-paid card.

REMOTE-CONTROL STEREO HEADPHONE CONTROL, *model II-879*, has on/off switch for speakers, 2 volume controls, ¼" headphone jacks. Connects with

cable to amplifier or receiver. Size 2⅞ x 4 x 2". $9.95. 25-ft. cable, $1.60. **Allied Radio Corp.**, 100 N. Western Ave, Chicago, Ill. 60680.

Circle 46 on reader service card

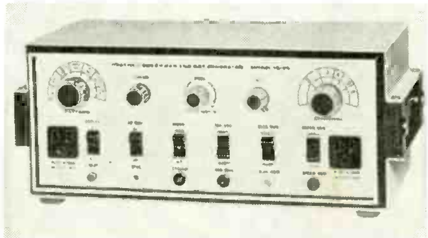
MULTIMETER, 100K ohms/V, *model TE-241*, has built-in transistor tester for I_{co} and alpha or beta tests of pnp and npn transistors. Taut-band meter movement protected by electronic overload circuit. Ranges: dc: 0 to 0.12, 0.6, 3,



12, 30, 120. Ohms–10K, 1000K, 100 meg. Ac: 0-6, 30, 120, 600. Decibel: –20 DB to + 58 DB. 3% accuracy. Size 5 x 6½ x 2⅝". $44.98. **Olson Electronics, Inc.**, 260 So. Forge St., Akron, Ohio 44308.

Circle 47 on reader service card

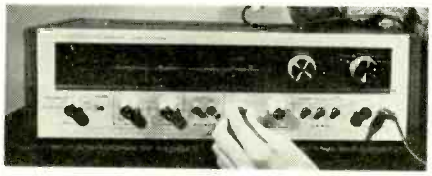
COLOR BAR-PATTERN GENERATOR, *model IG-28*, uses integrated circuitry to produce six 9 x 9 patterns–dots, cross hatch, shading bars, color bars, vertical and horizontal lines. Has clear raster for adjusting purity without upsetting agc. Front panel has variable tuning for channels 2 through 6, plus and minus video



output, sync output, two ac convenience outlets, built-in gun shorting circuits and grid jacks, vectorscope capability, switchable crystal, controlled sound carrier, copper-banded transformer to eliminate stray fields, zener-regulated power supply and 3-wire line cord. Beige and brown. Kit, *IG-28*, $79.95. Factory-wired and tested, *IGW-28*, $114.95. **Heath Co.**, Benton Harbor, Mich. 49022.

Circle 48 on reader service card

STEREO RECEIVER. The *SX-1500TD* features a microphone mixing circuit, with mike jack and level control on the front panel to enable user to sing along with records and to record voice and record on tape if desired. Other features include a speaker-selector switch for five



switching arrangements using three pairs of speakers and a switch providing separate, independent use of the preamplifier and power amplifier sections. FM IHF usable sensitivity 1.7 μV. Includes FET front-end and 180-watt audio output. $399.95.–**Pioneer Electronics U.S.A. Corp.**, Farmingdale, L.I., N.Y

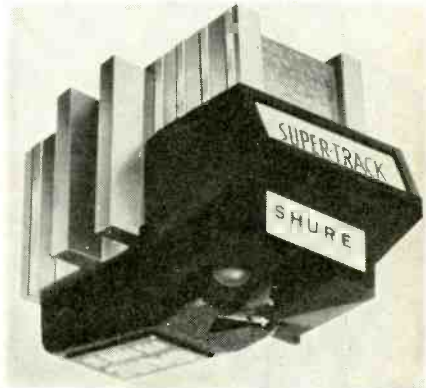
Circle 49 on reader service card

RECEIVER, FM—AM STEREO—*Allied Model 339*. Specifications: Power output

at 4 ohms: 40 watts ±1 dB; 32 watts IHF; 11 watts per channel rms. Response: 20-40,000 Hz, ±3 dB. Harmonic distortion: 1% at rated power. IM distortion: 0.22%. Hum and noise: Mag phono, – 65 dB; aux., – 65 dB. Outputs: 4-16 ohms, stereo headphones, recorder. Inputs: tape, magnetic phono, auxiliary, tape monitor. Tuner Circuit. FM; IHF sensitivity: 2.5 μV. Selectivity exceeds 20 dB. Separation exceeds 25 dB. Capture ratio: 7.0 dB. Signal-to-noise: exceeds 56 dB. AM: Sensitivity: 8 μV. Controls: selector (AM, FM mono, FM, stereo, phono, aux.), ganged bass and treble. Dual concentric volume, mono-stereo, main/remote speaker, power, loudness, tape monitor.–**Allied Radio Corp.**, Chicago.

Circle 50 on reader service card

PHONO CARTRIDGE *V-15 Type II*. Improved trackability in bass and mid-frequencies compared with its predecessor. Tracks most records at ¾ gram, including those containing heavily modulated bass drum, tympani, organ pedal,



bassoon, tuba, or piano passages. The improved V15 Type II is $67.50. Owners of older V-15 Type II cartridges can better performance by replacing their present stylus with the VN15 improved elliptical stylus at $27.–**Shure Brothers Inc.**, Evanston, Ill.

Circle 51 on reader service card

FM MONITOR RECEIVERS. Four models for police, fire, public service and commercial use. The *model FR-2512* (25-50 MHz) and *FR-2513* (150-175 MHz) are 24-channel all solid-state fea-

turing dual-purpose power supply for 117 volts ac and 12 volts dc, dual limiter and Foster-Seeley discriminator, quadruple tuned rf stage and temperature-compensated noise-free squelch. A turret-type switch provides 24 crystal-controlled channels.

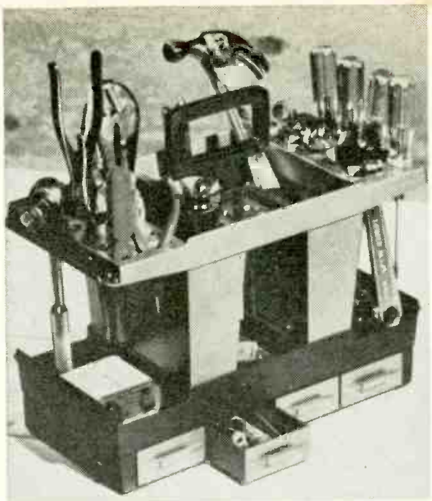
The *FR-2514* and *FR-2515* (25-50 and

150-175 MHz, respectively) are *Auto-Scan* models that signal-search and automatically lock on a signal on any one of 8 programmed channels. A priority-channel signal locks in to the exclusion of all other signals. Available with 8 crystal-controlled channels. Plug-in crystals allow instant frequency change.

The four receivers are for narrow-band (±5 kHz) operation. $169.95 for the 24-channel models and $189.95 for the *Auto-Scan* types—**Sonar Radio Corp.**, Brooklyn, N. Y.

Circle 52 on reader service card

TOOL CADDY, keeps tools together where you want them. Contains 39 tool-holding slots; two jumbo storage wells for large items, hammers, flashlights, etc.; four dust-free drawers for small parts,



nails, screws, nuts, bolts, etc. 11½" high by 14" long by 7" wide; beige and brown. $5.35, postage-paid—**Whicon Enterprises**, Irving, Tex.

ELECTRONIC IGNITION. *Tiger SST* capacitive-discharge ignition system. Factory-assembled and *Simpli-Kit* systems extend spark plug and breaker point life up to 100,000 miles, increasing gas mile-

age as much as 15%. Factory-assembled $39.95; kits $28.95. Both carry warranties. —**Delta International, Ltd.**, Grand Junction, Colo.

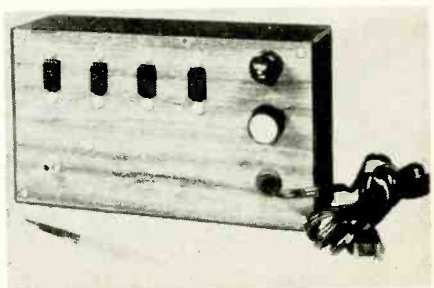
Circle 54 on reader service card

COLOR LIGHT ORGAN, *LO-104*, 3-channel organ provides 1.5 kilowatt output. Can transform a large room into a

psychedelic light-sound environment.—**Science Workshop**, Box 393, Bethpage, N.Y.

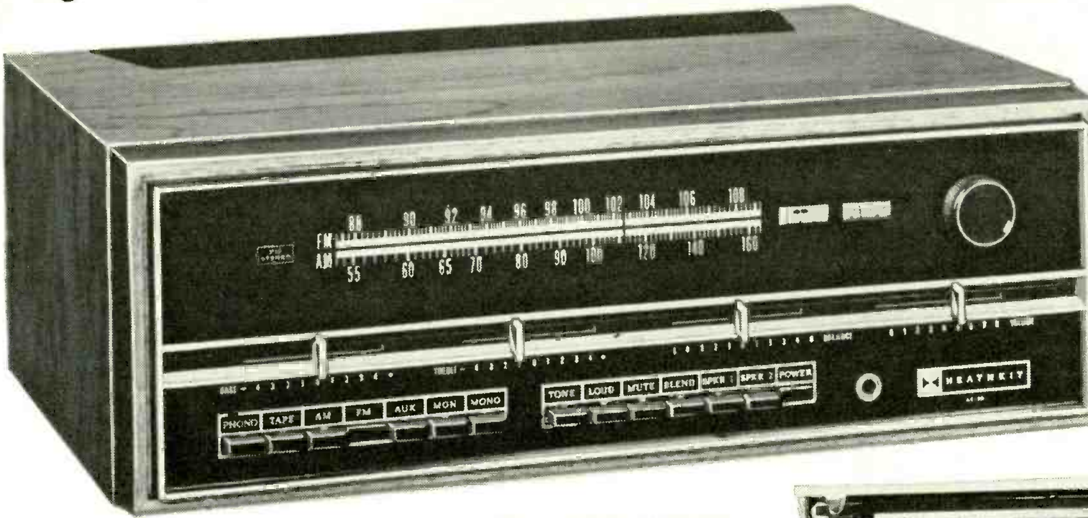
Circle 55 on reader service card

COLOR ORGAN has tuneable active R-C filters for frequency separation, all-silicon solid-state construction, four channels operating up to 250 watts of incandescent lighting per channel. Combinations of red, blue, green, and yellow follow rhythm and intensity of music applied to input. Program material taken off loudspeaker terminals of audio

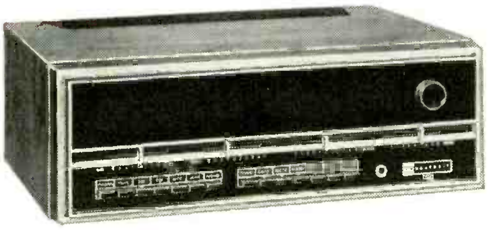


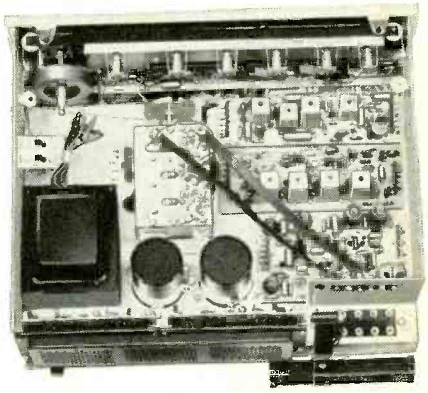
More New Kits From

Introducing The Advanced New Heathkit 60-Watt AM/FM/FM Stereo Receiver



Heathkit AR-19
$225.00*





Third In The New Generation Of Superb Solid-State Receivers From Heath . . . And Low In Cost

• Advanced solid-state circuitry with 108 transistors, 45 diodes and 5 integrated circuits • 60 watts music power output at 8 ohms • Less than 0.25% Harmonic & IM Distortion at any power level • Frequency response from 6 to 35,000 Hz • Direct-coupled, transformerless outputs for lowest distortion and phase shift • Dissipation-limiting circuitry protects outputs from damage even with a short circuit • Assembled, aligned FET FM tuner has 2.0 uV sensitivity to give you more listenable stations • Ball-bearing inertia flywheel tuning for smooth, accurate station selection • Preassembled, factory aligned FM IF circuit board speeds assembly and eliminates IF alignment, gives 35 dB selectivity • Multiplex IC circuit provides inherent SCA rejection • Pushbutton Mute control attenuates between-station FM noise • Blend control reduces on-station FM noise with a push of a button • Tone-flat pushbutton disables bass & treble controls for perfectly "flat" response • New linear motion controls for volume, balance, bass & treble • Individually adjustable level controls for each input including tape monitor eliminate annoying volume changes when switching sources • Switches for two separate stereo speaker systems for stereo sound in two different locations • Center channel speaker capability • Two front panel tuning meters give exact station selection • Stereo indicator light • Front panel stereo headphone jack • 300 & 75 ohm FM antenna inputs • High fidelity AM reception • Built-in AM rod antenna swivels for best reception • Massive power supply includes section of electronically regulated power • New Heath modular plug-in circuit board design speeds assembly, aids servicing • Built-in Testing facilities aids construction, simplifies servicing • Circuit board & wiring harness construction for easy, enjoyable 25 hour assembly

Ahead of its time . . . those who want to hear stereo high-fidelity as it will sound in the 70's can begin right now, at a modest price, with the Heathkit AR-19. Its design is an extension of the advanced circuitry concepts first introduced in the AR-15. These receivers are truly of a new generation . . . they've expanded audio engineering horizons and set the pace for the 70's.

Field Effect Transistor And Integrated Circuit Design. The AR-19 uses advanced semi-conductor circuitry . . . including five integrated circuits, with a total of 108 transistors and 45 diodes. The preassembled FM tuning unit uses an RF field effect transistor to provide high sensitivity and low cross modulation with no overloading on strong local stations. In the AM RF circuit also, field effect transistors give superior sensitivity and large signal handling capacity.

Ideal For Most Home Stereo Installations. The AR-19 is just right for the medium and high efficiency speaker systems that are so popular today. It can form the nucleus of a fine stereo system . . . and will probably be the most attractive part, thanks to its rich oiled pecan wood cabinet and to the "Black Magic" front panel. The scale and dial readings appear only when the power is on.

Features To Aid The Kit Builder. All 8 circuits of the AR-19 snap in and out in seconds. Think of the resulting convenience and ease of assembly! In addition, the AR-19 has built-in test circuitry . . . two test probes with the front panel meter for indications. With it, the user can check out circuit parts without the need for expensive external test equipment. Proper use of this feature is fully covered in the manual.

Don't Wait For Something Better To Come Along . . . it'll be a long wait. Up-grade your stereo system now, with this outstanding receiver value.

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

PARTIAL AR-19 SPECIFICATIONS — AMPLIFIER: Continuous power output per channel: 20 watts, 8 ohms. **IHF Power output per channel:** 30 watts, 8 ohms. **Frequency response:** (1 watt level) —1 dB, 6 Hz —35 kHz. **Power bandwidth for constant 0.25% THD:** Less than 5 Hz to greater than 30 kHz. **Harmonic distortion:** Less than 0.25% from 5 Hz to 20 kHz at 20 watts rms output. Less than 0.1% at 1000 Hz at 1 watt output. **IM Distortion:** Less than 0.25% with 20 watts output. Less than 0.1% at 1 watt output. **Hum and noise:** Phono input, —65 dB. **Phono input sensitivity:** 2.4 millivolts; overload, 155 millivolts. **FM: Sensitivity:** 2.0 uV, IHF. **Volume sensitivity:** Below measurable level. **Selectivity:** 35 dB. **Image rejection:** 90 dB. **IF Rejection:** 90 dB. **Capture ratio:** 2.5 dB. **Total harmonic distortion:** 1% or less. **IM Distortion:** 0.5% or less. **Spurious rejection:** —90 dB. **FM STEREO: Separation:** 35 dB at midfrequencies; 30 dB at 50 Hz; 25 dB at 10 kHz; 20 dB at 15 kHz. **Frequency response:** ±1 dB from 20-15,000 Hz. **Harmonic distortion:** 1.5% or less @ 1000 Hz with 100% modulation. 19 kHz & 38 kHz. **Suppression:** 50 dB. **SCA Suppression:** 50 dB. **AM SECTION: Sensitivity:** Using a radiating loop, 130 uV/M @ 1000 kHz. **Selectivity:** 25 dB at 10 kHz. **Image rejection:** 60 dB @ 600 kHz. 60 dB @ 1400 kHz. **IF Rejection:** 60 dB @ 1000 kHz. **Harmonic distortion:** Less than 2%. **Hum & noise:** —40 dB.

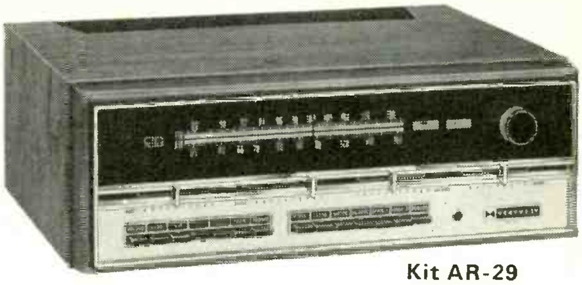
The Leader HEATHKIT®

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

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

Kit AR-29, (less cabinet), 33 lbs.................................**$285.00***

AE-19, Assembled oiled pecan cabinet, 10 lbs.....................**$19.95***



Kit AR-29
$285*

New Heathkit Deluxe 18-Watt Solid-State Stereo Phono

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

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

Kit GD-109
$74.95*

New Heathkit 80-10 Meter 2 KW Linear Amplifier

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

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

Kit SB-220
$349.95*

New Heathkit Solid-State Portable Fish-Spotter

Kit MI-29
$84.95*

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

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

Kit MI-19
$69.95*

New Heathkit Solid-State Depth Sounders

Let its flashing indicator light guide you through strange waters . . . day or night. Sounds to 200 ft. Has Noise Rejection and Sensitivity controls. Operates from your 12 VDC boat battery. Sun-shielded dial. All solid-state.

Kit MI-19-1, (with thru-hull transducer), 7 lbs...............**$69.95***

Kit MI-19-2, (with high speed transom mount), 7 lbs.......**$69.95***

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FREE 1970 CATALOG!

Now with more kits, more color. Fully describes these along with over 300 kits for stereo/hi-fi, color TV, electronic organs, guitar amplifiers, amateur radio, marine, educational, CB, home & hobby. Mail coupon or write Heath Company, Benton Harbor, Michigan 49022.

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Circle 107 on reader service card

Circle 108 on reader service card

amplifier. $49.95 in kit form. $65.00 completely assembled. **Edison Instruments, Inc.,** 54 West Cherry St., Rahway, N. J. 07065

Circle 56 on reader service card

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

STEREO/INTERCOM SYSTEM, built-in, includes Master Unit, *model 2071,* with solid-state dual channel amplifier and FM stereo, FM/AM radio tuner. Fold-In-Wall record changer *N2073.* Tape recorder, *model 2406,* uses 4-track

stereo and monaural tape. Pushbutton operation with record-interlock and pause-lever for editing. Intercom protects with door answering from any remote speaker. **NuTone,** division of **Scovill,** Madison and Red Bank Roads, Cincinnati, Ohio 45227.

IMPROVED HEATHKIT COLOR TV KITS. The 1970 line of Heathkit color TV includes three improvements that deliver better viewing and safer operation to the set owner.

Video bandpass has been increased to provide sharper, more detailed pictures, as exhibited in greater test-pattern resolution and in improved broadcast picture quality. The new circuitry is included in current production of all Heathkit color TV receivers. The circuit modification components are also available to any Heathkit color TV owner, on request, at no charge.

An ac interlock will be included in all future Heathkit color TV cabinets. The interlock is available to Heathkit set owners, at no charge, on request.

Also included as standard equipment in the 1970 Heathkit color TV's, are the new color picture tubes which deliver brighter pictures, more vivid color, and better resolution. As optional equipment at additional cost is the RCA Hi-Lite Matrix color picture tube for Heath models GR-681 and GR-295. **Heath Co.,** Benton Harbor, Mich. 49022. R-E

NEW LITERATURE

All booklets, catalogs, charts, data sheets and other literature listed here with a Reader's Service number are free for the asking. Turn to the Reader's Service Card facing page 81 and circle the numbers of the items you want. Then detach and mail the card. No postage required!

RECORDING BASICS, a 24-page booklet, offers tips on properly selecting magnetic tapes, recording techniques and recording procedures in non-technical terms. It also defines various types of tape recorders and illustrates the proper techniques for editing and splicing magnetic tapes as well as maintenance tips for recorders. Write to **3M Co., Magnetic Products Div., Market Service Dept.,** 3M Center, St. Paul, Minn. 55101

Circle 76 on reader service card

JAPAN ELECTRONICS DIRECTORY is a 16-page book listing the manufacturers of Japanese: consumer electronic products and parts; hi-fi sets and components; auto radios and tape players; communications systems; computers; electronic measuring equipment; radar equipment; automatic control systems; transformers, relays, coils, capacitors and other electronic devices. Material obtained by enclosing a 6¢ stamped, self-addressed #10 envelope to:—**Electronic Manufacturers' Directory,** Japan Light Machinery Information Center, 437 5th Ave., New York, N.Y.

CRYSTAL BULLETIN, 12 pages, contains a list of quartz crystals in the range from 50 kHz–200 kHz. Complete dimensional data for standard and custom units are included along with revised chart listing specifications on all military type crystals.—**K-W Industries Inc.,** Prague, Okla.

R-E

Circle 78 on reader service card

(*continued from page 42*)

With this additional voltage, V_{R1} (Fig. 7b) is the resultant. Notice the resultant is phase-shifted slightly from V_s and therefore from V_c and V_o. The phase shift shown is approximately the resultant phase shift with minimum V_c (R at maximum resistance setting). When more V_c is added by decreasing resistance R, the phase of the resultant is shifted toward V_c (Fig. 7c). In this case, resistance R is at minimum and effectively out of the circuit. Only a small fixed resistor remains, which limits the total phase shift to almost that of V_{R2}. Total phase shift from maximum to minimum R ranges from V_{R1} to V_{R2}, the effective tint control range.

Noise-immune and sync and agc

Another interesting solid-state circuit is the novel keyed agc and noise-immune sync used in the RCA CTC 42X. The circuit is shown in Fig. 8. The agc system operates by comparing the amplitude of the sync tips with an 18-volt reference level. Composite video (2.4V p-p) at the emitter of the second video amplifier is riding on a 15.4-volt dc level which places the sync tips at 17.8 volts. This signal is fed to the base of Q501, the agc keyer. The emitter of Q501 is biased at 17.2 volts so that (with the inherent 0.6 base–emitter voltage drop) the transistor cannot conduct on signal voltages below 17.8.

On signals too weak to develop the 17.8-volt sync-tip amplitude needed to cause the Q501 ot conduct, the agc-controlled rf amplifier and the first and second i.f. amplifiers operate at maximum gain.

When the signal level increases to the point where the sync-tip level exceeds 17.8 volts, Q501 conducts during the horizontal pulse interval. This conduction creates a negative charge on the 330-pF capacitor and the agc lines.

Low-level signals that are above the agc threshold develop a negative agc voltage that acts to reduce only the gain of the i.f. amplifier stages. As signal level further increases, the rf amplifier gain is reduced until the tuner is operating at minimum gain. As the signal level increases beyond around 100 mV the i.f. stages are again influenced by agc.

Transistors Q504, Q502 and Q503 prevent incoming noise pulses exceeding the blanking level from causing false triggering of the horizontal and vertical sweep oscillators. Sync amplifier Q502 is a common-base amplifier operating with 15.4 volts of emitter bias via direct coupling to the emitter of the second video amplifier. The signal (with sync positive) is developed across the 1,200-ohm collector resistor. The 470-pF capacitor strips off the high-frequency video information while the sync pulses are fed to the sync separator.

The sync separator base is supplied from a regulated 18-volt source. Its collector is fed from the 280-volt line and clamped to ground by a 18,000-volt resistor that limits the collector voltage to around 36 when the transistor is cut off. The sync output, taken across the 18,000-ohm resistor, consists of negative-going pulses of around 36 volts. These pulses are differentiated and integrated to provide horizontal and vertical sync.

Noise gate Q504 (a pnp transistor in a common-base circuit) has its base connected to 18 volts positive while the composite video with positive-going sync is fed to its emitter. On a noise-free signal, the 17.8-volt sync tips cannot drive the stage to conduction. On the other hand, noise pulses that exceed the sync-tip level by only a few millivolts will drive the noise gate to conduction. The noise-gate output develops a positive-going pulse across R510 with amplitude high enough to drive the sync amplifier base to cutoff for the duration of the noise pulse. **R-E**

Circle 110 on reader service card

Circle 111 on reader service card

TRY THIS ONE

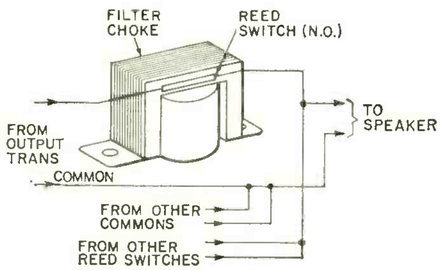
MATCHING MICROPHONES

To tell if a pair of microphones is well matched, place the two side by side as close together as possible. Hook them up, out of phase, to a single input. The response should be almost nil for sounds (voice) directed to the mikes. If this is not so, either they have different response curves or they were out of phase to begin with.—*Harry J. Miller*

AUTOMATIC SPEAKER SWITCHING

If you have only one hi-fi speaker set up and want to use it for all your equipment such as TV, phonograph, radio and tape recorder, you'll find the switching rather complex. And, you must remember to switch the speaker to the desired equipment each time you use it. Since no two instruments are in use at the same time, I use reed switches for automatic switching.

A switch is connected as shown in the "high" side of each output transformer secondary lead. The switch is mounted on the filter choke of each instrument so it closes when that set is turned on. The common sides of all the output circuits are connected together and to one side of the speaker voice coil.—*Stanley Zlotkowski, Sr.*



(Do not use this scheme on transformerless (ac-dc) equipment. You may inadvertently connect the hot side of the power line to all your other equipment.—*Editor*)

BATTERY-ELIMINATOR PROTECTOR

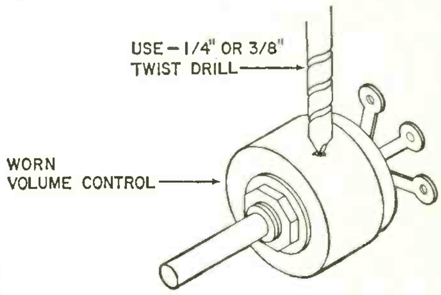
I use an Eico 1060 battery eliminator/charger when servicing transistor radios. This unit packs quite a wallop if its leads are shorted.

To prevent damage, I insert a No. 47 pilot lamp in series with one of the leads. In the event of a short, the lamp limits the current and lights to visually indicate a short circuit. This lamp has no affect on the 8–10 mA that is drawn by most small transistor radios.—*Oscar Blair*

QUICK REPAIR FOR OLD VOLUME CONTROLS

Many times, old radios with volume control trouble are brought in for repairs. In most cases, washing out the control is all that is needed. But often, old controls are sealed and cleaning fluid cannot be injected.

I have been able to avoid replacing these controls by drilling a *tiny* hole in the case of the control so cleaning fluid can be injected. Here is how it's done. Use a *large diameter* drill (see drawing) and *don't* drill all the way through the cover. Go *almost* through.



Then take a sharp ice pick and puncture the partially drilled hole. Make only a *tiny* opening, just large enough to insert the needle of the injector. *Do not* use a small-diameter drill for making the hole; it may go through and damage the control.

This scheme has enabled me to avoid replacing controls in many old radios.—*Joseph D. Amorose*

(*continued on page 100*)

COMING NEXT MONTH

FEBRUARY 1970

- **Build R-E's Pulse Generator**
  Professional-quality instrument easily matches generators costing twice as much. Variable frequency, pulse width and delay.

- **30 Projects with the CA3035**
  Learn how this versatile linear IC from RCA works. Then tackle the useful projects that interest you.

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  An expert shows you which capacitors to use in specific circuit applications, and what the important differences between capacitor types are.

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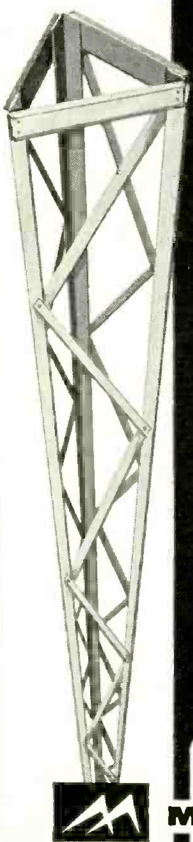


NEW SEMICONDUCTORS

LOW-VOLTAGE UNIJUNCTION

The 2N5431 is a Motorola unijunction transistor designed for operation on supply voltages as low as 4 volts. Made by improved construction techniques, this UJT has an emitter current leakage of only 10 nA, about 1/100th the leakage of some earlier types. Likewise, peak point leakage current is only 0.4 μA maximum at V_{B2B1} of 25 V and 4.0 μA at 4 V. These two characteristics are critical for long-time-delay, low-leakage circuits.

Other outstanding characteristics are intrinsic standoff ratio (η) range of 0.72–0.80, base-to-base resistance R_{BB} range of 6,000 to 8,500 ohms. Maximum reverse emitter voltage (V_{B2B}) is 30 V, maximum emitter current is 50 mA rms, power dissipation is 300 mW and maximum emitter saturation voltage is 3V.

The 2N5431 is in a TO-18 case. $3.25 in lots of 1,000.

FAIRCHILD SH2200

The SH2200 is a new hybrid-circuit high-performance lamp and relay driver featuring a 50-volt output and a sinking current of 500 mA at 6 volts. This Fairchild multichip device is a pin-for-pin replacement for the firm's SH2001, a lower-voltage lamp driver that sinks up to 250 mA.

Designed for logic flexibility, the SH2200 provides a combination of four NAND gates and an inhibit (NOR) input. It can interface with all other current-sinking logic circuits.

Besides being useful as a lamp and relay driver, the SH2200 will serve also in display systems, tape readouts, go-no-go testers and readouts of computer equipment and for solenoid, memory and clock driving.

The device is available in a plastic dual-in-line package and temperature range of 0° to +70°C at $5.65 each in lots of 1-24 and in T0-100 package and 10-lead ¼-inch flatpack (operating temperature −55°C to 125°C) for $17.93 (to 24). **R-E**

"You had to make that neighbor mad. He has some sort of laser beam."

NEW BOOKS

G-E RADIO SERVICE GUIDE, Vol. VII, 1967–1969. Compiled and edited by E. J. Dyman, R. deLaubell and R. Cannon. General Electric, Radio Receiver Dept., Accounting Operations, 1900 Bleeker St., Utica, N. Y. 13501. 8½ x 11 in. 550 pages, soft cover, spiral bound. $6.95 plus state and local taxes where applicable.

A compilation of service data for all G-E radios, phonographs, tape recorders and CB radios made in 1967–1969. Contains schematics, alignment procedures, parts lists, pictures of each model, dial stringing diagrams, voltage and resistance readings, transistor substitution charts, exploded mechanical views of tape recorders and (a new feature in this volume) bottom-view component layout drawings. A must for the efficient service shop.

THE RADIO AMATEUR'S HANDBOOK, 46th Edition, edited by Doug DeMaw, W1CER. American Radio Relay League, Newington, Conn. 06111. 6½ x 9½ in., 710 pages. Soft cover $4.00 in U.S. and possessions, $4.50 in Canada and $5.50 elsewhere. Hard-cover clothbound $6.50 in U.S. and Canada, $7.00 elsewhere.

This 46th (1969) Edition is printed on non-gloss paper for minimum glare and sharp, clear photographs. It has undergone considerable revisions in sections devoted to construction and theory and new material has been added to cover such subjects as dual-gate MOSFET's, solid-state product detectors, oscillators, i.f., rf, af and dc amplifiers. New construction projects such as solid-state transceivers and transmitting and transceiving converters have been added.

For the past few years, each new edition of The Handbook has been revised with some material—particularly construction projects—deleted or greatly condensed to make room for the new. In the process, some illustrations used in the 1968 Edition have been dropped or rearranged without appropriate changes in text references. As a result, many references to illustrations are completely meaningless. However, the most disturbing result of revisions in the 1969 Edition is the deletion of the 2-kW pep 3-1000Z grounded-grid linear amplifier and its power supply from Chapter 6. There are no construction details or power supply schematics for the 3-400Z and 3-500Z linear amplifiers. The text refers the reader to the power supply for the 3-1000Z amplifier described later in the chapter. But, the 3-1000Z amplifier was not included in the latest Edition. You'll have to go back to the 1968 Edition.

Even with its omissions and editorial "goofs", The Handbook is still the standard manual for radio communications, theory, design and construction techniques and is equally useful to beginners, advanced amateurs and professionals.—W2PWG **R-E**

Circle 116 on reader service card

Circle 115 on reader service card

IC COLOR PATTERN GENERATOR
(continued from page 51)

screw and nut. Mount the transformer last to keep the board light while mounting the other components.

Ground the crystal cases to the adjacent ground area.

Use No. 26 solid wire for the connections to S1-a and S1-b. Connections from S1-a to the integrated circuits should be made on the component side of the board directly onto the integrated circuit.

S1-a-2 will have two leads, one to IC2-B-8 and the other to IC10-B-12. Bring ground and B+ to S1-b from any convenient point.

The output is taken from the two circles to the left of R23 to the output socket with a piece of 300-ohm twin lead.

Initial tests

Make sure there are no solder splashes shorting adjacent foil runs. Then, while monitoring the emitter of Q5 with a dc meter, apply power. The voltage should rise to about +2.9 in around 5 sec. If this voltage is obtained, observe the waveform at pin 5 of IC11 with a scope. You should see the waveform shown in Fig. 5 with the selector switch in position 6. If the observed signal is absent or greatly different, carefully check the jumpers, IC orientation and solder connections. Verify that B+ is on pin 11 of all IC's and on the arm of S1-b. A 189-kHz square wave should exist at pin 2 of IC12. The duty cycle should be adjusted to about 50% with R31.

Since some of the specified capacitors have a large tolerance, it may be necessary to adjust some resistors to obtain the proper waveforms.

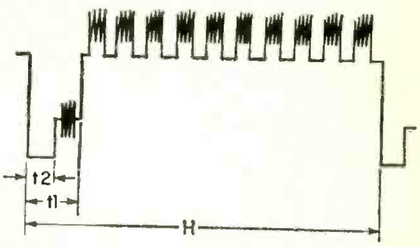


Fig. 5—Waveform at IC11-5 with the scope sweep at 15.75 kHz. Adjust R4 until T1 is 16% of H. Adjust R14 and/or R15 until T2 is 8% of H. Selector switch must be in Color Bar position.

Referring to Fig. 5, adjust R4 until t1 is about 16% of H, and adjust R14 and/or R15 until t2 is about 8% of H.

Next observe pin 3 of IC9-a with the scope sweep set to 30 Hz. Adjust R17 and/or R16 until T3 of Fig. 6 is about 5% of V.

Finally, adjust R7 until the waveform in Fig. 7-a is obtained at IC12-7.

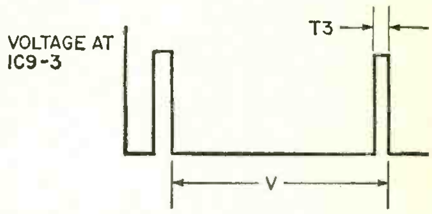


Fig. 6—Waveform at IC9-a-3 with sweep about 30 Hz. Adjust R17 and/or R16 until T3 is about 5% of V.

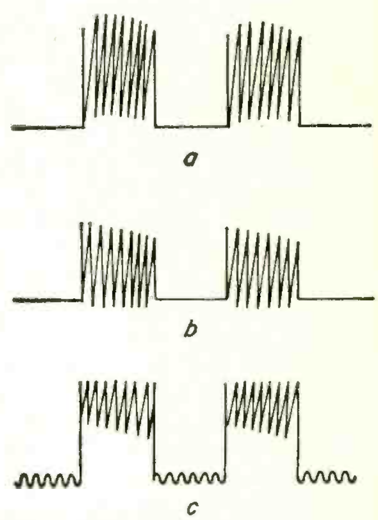


Fig. 7—Waveforms at IC12-7. (a) Waveform when R7 is correct value. (b) R7 too small reduces chroma level. (c) R7 too large also reduces chroma level.

Final tests

Tune a normally operating, well-converged color set to channel 3, 4 or 5, whichever operates in your area. Fine-tune the station carefully. Connect the set's antenna terminals to R23 with a piece of twin lead. With the pattern generator on the color bar position and the set's color control off, adjust L1 until the edges of the vertical bars are sharp with just a little ringing noticeable. Turn the color control back to normal and adjust C4 until the color bars fall into sync and the third bar from the left is red.

Check the remaining patterns. Dot and vertical line width can be varied to taste with R13. Contrast can be varied with R20. Horizontal lines are one line high per field, but the interlaced pattern will produce a horizontal line two scanning lines high each frame. On some sets every other horizontal line will appear half the height of the remaining ones. Slight readjustment of the vertical hold control will make them all equal.

If a chroma amplitude control is desired, replace R11 and R12 with a 500-ohm linear pot. Its arm goes to C23.

If a clear raster would be more useful to you than the horizontal or vertical line pattern, connect S1-a-2 or S1-a-3 to B+ through a 620-ohm resistor instead of to IC2-8 or IC12-6.

Drill the rear cover of the generator case for the ac cord and the output socket.

Mount the PC board on the rear cover using 3/8-inch plastic spacers and 4-40 screws, 3/4 inch long.

A hole on the front for the switch (and chroma pot if used) and two holes for the handle complete the project. The handle shown in the photo was obtained from the cabinet ware department of a discount store.

Total cost of the generator will be $45 to $50. **R-E**

PARTS LIST

All resistors 1/4 watt, 10%, unless noted
R1—33,000 ohms
R2, R30, R31—15,000 ohms
R3—6,200 ohms, 5%
R4—6,800 ohms
R5—270,000 ohms
R6, R20, R26—1,000 ohms
R7, R13—2,700 ohms
R8, R11, R12—220 ohms
R9, R15—10,000 ohms
R10—22,000 ohms
R14—220,000 ohms
R16, R29—9,100 ohms, 5%
R17—68,000 ohms
R18, R23—330 ohms
R19—470 ohms
R21, R25—1,500 ohms
R22, R24—680 ohms
R27—4,700 ohms
R28—8,200 ohms
All capacitors ceramic discs, rated 10 volts or more, unless noted.
C1, C7—.01 μF
C2, C6, C19—.047 μF (Sprague HY-310)
C3, C18, C25—0.005 μF
C4—3–16 pF (Erie 503-001-19B)
C5—100 pF
C8—56 pF
C9—300 pF
C10—0.0033 μF
C11—0.47 μF (Sprague HY-330)
C12, C13—3.3 pF
C14, C16, C17—10 pF, NPO (Sprague Q10)
C15—25 pF NPO (Sprague Q25)
C20—1000 μF, 15V, electrolytic, (Sprague TVA 1163)
C21—200 μF, 6V, electrolytic, (Sprague TE 1104)
C22—140 μF, 6V, electrolytic, (Sprague TE 1102.5)
C23—470 pF
C24—.02 μF

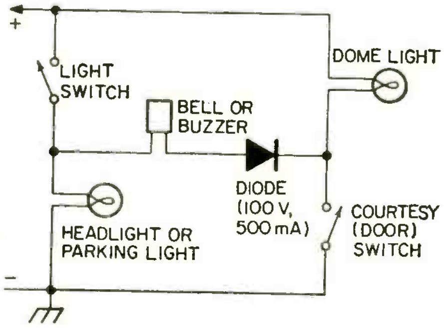
Semiconductor devices
D1, D2—1N34 or similar germanium diode
IC1–IC8—Motorola MC 890P
IC9, IC10—Motorola MC 824P
IC11, IC12—Motorola MC 889P
RECT—Full wave bridge, 25 PIV, .75 A (Motorola MDA920-1)
Q1, Q2, Q3, Q4—2N3855A or similar
Q5—RCA 2N5034, 2N5035 or Motorola MJE-520
L1—4 1/2 turns, #20 solid wire, spaced 3/8 inch, tapped 1/2 turn from B+ end, 1/4 inch diameter
T1—115 to 6.3 VAC filament transformer, 0.6A (Thordarson 21F21)
XTAL1—189-KHz crystal, wire leads (order crystal style HC6/U directly from Texas Crystals, Fort Myers, Florida. $6.00)
XTAL2—3.56379-MHz crystal (Order from above source. Specify HC6/U, with wire leads, for color TV. $2.95)
Coil form for L1—J. W. Miller 4500-2 1/4 inch dia., 7/8 inch long, (Newark Electronics part 59F352)
Cabinet—6 13/16 x 5 9/32 x 2 5/16 Allied part 42C7886
Cover—6 1/2 x 5", Allied part 42C7888
Output socket—Mosley 343 with mating plug 303
(An etched, undrilled PC board may be ordered from Techniques Inc., 235 Jackson St., Englewood, N.J. 07631. The price is $3.00)

NOTEWORTHY

SIMPLE HEADLIGHT REMINDER

Most of the headlight reminders that I've read about are rather complex, using transistor oscillators, SCR's or relays, and are generally connected to sound the alarm if the ignition is turned off while the headlights are on.

I think my circuit is simpler and more versatile. It permits you to leave your parking lights or headlights on



when you so desire without having the alarm sound for as long as the lights are on.

As the circuit shows, all you need is a bell or buzzer and an inexpensive diode. When the lights are on, voltage is supplied to one side of the buzzer. When the door is opened, the courtesy-light switch closes and completes the circuit to ground so the buzzer sounds. The diode prevents reverse current from flowing through the dome light, buzzer and headlight to ground.—*R. Kaacker*

HOT-CHASSIS SERVICING PRECAUTIONS

Since the chassis of some receivers are connected directly to one side of the ac power line, the following precautions should be observed when working on this type equipment:

1. Use an isolation transformer in the power line between the receiver and the ac receptacle.

2. When the receiver must be operated directly from the ac line, the power plug must be inserted in the receptacle so the chassis is connected to the grounded side of the power line. Check with an ac voltmeter to see if a voltage potential exists between the chassis and power source ground. The meter should read zero. If a reading is obtained, reverse the line plug and recheck for a zero reading.

3. When replacing a chassis in the cabinet, always be certain that all protective devices are put back in place, such as: non-metallic control knobs, insulating fishpapers, adjustment or compartment covers, shields, isolation resistor-capacitor networks, etc. Before replacing the back cover, inspect inside the cabinet to be sure that no stray parts or tools have been left inside.

4. Before returning the set to the customer, you must be sure that no shock hazard exists. Plug the ac line cord directly into a 120-volt ac receptacle (do not use an isolation transformer for this test). Using two clip leads of sufficient length, connect a 1500-ohm, 10-watt resistor in series with an exposed metal cabinet part and a known earth ground such as a water pipe, conduit, or similar object. Use an ac voltmeter of 1000-ohms-per-volt or greater sensitivity to measure the voltage drop across the resistor. Move the resistor connection to each exposed metal part (antennas, handle bracket, metal cabinet, screw heads, control shafts, etc.) and measure the potential across the resistor at each new connection. Now, reverse the line plug and repeat each measurement.

Any reading of 30 volts or more is excessive and indicative of a potential shock hazard which must be corrected before returning the receiver to the owner.—*RCA Television Service Data*

CIRCUITS

TRANSISTOR SAWTOOTH GENERATOR

If you have been looking for an interesting evenings project, you can construct this simple sawtooth generator with a minimum of cash and components.

The sawtooth generator is composed of two different and simple circuits. The pulse generator is nothing more than a simplified free-running multivibrator (Q1, Q2) that produces a narrow negative-going pulse used to drive the discharge transistor (Q3) into full conduction for a very short time. Until another pulse is developed from the multivibrator, C4 is again re-charging through R4 and R5 forming a linear increasing voltage at the collector of Q3 and the output terminal. Then another pulse will cause Q3 to conduct and complete another sawtooth waveform.

Using the components values suggested in the schematic, the generator frequency range will be from 100 Hz to approximate 1000 Hz. Any low-power pnp transistors such as the 2N190, 2N107, 2N188, etc. will perform well.

As shown in the schematic the 2-section 5-position selector switch is used so you can select other waveforms. (Fig. 2) generated by the multivibrator.

The waveform in Fig. 2-a is the negative-going sawtooth obtained when the selector switch is in position 1. Fig. 2-b is the positive-going sawtooth obtained with the switch in position 1 and the output leads reversed. Figs. 2-c, d and e are obtained with the selector at 2, 3 and 4, respectively. —*Charles D. Rakes.* **R-E**

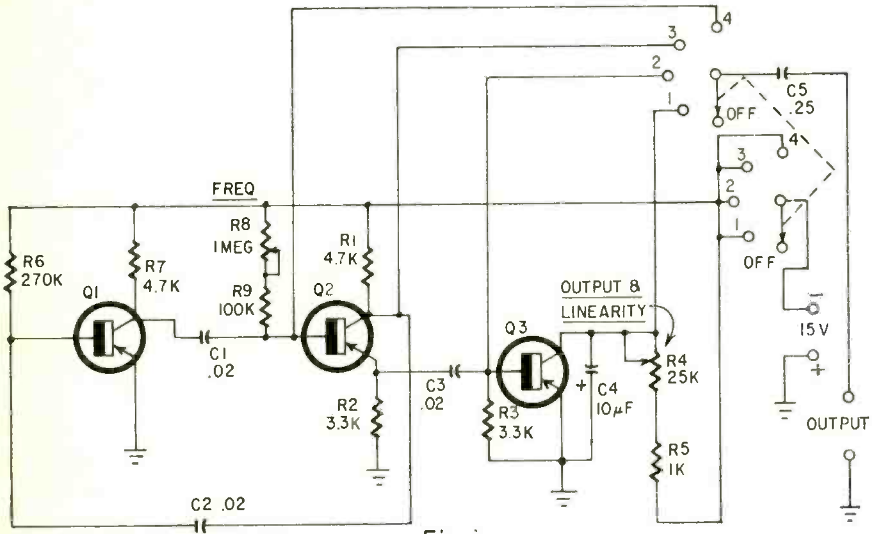


Fig. 1

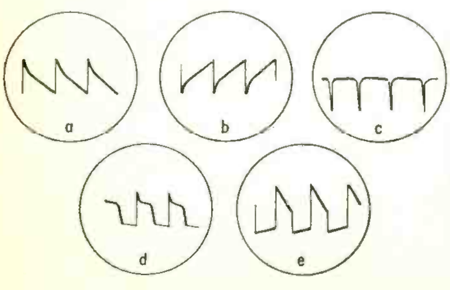


Fig. 2

MARKET CENTER

AUDIO — HI-FI

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INTEGRATED CIRCUIT KITS: Computers, audio, others. 1970 catalog free. **KAYE ENGINEERING,** Box 3932-D, Long Beach, California 90803

ELECTRONICS

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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 136 on reader service card

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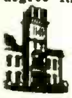

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(continued from page 88)

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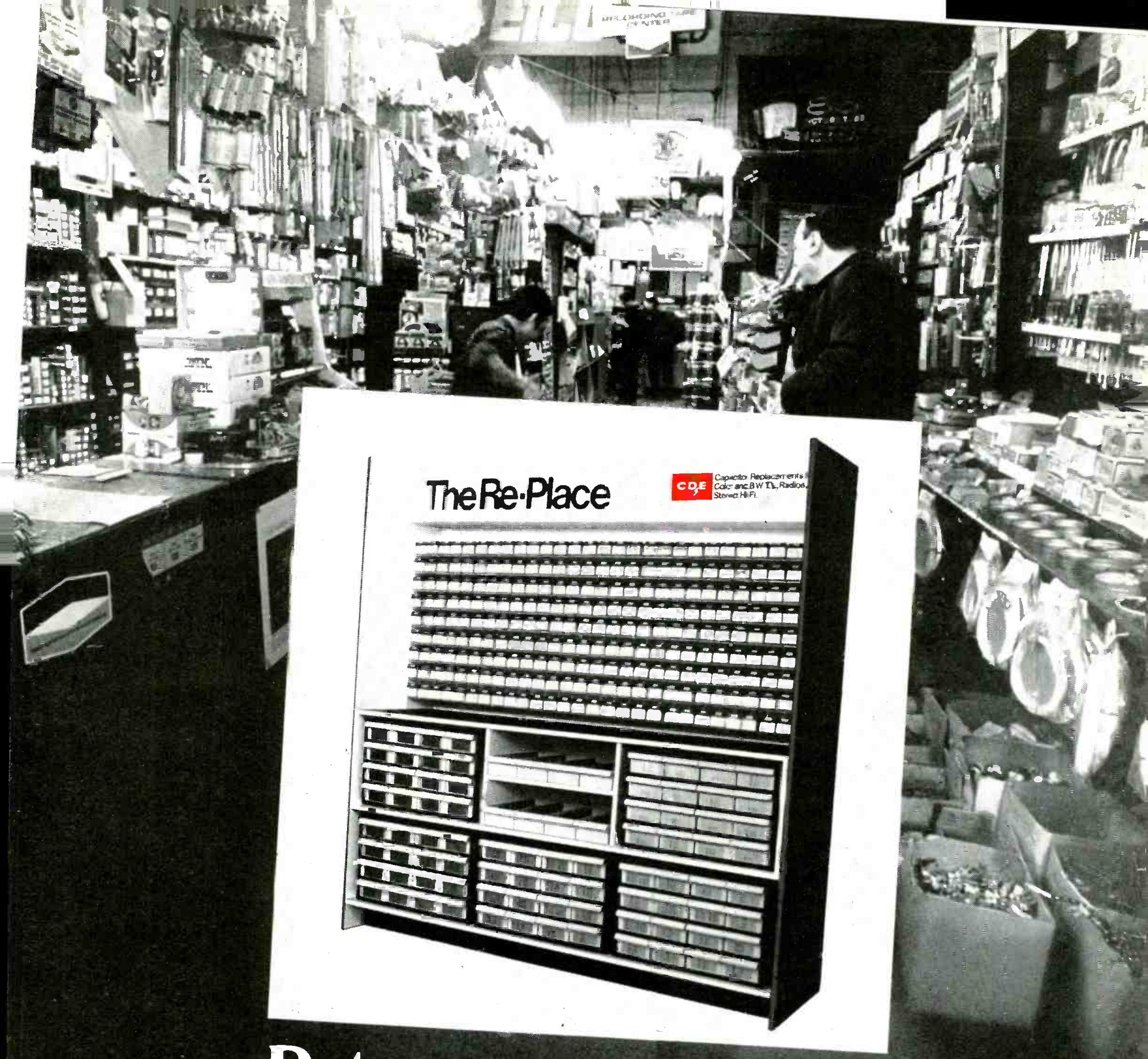

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