R-E TESTS — New color antennas

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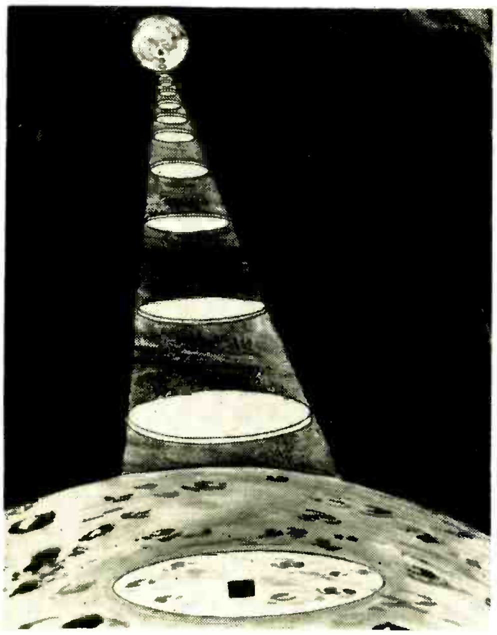
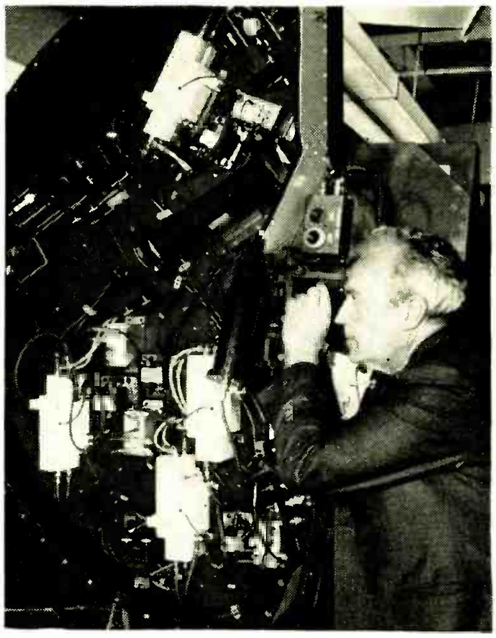
NEW & TIMELY

Volume 40 Number 9 RADIO-ELECTRONICS September 1969

LIGHT 'DISCS' PINPOINT DISTANCE TO THE MOON





A small reflector aimed at earth by Apollo 11 astronauts from the moon's surface is being used with a telescope-mounted laser for precise measurements of the distance to the moon.

The laser is used to fire 10-nsec bursts of light through a 60-inch Air Force telescope on an Arizona mountain top. The light pulses are 10 feet thick and 2½ miles wide when they finally reach the lunar surface. The minute portion of light reflected back to the telescope is timed by a cesium-beam atomic clock, which pinpoints the distance to within 1½ meters.

Dr. Renne S. Julian (photo), the Hughes Aircraft Co. scientist who built the rangefinder system for the A.F., said the laser can also be used to determine continental drift and "wandering" of the earth's poles in addition to other measurements.

The Q-switched ruby laser has three amplifier ruby stages that produce 10-Joule pulses. The pulse beam diverges 2 seconds of arc as it leaves the telescope.

LOOKING AHEAD

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

More bright color tubes

Picture brightness definitely will be a competitive weapon in the 1970 color sets. In addition to the high-brightness tubes reported last month, new super-bright versions have now been reported by Zenith, Sylvania, Westinghouse and Admiral.

The Zenith "Chromacolor" tube is quite a radical departure from conventional shadow-mask tube design, and is claimed to deliver 117% more brightness and 25% greater contrast than Zenith's previous model. While the standard shadow-mask tube has phosphor dots larger than the electron beam which excites them, Zenith's tube has a larger electron beam and smaller phosphor dots, with a contrast-enhancing black "surround" providing a "guard band" between the phosphor dots.

Zenith calls its mask an "iris mask" because the holes are enlarged after the phosphor dots are deposited, to make possible the larger electron beam. A higher light-transmission glass is used in the faceplate, since a low-transmission glass isn't needed to provide contrast. Zenith plans to phase into production a new electron gun to further increase brightness and resolution.

Computerized production

RCA recently lifted the curtain on phase one of a project which has quietly been in the works for some eight years—an electronically controlled plant to produce elec-

(continued on page 4)

CASSETTE CARTRIDGES HOLD 1 HOUR OF VTR

A prototype video tape recorder that uses cassette tape cartridges has been built by Sony Corp. The company expects to sell the cassette vtr within two years for about $500. Prerecorded tapes would cost about $28 and last for 1000 replays.

The cassettes use two tracks on a 1-inch tape, and at the vtr's 3¼-inches per second provide one hour of playing time. If successfully marketed, the Sony VTR could provide stiff competition for the CBS electronic video recording system that uses a special film instead of magnetic tape. ("Looking Ahead," February, 1969). The EVR system may also reach the consumer market within a few years.

SEMICONDUCTORS FOR LARGE-SCALE HEATING

The use of glassy semiconductor materials for large-scale heating was predicted by a British solid-state physicist. Writing in the *New Scientist*, Prof. A.K. Jonscher said that cheap resistive solid-state materials for heating buildings and roads is feasible "in the near future."

Glassy or amphorous semiconductors have so far been used only for bistable switching and memory elements (see "All About Ovonics," RADIO-ELECTRONICS, May, 1969). They can be manufactured in large quantities since a crystal growing process involving strict purity control is not a requirement.

IN THIS ISSUE

Tired of having to cross the room to turn off your TV set? Why not build a remote control that can operate anything you plug into it. It's foolproof against false triggering.

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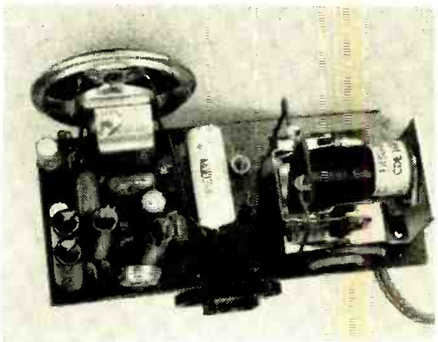
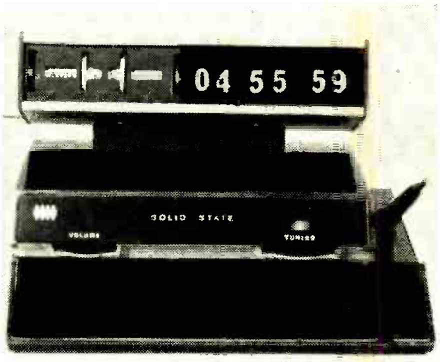
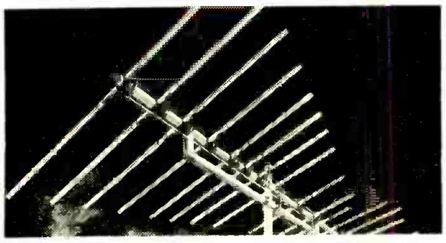


Sonic Remote-Control unit features a solid-state filter to prevent false triggering. see page 36



IC Digital Clock electronically winks off hours, minutes and seconds. For complete details . . . see page 43



Up in the air over TV antennas? Read the results of R-E's down-to-earth field tests. see page 23

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FIBER OPTICS USED IN SEC TUBE

CORNING, N.Y.—Tiny glass light pipes 12 times smaller in diameter than a human hair help provide the rapid-scan color telecasts from space in the Apollo series.

The fiber optics are used in the Westinghouse SEC (secondary electron conduction) TV camera tube (photo), first used for color broadcasts from Apollo 10. A precise mosaic of the fibers are fused to the faceplace of the camera tube for this application of the fibers.

One side of the tube's fiber optic faceplate is coated with a photosensitive material that converts light into electrons. The fiber optics used in the TV camera tube were made by Corning Glass Works.

USSR RADIO JAMMING REACHES NEW PEAK

A sharp increase in jamming of Voice of America broadcasts to the Soviet Union has been attributed to improved Russian technical skill or better use of old equipment. The interference with Russian and Ukrainian language programs now exceeds the level reached in 1963 before jamming was halted.

United States Information Agency officials said the decision to resume jamming was made after the Czechoslovakian invasion last summer. Officials told *The New York Times* they could see no political motive for the jamming.

NEXT MONTH

October is a hi-fi spectacular. There's a 200-watt stereo project built entirely with IC's. Once you've built one, hook up the 10-channel IC color organ project we'll also present. There's more audio too!

NEW ZENITH TUBE

CHICAGO—A new 23-inch color TV picture tube dubbed the Chromacolor tube has been introduced by Zenith for its 1970 line. The tube features a black-surround for the phosphor dots. This permits use of high-transmission glass with 25% greater contrast and twice the brightness of conventional tubes. RCA announced a similar color tube earlier (New & Timely, August).

Key to the Chromacolor's performance is a new iris (shadow) mask. The mask allows smaller and more efficient phosphor dots in conjunction with a larger electron beam. The entire phosphor dot area is "excited" instead of only 45–65% of the dot area as with conventional tubes. The Chromacolor incorporates a new rare-earth red phosphor and more efficient green and blue phosphors.

COMPUTER 'SPIES'

A cloak and dagger case involving computer "spies" was recently disclosed by the West German magazine *Der Spiegel*. An engineer employed at a West German computing center apparently duplicated magnetic tapes containing considerable data about the personnel, production, policy and profits of some 3000 German firms. The duplicate tapes were then handed over to the East Germans. According to the magazine, the engineer also supplied information on the best IBM computer model for decoding the tapes.

ELECTRONIC MAGAZINE TO USE EVR

The first issue of an "electronic" magazine will be published in 1970 by Delta Publications and TeleGeneral Corp. The biweekly magazine will be published on electronic video recording (EVR) cartridges, recently introduced by CBS.

The magazine, *Computer TeleJournal*, will cover the electronic data processing field with news and visual training articles. The journal will be supported by TV-type commercials. *TeleJournal* plans to initially distribute 200 VTR editions this fall, and expand production to some 500 cartridges next spring.

IN THIS ISSUE

Use the right tool for the job. You've heard it before, but where do you find out what the right tool is? Starting this month we're presenting a special clip-and-file series by Tom Haskett to explain the ins and outs of electronic tools.

LOOKING AHEAD

(continued from page 2)

tronic equipment. The company revealed that it is now building stereo-FM-AM tuners for its phonograph consoles in a computerized plant near Indianapolis, which is the pilot for computerization of all of RCA's consumer product operations in the next 10 years.

The tuner being produced by the computer-controlled system was also computer-designed, uses only 70 parts compared with 294 discrete components in a typical tuner. At the heart of the tuner are 16 thick-film ceramic modules. RCA claims the design of this single item would have taken 10 years if accomplished without computerization.

In RCA's plant, each step in production—from raw materials through subassemblies to final product—is checked by computer, which not only detects errors in assembly but tells how to correct them. RCA believes this computer production system eventually will eliminate conventional components, building products from raw materials in a single plant. It also saves time and inventory, and can be quickly responsive to market conditions, by automatically gearing production to computer information on market demand.

A company spokesman says a computerized plant may reduce the production time for a color television set from 30 to four days—at the same time reducing costs by eliminating many assembly operations and cutting down rejects and excessive inventories of parts and finished products.

Thin black-and-white tube

Philco-Ford is now showing a prototype thin monochrome TV set with 13-inch screen, which is only 5½ inches deep—and with no "doghouse" on the back. The secret is in the picture tube, whose neck emerges at an oblique angle from one side, instead of straight out the back.

Although production plans haven't been disclosed, Philco says costs would be about the same as for a conventionally designed b-w receiver. The tube is made from two pieces of flat pressed glass for front and rear panels. Distortion is corrected by a rectangular yoke and magnetic deflection circuits.

More video players

The search for a practical home video player is taking

(continued on page 6)

new directions. The latest proposal, under serious study by a major firm, is believed to involve a "self-destruct" principle. Not a recorder, but a playback-only device, the product is designed to play special video tape cartridges which can be run through the machine only once—can't be rewound—and must then be exchanged for new program material.

The machine, understood to be under development by Cartridge TV, Inc., is believed to be backed by Avco Corp., a conglomerate firm with large interests in the entertainment and television broadcasting field. The cartridge uses quarter-inch tape, helically scanned.

Another machine which uses quarter-inch helically-scanned tape is about to go into production. Although not designed for consumer use, it's noteworthy because of its extremely compact size and low weight—only 16 pounds. The four-piece package includes a recorder-playback machine, which operates for 20 minutes on a 5-inch reel, a combination microphone-camera, a monitor with 3-inch screen, and a rechargeable battery pack. The combination, by Roberts Electronics, is expected to be available next year at about $1700. It records and plays back in monochrome only.

TV X-ray regulations

Department of Health, Education and Welfare has proposed X-Ray safety standards for color television receivers—but they were quickly called back for further study when a technical advisory committee objected.

The proposed standards would have accepted the current upper limit of 0.5 milliroentgens per hour at 5 centimeters from any surface of the receiver, but modified this limit to apply to "any point accessible to an individual under any conditions of operation or service." In addition, the limit would have been reduced to 0.1 milliroentgens as of mid-1972.

Members of the technical advisory committee, composed of members drawn from science, industry and the general public, noted that no instrument had yet been devised that could consistently measure radiation at the 0.1-milliroentgen point, which in many cases could be lower than the general background radiation. The government agreed to restudy the subject.

Both industry and government agree that it is desirable to eliminate all possibilities of radiation from color television receivers. A workable standard must be developed by January 1, under the Radiation Health and Safety Act of 1969.

Unusual new products

Each year, some unique new electronic products are introduced. Many are never heard from again, while a select few actually make it at the marketplace. Here are some we observed recently:

A four-screen television set, very similar to one described several years ago in RADIO-ELECTRONICS by Hugo Gernsback, is being manufactured in Germany by Nordmende, which says it will export a U.S.-standards version next year. The receiver has a 23-inch color tube at viewing level, with three small monochrome tubes arrayed below it. It can simultaneously display the programs of four channels and is designed for those who must—or wish to—know what's on four stations at once. Suggested U.S. price: about $2500.

The success of the cassette has prompted TDK Corp. of Japan to demonstrate a micro-cassette, one quarter the size of a standard cassette. It is claimed to play for 45 to 60 minutes to 15/16 ips. Olympus Optical Co. will soon introduce a vest-pocket cassette recorder designed to use the razor-blade-size cassette.

A very vocal automobile burglar alarm will be marketed soon by Ballistics Control Corp. It's also a two-track cartridge tape player. Just before the car is locked, a special cartridge is inserted in the player and locked into place. If the vehicle is broken into, the tape starts to play, screaming: "Help, help, I am being stolen!" A special switch defeats the volume control to let the player shout at ear-splitting level. **R-E**

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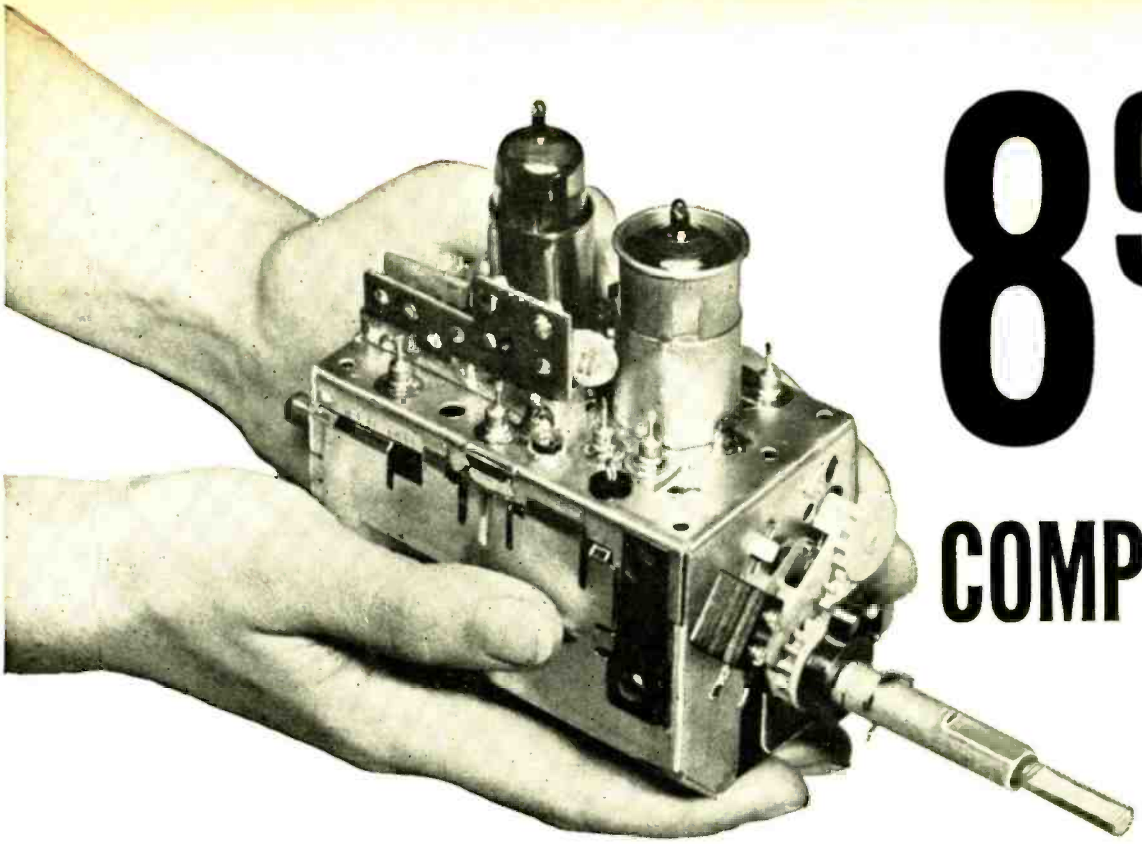

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CR6XL	Parallel 6.3v	2½″	12″	41.25	45.75	10.45
CR7XL	Series 600mA	2½″	12″	41.25	45.75	11.00
CR9XL	Series 450mA	2½″	12″	41.25	45.75	11.00

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

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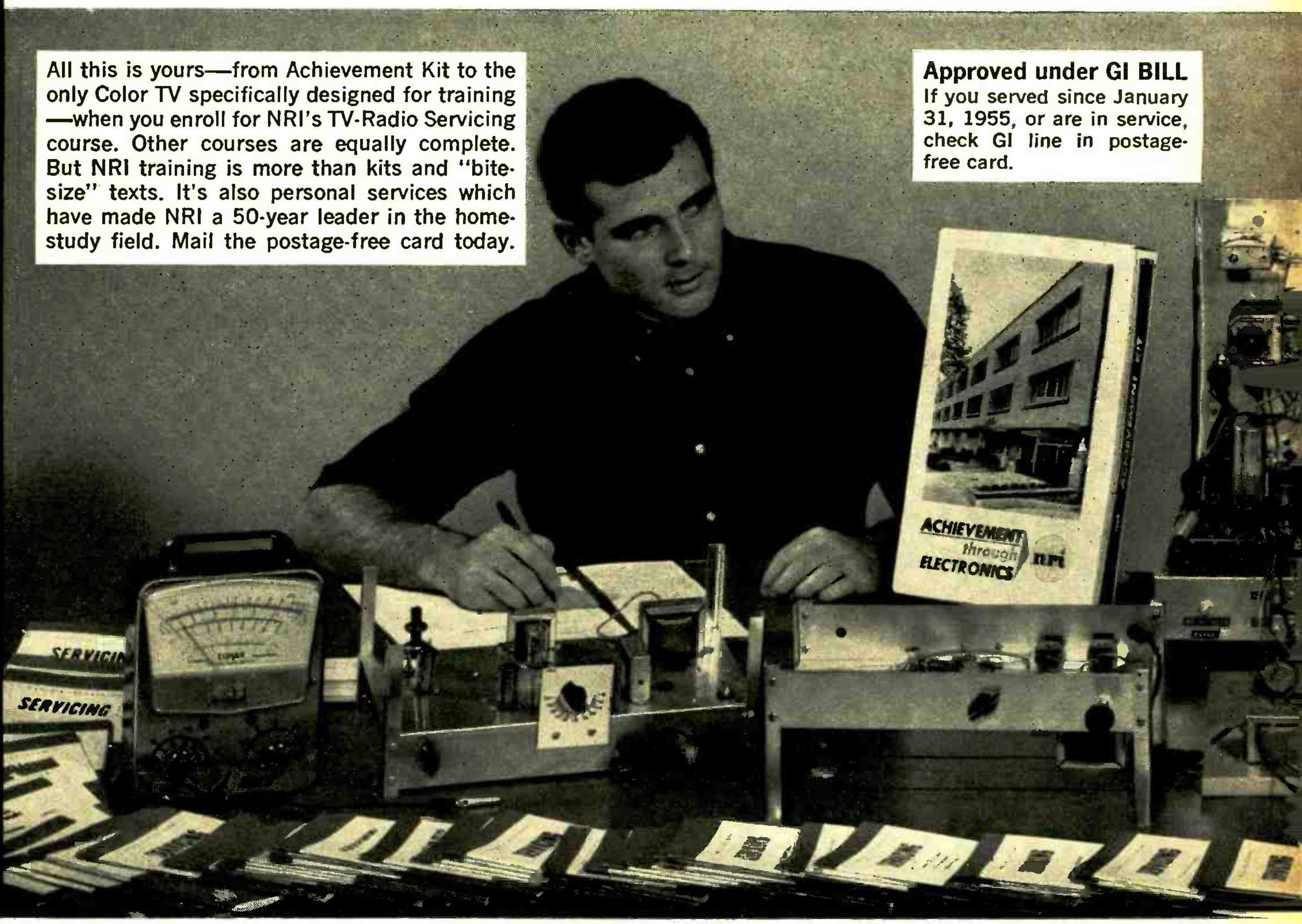

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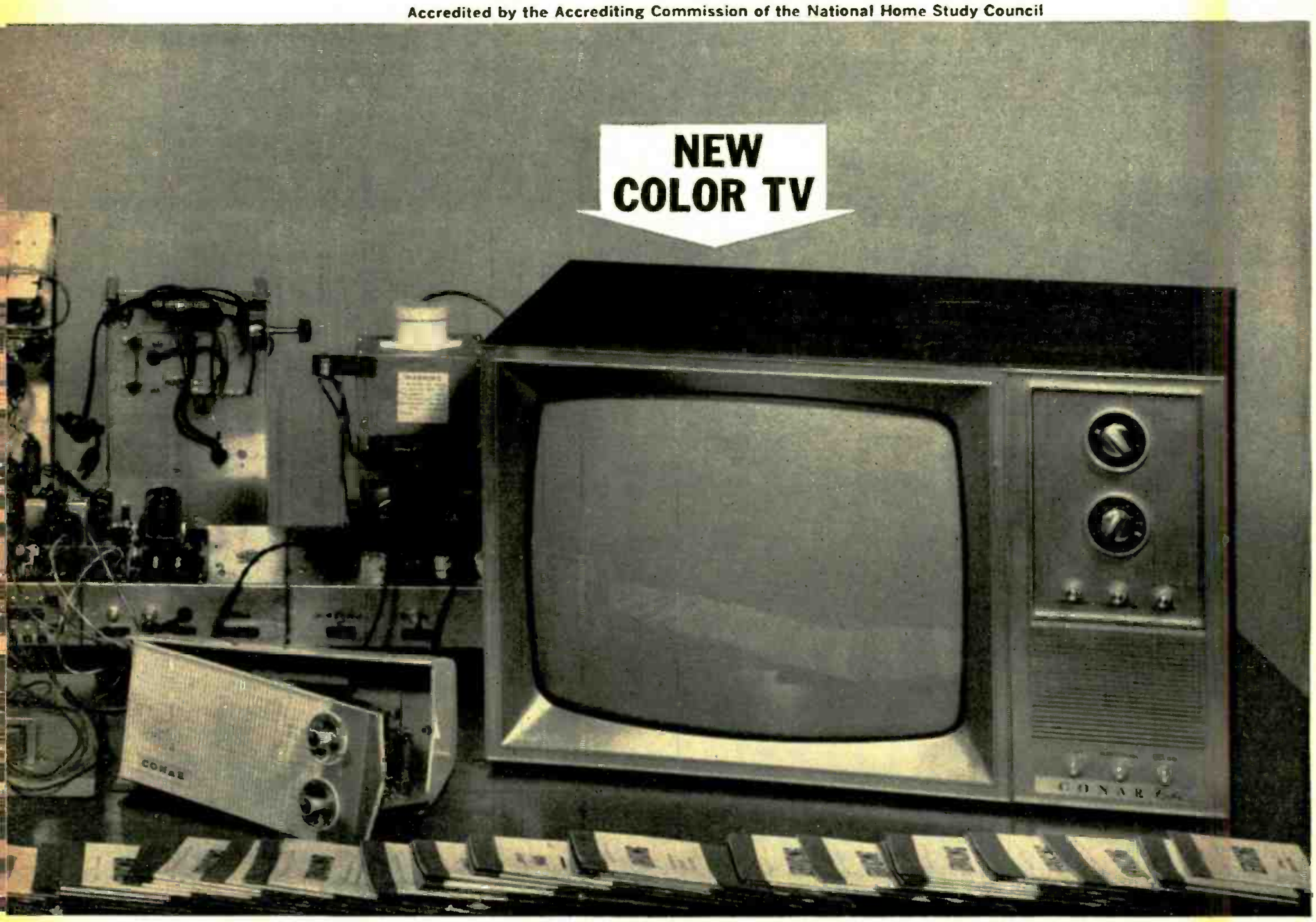

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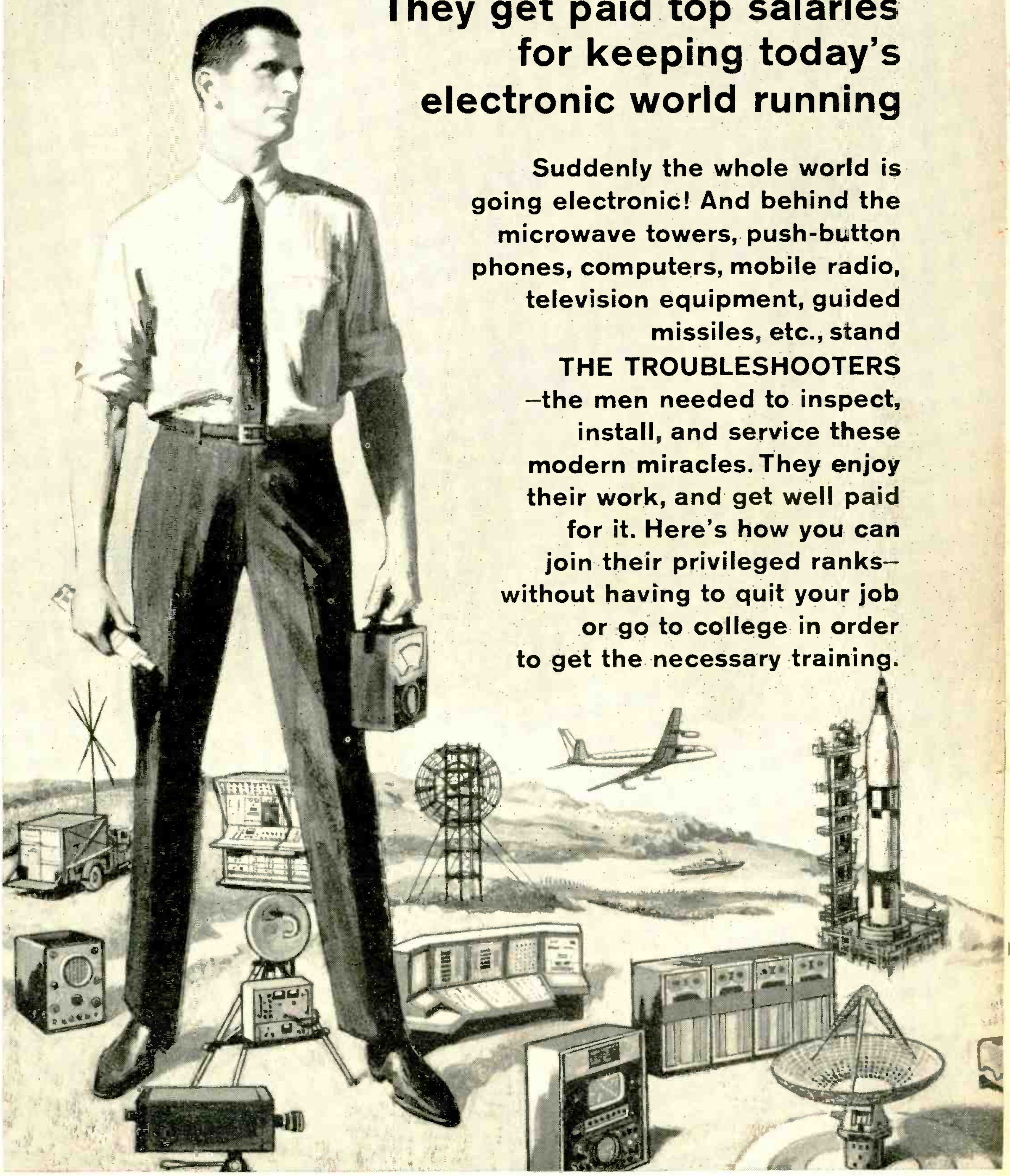

Suddenly the whole world is going electronic! And behind the microwave towers, push-button phones, computers, mobile radio, television equipment, guided missiles, etc., stand THE TROUBLESHOOTERS—the men needed to inspect, install, and service these modern miracles. They enjoy their work, and get well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

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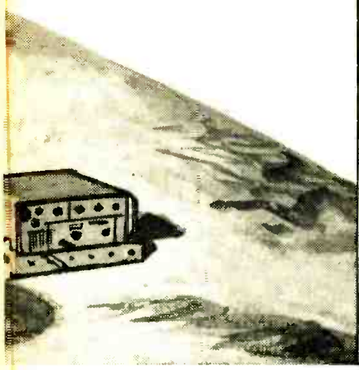

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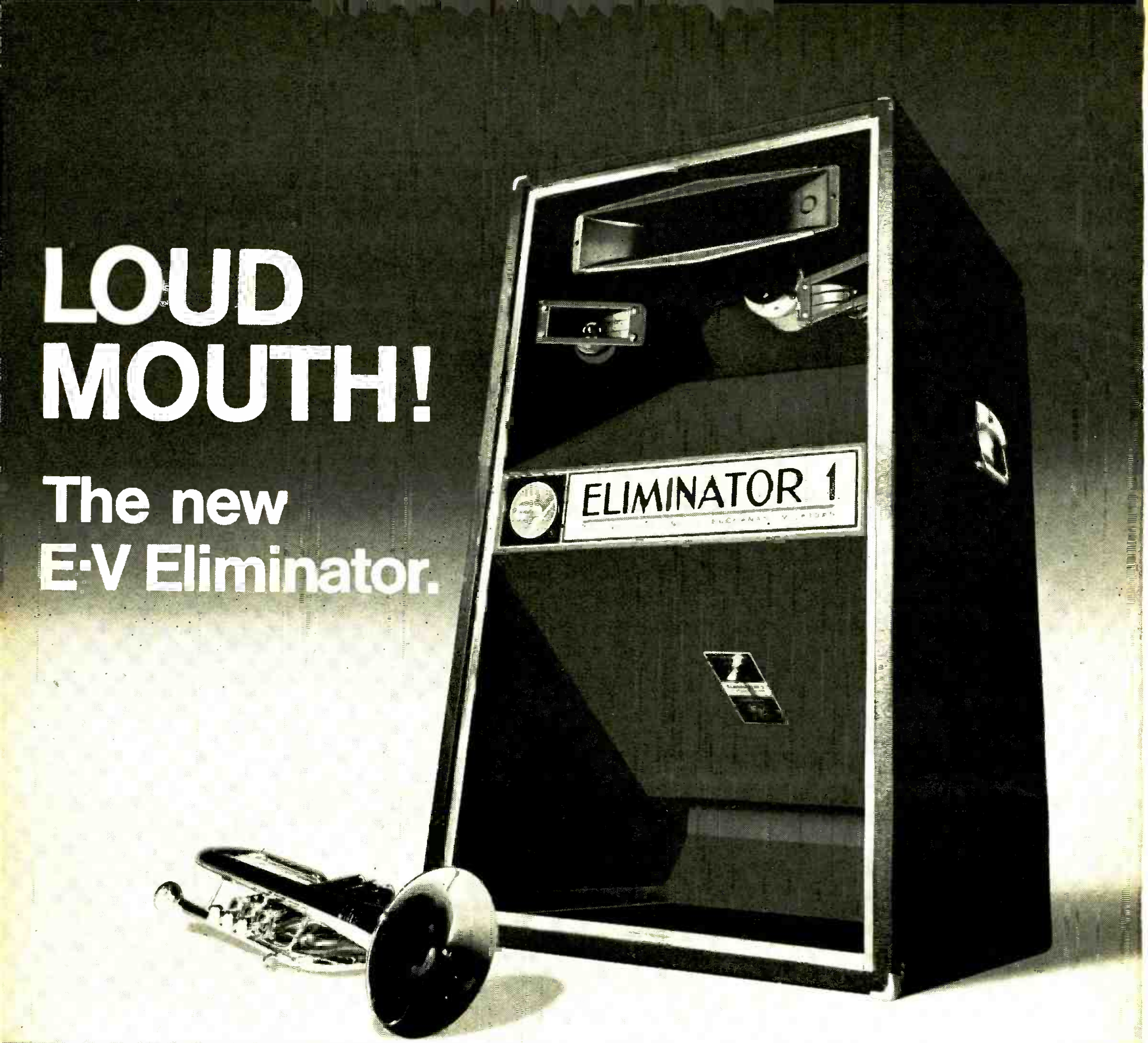

The first Eliminator was built to prove a point. Because young musicians, in a search for more volume, were literally driving the guts out of some very good speakers mounted in some very poor enclosures.

It started an intensive investigation into the failure of speakers (ours and the competition) used by guitars and organs. The testing was very rugged. For instance, we took miles of high-speed motion pictures while test speakers destroyed themselves with sound.

We found out a lot about how to improve our speakers. But we also learned that by simply putting our SRO/15 speaker in a folded horn enclosure we created a combination that was unbeatable for efficiency, high power handling capacity, low distortion, and extended bass. It was an important first step.

Of course, this now meant we needed a solid high end. So we added the time-tested 1829 treble driver and 8HD horn, or (optionally) a T25A treble driver plus a pair of T35 super tweeters. These combinations were a revelation to musicians. They got more sound power per watt than they thought possible. And they could use the Eliminator for both vocals or instruments.

But we weren't quite satisfied. If the Eliminator was good for popular music, what would it do with other kinds of program material? So we tested it in good rooms and bad rooms. With test instruments and with live audiences. And we decided that the Eliminator was too good to sell only to the young.

For example, in one test installation in a difficult domed building, four E-V Eliminator 1 speakers far out performed an elaborate multicell installation in naturalness of sound for voice and music, in uniform sound pressure level throughout the listening area, and in the ability to reproduce the extremes of loudness of a big, driving jazz band with ease.

Granted, the E-V Eliminators have a flash of chrome. But don't be misled. They perform to beat the band. And they solve problems. Get turned on to the great sound of the E-V Eliminators today. It can open up an important new market...and shock your old ones!

ELIMINATOR I 3-way system: Response 55-15,000 Hz; Power Handling Capacity 100 watts RMS (white noise shaped to stringent lead guitar frequency spectrum); Dispersion 100°; Sound Pressure Level 122 db at 4' with full power input; Suggested Resale $339.50.

ELIMINATOR II 2-way system: Response 55 to 10,000 Hz; Power Handling Capacity 100 watts RMS (shaped to stringent lead guitar frequency spectrum); Dispersion 100°; Sound Pressure Level 123 db at 4' with full power input; Suggested Resale $319.50.

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R-E TESTS—

New antennas for color TV

by LARRY STECKLER
MANAGING EDITOR

HOW DO YOU TEST A COLOR TV ANTENNA? IN THE ANtenna lab you set it up on a mast equipped with a rotator. The mast is carefully located so it is shielded from actual broadcast TV signals. Then you set up a transmitting antenna at some specific distance from the TV antenna. Next you transmit a constant strength signal at the desired frequency and measure the signal strength being received. While receiving the signal you rotate the TV antenna and draw a pattern that shows the receiving antenna's characteristics.

That's great for an antenna manufacturer who is trying to design his antenna to deliver maximum gain and minimum side lobes. But in practical use it is just a little bit different. For once you have erected an antenna on your roof you're no longer in the laboratory. That antenna will be receiving signals from a number of transmitters simultaneously. It will be picking up both direct and reflected signals. It will not be perfectly matched to your TV receiver every time. And what you are really interested in is "what kind of picture it will deliver?"

So we performed practical viewing tests of the antennas mentioned in this article. We picked three locations in Long Island, New York at distances of 25, 45, and 75 miles from the transmitting antennas atop the Empire State Building in New York City. We connected these antennas to a Heathkit GR-681 color TV receiver (23-inch screen) with a 50-ft length of 300-ohm twin-lead. Then we viewed and reported on the results. We used the same set at all three locations. We mounted all the antennas in the same spot, on the same mast, one at a time in each location, and we rated the reception we viewed.

Excellent, good, fair or poor!

Now, how did we rate reception? We've labeled what was viewed as excellent, good, fair, and poor. An "excellent" picture means perfect reception—no snow, no ghosts, no wavering, no confetti, no color drifting in and out, and more than adequate signal strength. In some instances some of the antennas we tested were "too good" for the distance. They delivered so much signal that it was necessary to reduce the amount of signal delivered to the receiver with a resitive pad. These show up in the listings as excellent* (note the asterisk).

A "good" picture is also no snow, no ghosts, clear and sharp, no confetti and no color drift. But in this instance signal strength at the set was just adequate and any interference, like that caused by a plane passing overhead would upset the perfect appearance.

A "fair" picture is one with minimal but visible amount of snow indicating insufficient signal strength. Color would occasionally fade out for brief intervals and confetti would become visible. An antenna rated fair could be used, but a more elaborate antenna is indicated. Note however, that if an antenna is rated "fair", at say a distance of 45 miles, it might well be rated "excellent" at 25 miles.

A "poor" picture is one that is unpleasant to watch. There is heavy "snow", the picture is not clear, and wavering flickering and noise is common as is lack of color and heavy confetti. Again, the same antenna, moved closer to the transmitter will be upgraded. For clarification a set of photographs illustrate the various types of signal reception conditions just described.

Are they all the same?

Yes and no is the only answer to that one. Most antennas in a given price range do seem to offer similar performance, but they are made differently, they don't look alike and offer different fringe benefits.

Almost every TV antenna made today is weatherproofed. This is done by coating the aluminum elements with either a colorful (usually gold) finish. The purpose is to protect the aluminum elements against corrosion. The color is usually intended to make the protection visible and prove that it is there. Actually, this protection is more cosmetic than anything else.

For when aluminum corrodes (oxidizes) it forms a thin white layer of oxide and the process stops. It is not like a piece of steel rusting. That process continues until there is no steel left. So while that white oxide coating might not look too good, it will have little effect on how well the antenna works or how long it lasts.

As to appearance, this depends upon the theory around which the antenna is built. One type uses a group of very similar elements one behind the other and each one shorter than the one in front of it (longer if you count the other way). Another trend is equal size elements. Still another uses a multitude of varied length elements in what seems like a haphazard manner. But no matter what the shape and physical appearance it's the performance that counts.

There are other physical differences that can make a difference. For example, Sylvania uses seamless tubing to make the elements of their antennas. If you want to mount your antenna in an area where high winds are common, the added strength of this type construction could be extremely advantageous.

Booster amplifiers can be added.

Several makes of antennas provide for mast- or boon-mounted booster amplifiers. This is important if you are in a reception area where an amplifier is required. If you can't mast-mount the amplifier and have to locate it at the set it may not do the job you

EXCELLENT

GOOD

expect from it.

If the antenna you select is physically long; long enough to require additional bracing, look for a unit that includes a brace or has a double boon to provide that needed additional support. In any event, if you use a large antenna you will probably have to provide guy-wire supports to prevent it from breaking off the mast in high winds or wintertime icing and snow conditions.

One word about masts here. If at all possible use a galvanized steel mast. Sure, they may rust, but they are considerably stronger than an aluminum mast of the same dimensions.

Antenna installation techniques

Every antenna we tested was a fold-out design. That means that after you are up on the roof you fold out the antenna elements, lock them into place and then put the antenna on the mast. This way you don't have to handle an assembled antenna and try to get up on the roof at the same time.

When installing an antenna, there are some basic precautions you should observe:

1. Make sure there are no dangerous obstructions close by—high voltage wires are a particular danger.

2. Whenever possible enlist the aid of another person. Two-man antenna installations are much easier and safer.

3. Avoid installing antennas on windy days.

4. If the roof has an uncomfortable pitch, use a safety rope fastening you to some secure point to protect against falling off the roof.

5. Always ground the mast and use a lightning arrester on the antenna lead-in. And ground to a secure ground not just any old pipe sticking out the roof.

What about FM

Many all-channel vhf TV antennas act as a good FM antenna too, but some are designed to deliberately eliminate FM reception to improve performance on TV frequencies. So if FM reception is important, pick an antenna designed to deliver it.

UHF antenna tests to come

We made no tests of uhf performance and therefore the table only details reception of channels of 2 through 13. We did however test the vhf performance of vhf-uhf combination antennas.

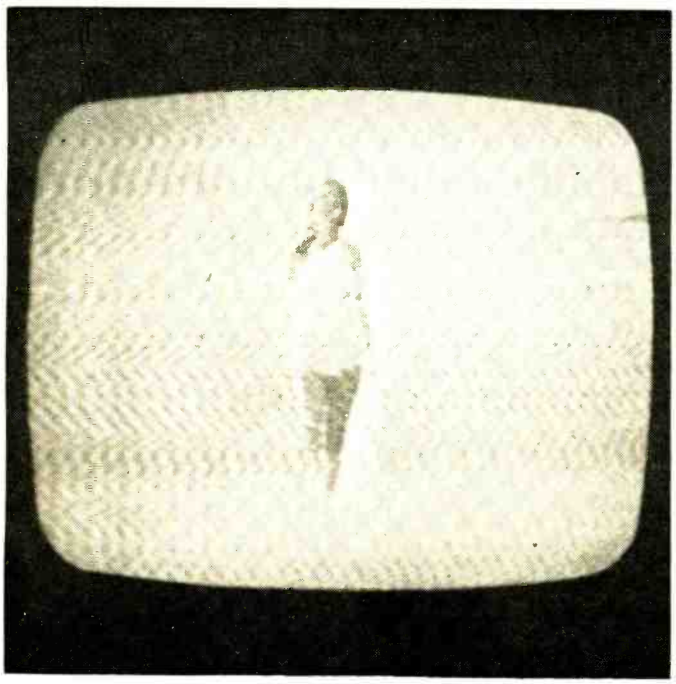
Miscellaneous notes of this and that

Many of the combination types include frequency splitters. These devices attach to the antenna terminals of the TV receiver and couple the set to the antenna lead-in. Separate connection for the uhf and vhf terminals on the set are provided. Make sure the appropriate leads are connected to the appropriate terminals. In some instances a three-way splitter is provided to break the signal coming down the lead-in into vhf, uhf and FM frequencies.

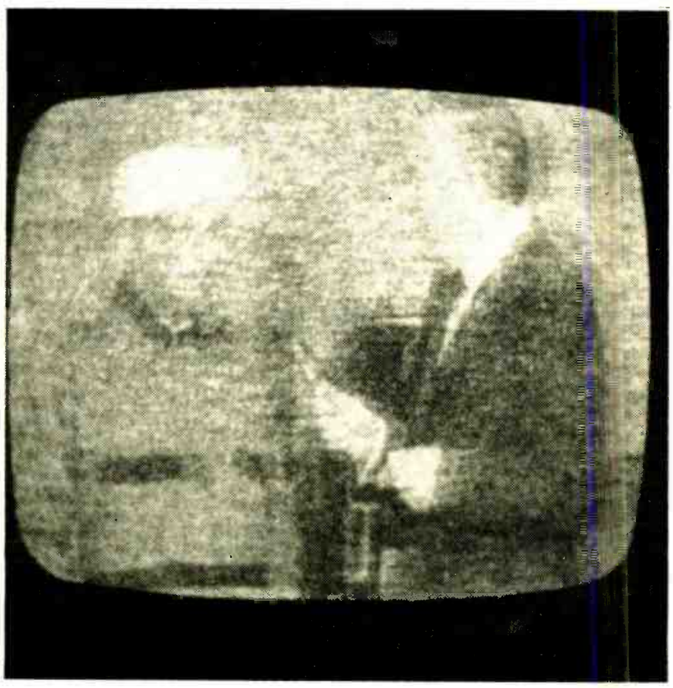
One antenna maker, Winegard issues a special 2-year warranty with their antenna. It provides that should your antenna be damaged by wind or other weather conditions during this period, it will be replaced at a fixed price that is about 40% less than the full list price of the antenna at the time of purchase. A complete price replacement schedule is included with each warranty. This price does not include installation charges.

The table on antenna performance is on the next page. We feel you will find it a valuable aid in selecting the antenna that's best for you. **R-E**

FAIR



POOR



ANTENNA PERFORMANCE TEST RESULTS

MANUFACTURER	MODEL	PERFORMANCE AT DISTANCE OF		
		25 MILES	45 MILES	70 MILES
Channel Master Ellenville, New York	1210 1211 3661 3617	Excellent* Excellent* Excellent* Excellent*	Excellent* Excellent* Excellent Excellent	Excellent Excellent Good Good
The Finney Company 34 West Interstate St. Bedford, Ohio 44146 **Also available in 75-ohm version	CSV-7** CSV-10** CSV-18** CSB-2** CSC-3 CSD-3	Excellent Excellent Excellent* Good Excellent Excellent	Good Excellent Excellent* Fair Good Excellent	Poor Good Excellent Poor Fair Good
Gavin Instruments Inc. 1450 U.S. Route 22 Sommerville, N.J. 08876	1011SB 1015SB 1019C 1113B 1118B 1122B	Excellent* Excellent* Excellent* Excellent* Excellent* Excellent*	Good Excellent Excellent* Good Excellent Excellent	Fair Good Excellent Poor Good Good
Jerrold Electronics Corp. 401 Walnut St. Philadelphia. Pa. 19106	PIX-45 CG-82 PX-B50 VU-934	Good Excellent Good Excellent*	Good Good Fair Excellent	Fair Fair Poor Excellent
JFD Electronics Corp. 1462 62nd St. Brooklyn, N.Y. 11219	LPV-VU90 LPV-VU120 LPV VU150 LPV-VU180 LP-TV100 LP-TV130 LP-TV160 LP-TV190	Excellent Excellent* Excellent* Excellent* Excellent Excellent* Excellent* Excellent*	Good Excellent Excellent* Excellent* Good Excellent Excellent Excellent*	Poor Fair Good Excellent Poor Fair Good Excellent
Kay-Townes Antenna Co. P.O. Box 593 Rome, Ga. 30161	CT-18G CT-24G CT-30G CT-34G CT-42G	Excellent Excellent Excellent* Excellent* Excellent*	Fair Good Good Excellent Excellent*	Poor Fair Fair Good Excellent
RCA Corp. Parts & Accessories 2000 Clements Bridge Rd. Deptford, N.J.08096	10B910 10B917 10B920 10B925 10B930	Excellent Excellent* Excellent* Excellent* Excellent*	Good Good Excellent Excellent* Excellent*	Poor Fair Good Good Excellent
S&A Electronics, Inc. 202 W. Florence St. Toledo, Ohio 43605	ST-20 UVM-30 UVM-40	Excellent* Excellent* Excellent*	Excellent Good Excellent	Excellent Fair Good
Sylvania Electric Co. 730 Third Ave. New York, N.Y. 10017	10VU 20VU 30VU	Excellent Excellent* Excellent*	Good Excellent Excellent*	Fair Good Excellent
Winegard Co. 3000 Kirkwood St. Burlington, Iowa 52602	CW-46 CW-48 SC-80 SC-81 SC-52 SC-53 SC-54	Excellent Excellent* Excellent Excellent* Excellent Excellent* Excellent*	Fair Good Good Good Good Excellent Excellent*	Poor Poor Fair Good Fair Good Excellent
Zenith Sales Co. 1900 N. Austin Ave. Chicago, Ill. 60639	973-87 973-92	Excellent Excellent*	Good Excellent	Fair Good

*Required pad at antenna terminals of TV set.

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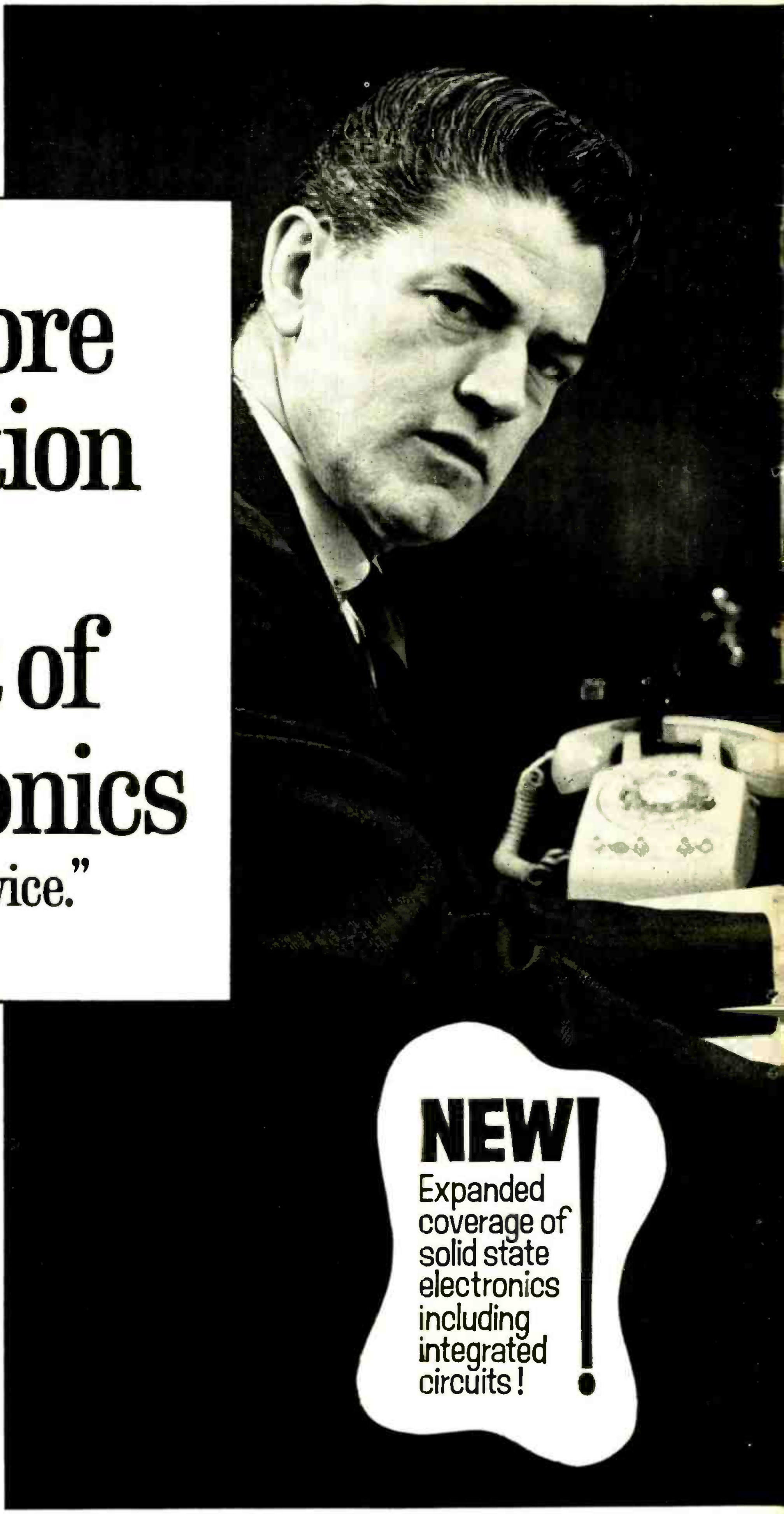

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Knight-Kit KG-387 90-watt guitar amplifier kit

This kit is only part kit. The speaker system which used two 12-inch Jensen heavy duty speakers is completely assembled when you receive it. The amplifier unit, which you do assemble yourself, sits piggyback, atop the speaker enclosure.

Assembly is rapid and comparatively easy. The instruction manual is quite clear and precise and the pictorial presentation of the various assembly steps is excellent.

The field-effect transistors used in the preamp stages deliver a low noise level (60 dB down) with distortion free sound.

The high input impedance is an advantage too. It permits maximum transference of deliberate harmonics for better tonal color. The amplifier has two channels with two inputs per channel. The normal channel is intended for the lead instrument or performer. The second channel brings in tremelo and/or reverberation. The tremelo has separate rate and intensity controls for maximum flexibility.

Remote switching through a plug-in foot pedal (it's included with the kit) lets the performer control reverb and tremelo while leaving his hands free.

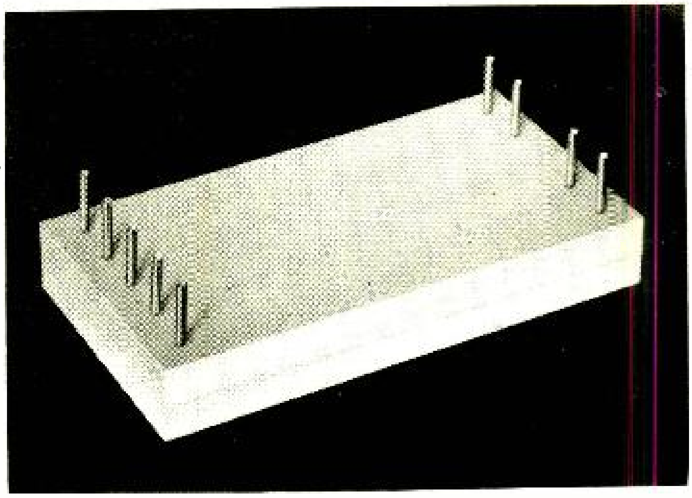
Controls provided are Volume, Treble, and Bass on the normal channel; and Volume, Treble, and Bass, plus Tremelo Intensity, Tremelo Rate, and Reverb Depth.

The units are portable. Each one is provided with a strap-type carrying handle. Total weight is about 50 pounds. The speaker enclosure measures 26½ x 10 x 22¼ inches; the amplifier, 5¾ x 19¾ x 8¾ inches. —*Chester H. Lawrence*

SPECIFICATIONS

Power Output: 90 watts peak music; 30 watts rms
Bass Boost: 9 dB minimum at 80 Hz
Treble Variation: 20 dB at 10 KHz
Reverb Depth: Variable; 75% maximum
Tremelo Depth: Variable; 2 to 10 Hz
Signal-to-Noise Ratio: 60 dB below rated power output
Input Sensitivity: 40 mV for rated output
Input Impedance: 500,000 ohms
Input Capacitance: 10 pF maximum

Power IC's are growing up. This smaller-than-a-matchbox hybrid unit packs a man-size wallop



Experiment With 15-WATT IC POWERHOUSE

By **JIM ASHE**

A FEW YEARS AGO AN AUDIO AMPLIfier delivering several watts of power was regarded as a novelty if it could be packaged into the general dimensions of a book. Now transistor and thick-film technologies have produced a 15-watt IC amplifier so small you can drop one or two in your jacket pocket and forget where you left them.

Bendix Semiconductor Division's BHA-0002 amplifier requires only a few external components, a 30-volt supply and about 350 mV of signal to deliver 15 watts of clean audio into a 3.2-ohm speaker. Yet the IC takes up only about 0.67 cubic inch. In a typical circuit its 3-db points are around 20 Hz and 30 kHz, and its third-harmonic distortion will upset few if any listeners.

Amplifier specifications

The unit is a five-transistor, direct-coupled, complementary output circuit in a convenient 10-terminal package. Mechanical details appear in Fig. 1. For a 15-watt output this building-block device should be mounted on a heat sink equivalent to a piece of ⅛-inch aluminum at least 6 inches square. It may be operated without a heat sink under 2 watts. A key specification is the 30-watt *maximum* dissipation for a case temperature of 122° F. On the test bench, part of the case (arrow) appeared to originate most of the heat, but good practice is to heat-sink the entire bottom surface. A good thermal-

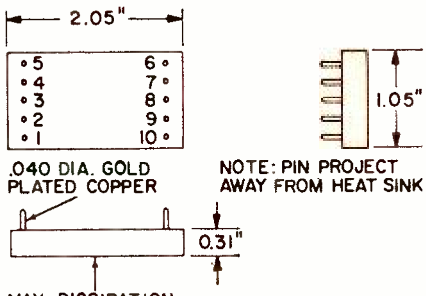
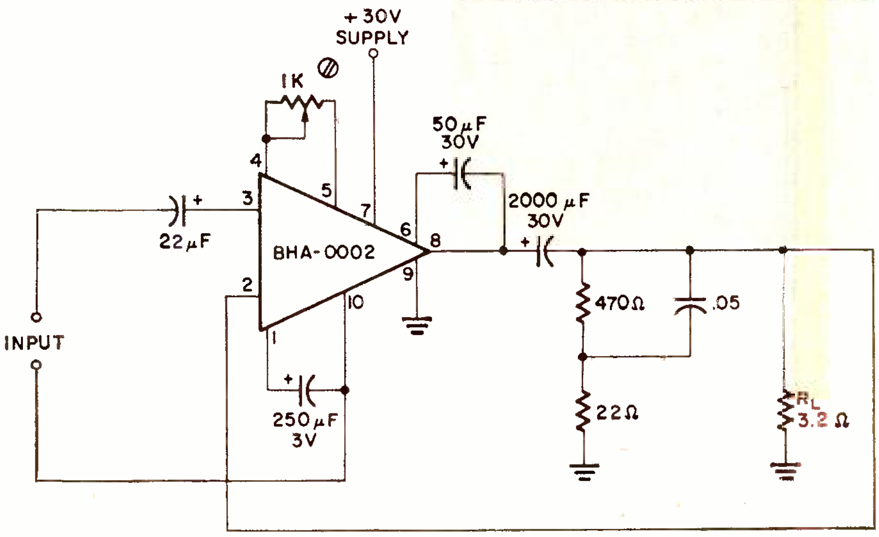


Fig. 1—Mechanical details of Bendix's BHA-0002 15-watt IC power amplifier.

Fig. 2—Use this test circuit, and the IC can be used without alterations for most applications. The 1K pot is adjusted for desired resting current

TABLE I

MAX. SUPPLY VOLTAGE: 40V.
MAX. SUPPLY CURRENT: 1.2 A.
POWER DISS. 30W.
MAX. OPERATING CASE TEMP. 100°C.
POWER GAIN AT 15W., 1 KHz, 60DB TYPICAL
INPUT VOLTAGE AT 15W., 1 KHz, 0.5V MAX.
FREQ. RESPONSE MINUS 2DB POINTS IN TEST CIRCUIT: 25Hz, 20KHz AT 15 W.
EFFICIENCY: 60% MAX.
DISTORTION AT 1KHz 15 W., 1% MAX.
INPUT IMPEDANCE 18K OHMS MAX.
NOISE OUTPUT RELATIVE TO 15 W. OUTPUT WITH OPEN-CIRCUIT INPUT OVER BAND FROM 50Hz TO 10KHz: -70 DB.
THERMAL RESISTANCE FROM JUNCTION TO CASE: 5°C/WATT MAX.



jointing paste should be used, with the IC secured by the convenient bracket provided with the device.

Electrically, the BHA-0002 IC is a low-output-resistance, 60-db gain amplifier. This is *not* 60 db *voltage* gain. There is an impedance reduction from 18,000 ohms input resistance to the 3.2-ohm load, with an actual voltage gain of about 20. Note the rated output of 15 watts into 3.2 ohms is achieved with a 500-mV (maximum) or 350-mV (typical) input.

Complete electrical specifications appear in Table I. Except where indicated, these are test-circuit characteristics (Fig. 2).

Performance curves (Fig. 3) show third-harmonic distortion under 2% and good wide-band response, and indicate distortion doesn't sneak up on you as power level increases. The power vs. voltage chart suggests there's not much to be gained by operating the IC at less than 14 volts. This was verified on the workbench.

This transformerless amplifier cannot develop the same power into an 8- or 16-ohm load that it does into a 3.2-ohm load. If load resistance is doubled, the power delivered into the load goes down by one-half. If you have 8-ohm speakers, a simple solution is to use two in parallel.

How It Works

The BHA-0002 circuit is shown in Fig. 4. There are two input terminals: No. 3, signal input, and No. 4, feedback. Resistors R3 and R4 are of very different values, so these terminals are not interchangeable. Terminal 3 measures 18,000 ohms, so from this and the electrical specs in Table I, we know the driving or preamplifier circuit should be able to deliver a maximum of 0.5 volt into an 18,000-ohm load (see Fig. 5).

In Q1's emitter circuit is terminal 1, which is to be connected to an external emitter-bypass capacitor. The signal from Q1's collector is applied to the bases of Q2 and Q4, and a bit of feedback through C1 provides for a circuit high-frequency rolloff. All voltage gain in the IC takes place in Q1's collector circuit.

Looking at Q2 and Q4, you may think for a moment that we have something really new: a phase-inverting emitter follower. No, transistors Q2 and Q3 add up to an npn Darlington pair, which works as an emitter follower down to terminal 8, while Q4 and Q5 are a complementary Darlington pair acting as another emitter follower from terminal 8 toward ground. In this arrangement, a large signal of either polarity finds an emitter follower in its most effective style of operation—carrying lots of current—to deliver maximum power to the load. This is our quasi-complementary audio amplifier.

From terminal 8 there is a connection back through R2 to the input terminal. If we assign a "plus" to the input and follow it through the circuit and back through R2, we see it comes back minus, so R2 is both feedback and bias resistor. This loop, entirely within the IC, controls overall gain and cannot be adjusted externally. But two other loops are available which have some effect on gain and frequency characteristics.

The first proceeds from output terminal 8 back to terminal 2. This is a positive-feedback boost loop. It increases overall gain slightly, and probably improves positive-going linearity too, although this was not apparent in eyeball oscilloscope checks. The other loop proceeds from the output back to terminal 6. Capacitor values here are not critical.

Finally, there are bias-adjust terminals 4 and 5. These provide for adjusting the resting bias current to a few milliamperes, and various resistances will be needed for different BHA-0002 samples. To reduce rest-

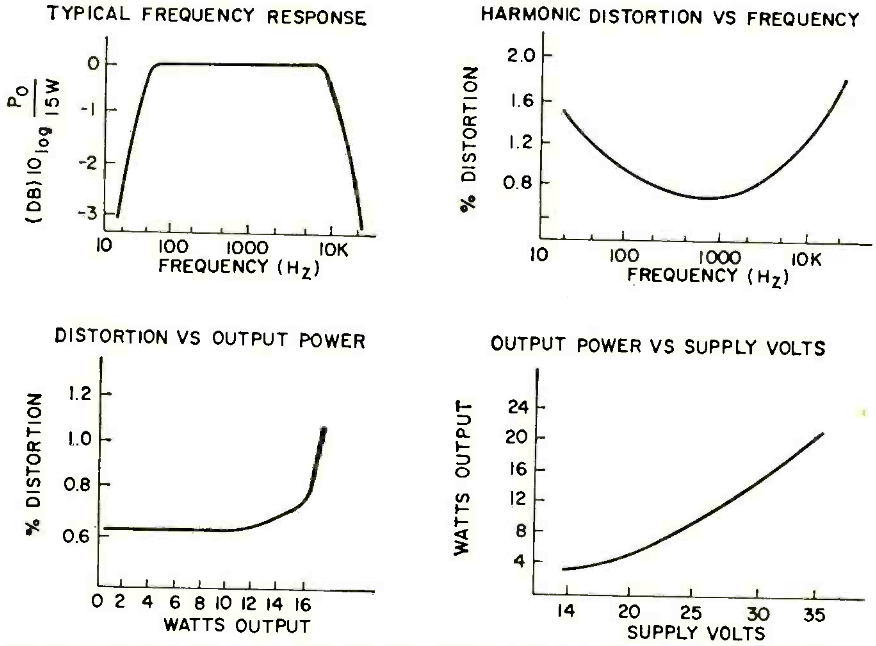


Fig. 3—**Performance curves** for the IC. Output depends on power supply voltage.

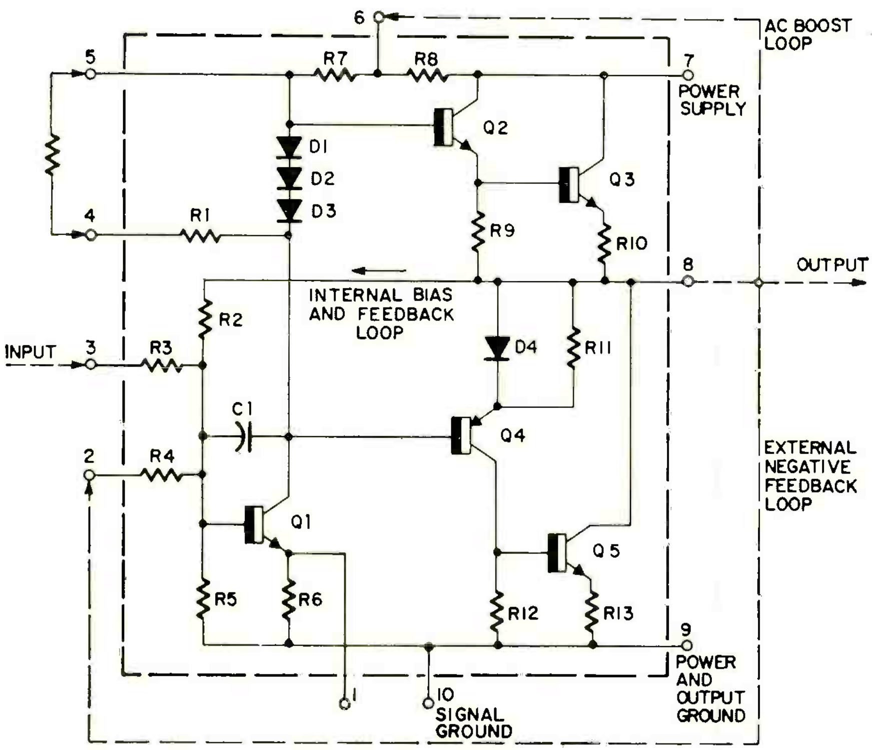


Fig. 4—The BHA-0002 schematic. Resistor between terminals 4–5 sets the gain.

ing current, use smaller resistors. The two IC's I tested seemed happy with 330 and 560 ohms (½W) respectively, in place of the 1000 ohms Bendix uses in its standard testing circuit.

Fig. 2 shows an extra RC network across the output load. Two test samples did not seem unstable without this extra load, which does not necessarily eliminate the possibility this network provides a high-frequency stabilizing effect for *some* production-run IC's. Another possibility is that this network is provided to neutralize a bit of inductive reactance not shown in R_L, but inherent in some specific application.

Application notes

Some electronic devices are hard to work with. You might say they are "nervous." But the Bendix BHA-0002 created an entirely different impression: that of a well-engineered and stable circuit. One of two samples absorbed a real beating on the lab bench but continued to work. If the BHA-0002 is used according to specs, it should be very satisfactory.

One point not mentioned in the Bendix literature could be important in hobbyist and one-of applications where power supplies typically have uncertain specifications. The IC draws a heavy current when delivering power, which then drops to a few milliamperes under resting conditions. If supply regulation is not too good, supply voltage soars.

But the IC's idling current seems to show a rather strong dependence upon supply-voltage threshold. When the supply voltage rises over this critical value, which depends upon the IC and the value of resistance between static current zooms. A safety Zener across the supply output terminals 4 and 5, could be an excellent safety provision (Fig. 6).

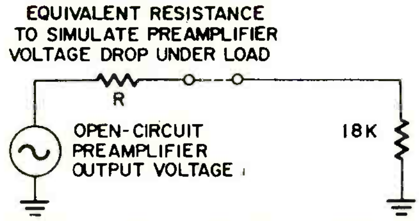


Fig. 5—A preamp sees the amplifier as an 18K resistor demanding 0.5 volt.

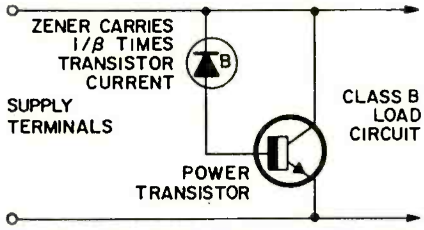


Fig. 6—Circuit stabilizes supply voltage as load falls from 0.5 A to a few mA.

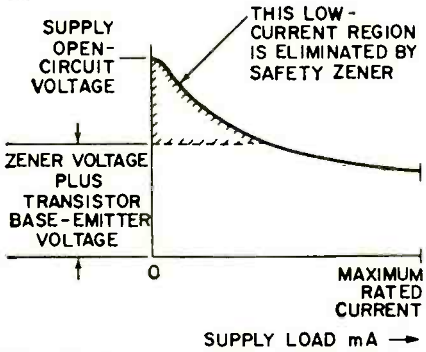


Fig. 7—Power supply characteristics with safety Zener in the circuit.

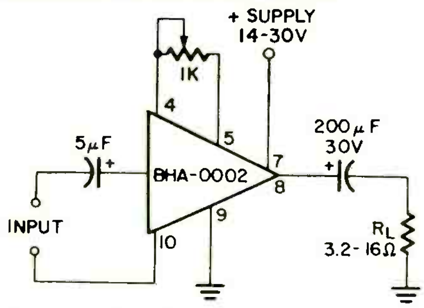


Fig. 8—The IC with two capacitors and a resistor makes a nice af output stage for a tuner or a phono preamp.

Here a Zener diode (or two or three of them in series) are connected to a transistor to form an "amplified Zener." This dodge substitutes an inexpensive Zener for an expensive one. The transistor, following the dictates of the Zener in its base circuit, thinks it's a very good Zener itself, and does a superior regulating job. The Zener goes into breakdown at a few volts above full-load supply voltage, giving the supply output characteristic of Fig. 7.

Since the Zener generates no heat when the IC is delivering heavy power, and the amplifier is resting when the amplified Zener is dissipating power, both can be installed on the same heat sink. The actual Zener diodes can be placed elsewhere on a convenient circuit board.

The Bendix test circuit (Fig. 2), will serve for most practical applications. Some of the electrolytic capacitors may be smaller if the IC is used for communications rather than hi-fi application.

Look again at Fig. 2 and the schematic of the BHA-0002 in Fig. 4. When you trace the feedback loops, which are all ac-coupled, and observe the two ground terminals, you'll notice the input circuit seems to be floating. Why?

It's because terminal 9, the power ground, also carries very heavy signal currents. If this same terminal is the input-circuit ground return, there can be an unwanted feedback loop from the output back to the input across wiring or grounding resistance. Bendix eliminated this possibility by providing a special separate ground return for the tiny input currents. A suggested input arrangement appears in Fig. 8, if you're willing to get by with slightly reduced bandwidth, gain and somewhat higher distortion. **R-E**

NEW TUBES AND SEMICONDUCTORS

13JP22—NEW COLOR PICTURE TUBE

This tube, made by Admiral, is the first US-made 13-inch color CRT. It has almost twice as many color dots per square inch as other similar-size types. The result is a great increase in detail and clarity.

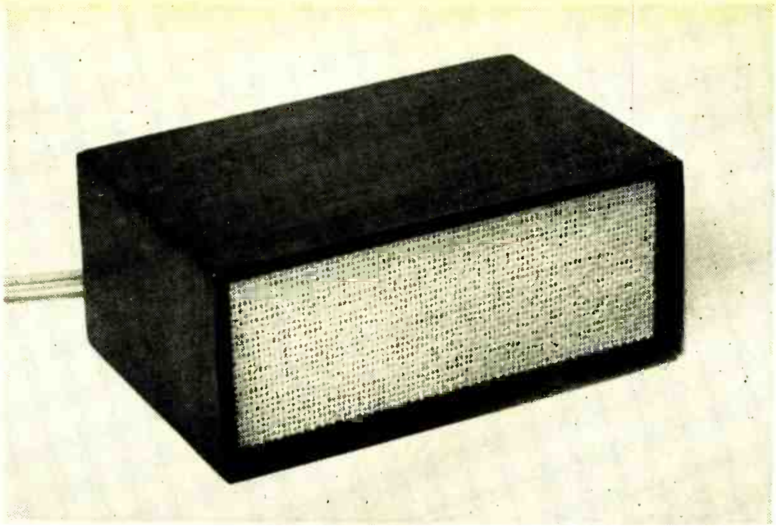
The 13JP22 features low-voltage focusing, vacuum-deposited shielding for stable static convergence and a thermally compensated mask assembly for stable color purity. The low-voltage focus element is insensitive to variations in high voltage applied to the Ultor.

Less than 14 inches in overall length, the new tube is extremely light in weight due to a new implosion protection system incorporating steel banding around the outer edge of face plate.

NEW VIDEO OUTPUT TRANSISTORS

The SE7055, SE7056 and SE-7057 are high-voltage npn transistors designed especially for use in television video output circuits. The SE-7055 is a 220-volt unit with a collector-base capacitance of only 3 pF. The SE7056 and SE7057 are rated at 300 and 450 volts, respectively. The 300-volt unit has a collector-base capacitance of 3.5 pF and the other has a capacitance of 2.5 pF.

These three Fairchild units are supplied in TO-39 packages and feature a dissipation of 7 watts at 25°C case temperature or 1 watt at 25°C ambient. Typical frequency response extends to 80 MHz when driving up to 10 mA. Their design eliminates the need for picture-tube arc protection diodes. Other applications include such service as drivers for storage tubes, electroluminescent displays, high-voltage indicator tube and for high-voltage switching, regulator and power supply circuits. **R-E**



REMOTE

A 'tweet' or 'hoot' operates anything filter and time-delay circuits it as a TV remote control for a start.

by LARRY E. WILSON

DO YOU ENVY YOUR NEIGHBOR when he turns his TV set on and off from his easy chair? And how about that set in the bedroom? Hate to get up and cross the cold floor to turn it off after the late show? The Sonic I will take care of these problems. "Tweet," your set's on; "tweet," it's off. You can't misplace the transmitter either.

Remember some of the unpleasant traits of sound-operated controls? Set them for maximum sensitivity and any nearby noise triggers them. Cut the sensitivity, and you have to shout into the pickup before they operate.

The Sonic I eliminates both these problems through frequency discrimination and noise suppression.

Circuit operation

A 2¼-inch PM speaker is used as the sound pickup (Fig. 1). To match the 80-ohm speaker impedance without using a transformer, Q1 is connected as a common-base amplifier. The amplified signal from Q1 is applied to the input of selective amplifier Q2. Three capacitors (C3, C4 and C5), two resistors (R4 and R5), and Q2's input impedance form a phase-shift network that feeds back Q2's output to the base in phase with the input at only one particular frequency.

Consequently, only signals of the correct (pass) frequency are amplified. This type of active filter can readily achieve a Q of over 100 at frequencies where inductors of thousands of henries would be needed in an LC network.

The amplified signal passes from the selective amplifier to the base of Q3. There it is rectified and amplified to turn on silicon controlled rectifier SCR1, which in turn pulls in impulse-ratchet-relay RY1. This relay is modified to open and close the power contact on alternate operations. [*A Cornell Dubilier Electronics Type 1450 program relay was used, but may now be difficult or impossible to obtain. See the parts list for alternate relays.—Editor*]

The Sonic I will operate only when it "hears" a specific frequency. But a noise impulse (such as a hand clap or sneeze) contains all frequencies and could actuate the relay. Capacitor C8 and R10 introduce a small time delay at the collector of Q3, preventing the voltage from rising until a large number of cycles of the pass frequency have occurred. The steep wavefront noise is not present long enough to allow C5 to charge to the SCR trigger voltage, and noise immunity is assured. Capacitor C10 prevents line transients from turning on Q4.

Construction

For the circuit board, use a piece of Vectorboard or plain drilled phenolic. The speaker and ac outlet shown in the photo were glued on.

The values of C3, C4 and C5 determine the operating frequency. I have found that 0.008-μF capacitors are just about right for a medium-frequency whistle (2 kHz). The operating frequency is approximately 0.033/R4C4 in kHz. Install a ratchet impulse relay as shown in the photo. The relay bracket is made from $^1/_{16}$-inch aluminum.

The Sonic I cabinet shown was made with ¼-inch fir plywood, undercoated with latex paint, sanded smooth and sprayed with flat black enamel. Grille cloth was cut to size and glued in place.

CAUTION. Any cabinet used to house the Sonic I should be a nonconductor! The ac line is connected directly to one side of the circuit, and housing the Sonic I in a metallic cabinet could present a serious shock hazard in the home.

How to adjust

Check the wiring and plug in the Sonic I. Use a scope or the 5-volt ac (or less) range of a vtvm to measure the voltage across R7. Adjust sensitivity pot R6 until the selective amplifier is oscillating. Set the voltage at 0.3 volt rms (0.45 volt p-p).

Whistle into the speaker, changing pitch until the relay clicks. This is the operating frequency.

If the relay doesn't operate the first time you try it, turn the sensitivity pot completely clockwise and the relay should pull in and hold. Back the pot off until the relay drops out. This shows that everything up to Q1 is operating properly.

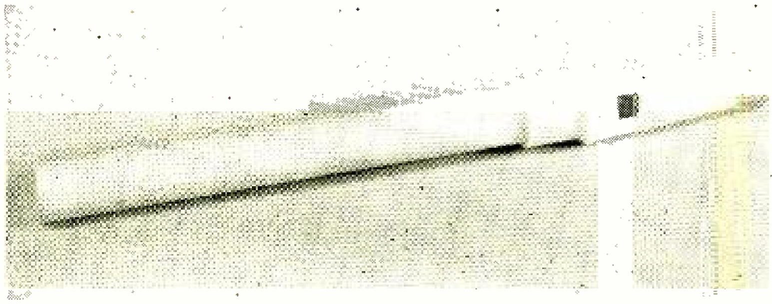
(Incidentally, you can use this method to adjust the Sonic I if you don't have a scope or a vtvm. back off the pot a few degrees past the point where the relay drops out. This should be sufficient for most applications of the circuit.)

Check all connections for cold solder joints and measure B+; it

CONTROL

Slick As A Whistle

you plug into the Sonic I. Solid-state
prevent false noise triggering. Use
It will add a new note to your life.



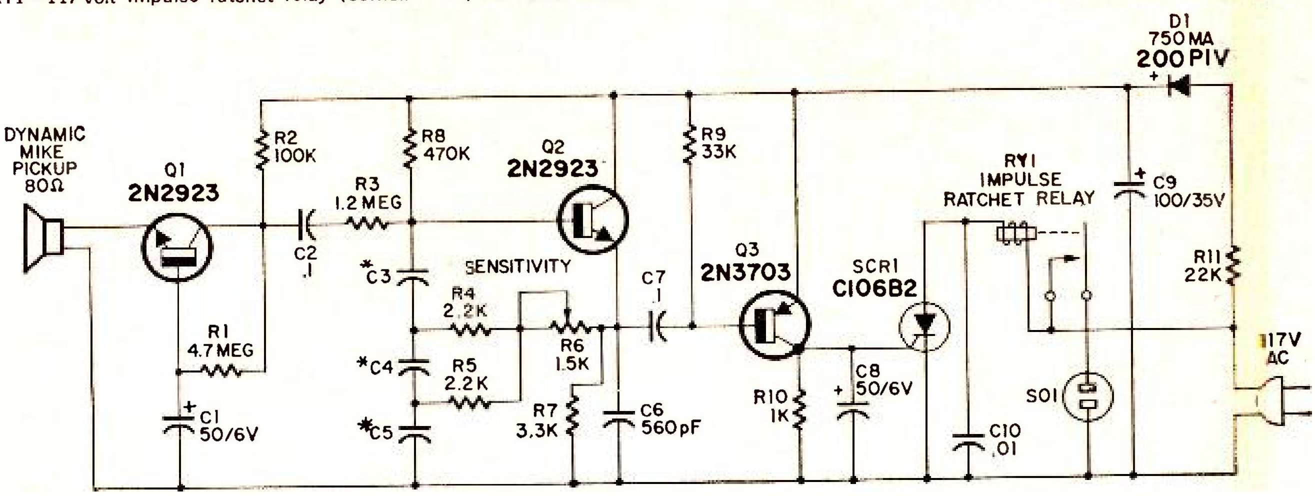
should be between 10 and 15 volts. Low B+ indicates a short, while too high B+ tells you that not enough current is being drawn. Transistor Q1's collector and Q2's emitter should be about one-half the B+ voltage. If the relay doesn't pull in with the pot advanced all the way, you may need a higher-gain transistor for Q2. Minimum beta should be around 100.

If the relay "machine guns" when installed in the cabinet, you have acoustic feedback. Check the voltage across R10–C8. It should be zero. If not, back off the pot until you obtain a zero reading. If this doesn't help, you may need a *lower*-gain transistor for Q3.

Plug your TV (or whatever is to be controlled) into the outlet on the Sonic I, and the Sonic I into a wall outlet. Turn on the TV set, then whistle the right tone and, "click," the TV's off and, "click," it's on again.

PARTS LIST

C1, C8,—50 μF, 6-volt lectrolytic capacitor (Lafayette 99H6077)
C2, C7—0.1-μF, 100-volt epoxy capacitor (Sprague Type 225P-10491)
C3, C4, C5—.0033–.01-μF molded tubular capacitor (value depends on desired operating frequency). (Sprague Type 160P-6TM)
C6—560 pF, 500-volt ceramic-disc capacitor (Centralab Type CE-561)
C9—100-μF, 35 volt aluminum electrolytic capacitor (Mallory Type MTA100F35)
D1—750-mA, 200-PIV silicon diode
RY1—117-volt impulse ratchet relay (Cornell Dubilier Electronics Type 1450 program relay, available from Electronic DistributorsInc., 4900 North Elston Ave., Chicago, Ill. 60630 (see text). Guardian Type IR-640L-A-120), or Potter & Brumfield PC or AC Series.)
Q1, Q2—2N2923 transistor (G. E.)
Q3—2N3703 transistor (T. I.)
Q4—C106B2 silicon controlled rectifier (G. E.)
All resistors are ½ watt, 10%
R1—4.7 megohms
R2—100,000 ohms
R3—1.2 megohms
R4, R5—2200 ohms
R6—1500-ohm potentiometer (Mallory MTC152L1)
R7—3300 ohms
R8—470,000 ohms
R9—33,000 ohms
R10—1000 ohms
R11—22,000 ohms
SO1—117-volt 2-prong ac receptacle (Cinch-Jones 2R2)
SPKR1—2¼-inch, 80-ohm PM speaker
MISC—3 x 6-inch piece of phenolic board or Vectorboard, nonmetallic cabinet, 6-32 X 3/8-inch machine screws, 6-32 nuts, strip of 1½ X 1/16-inch aluminum, grille cloth



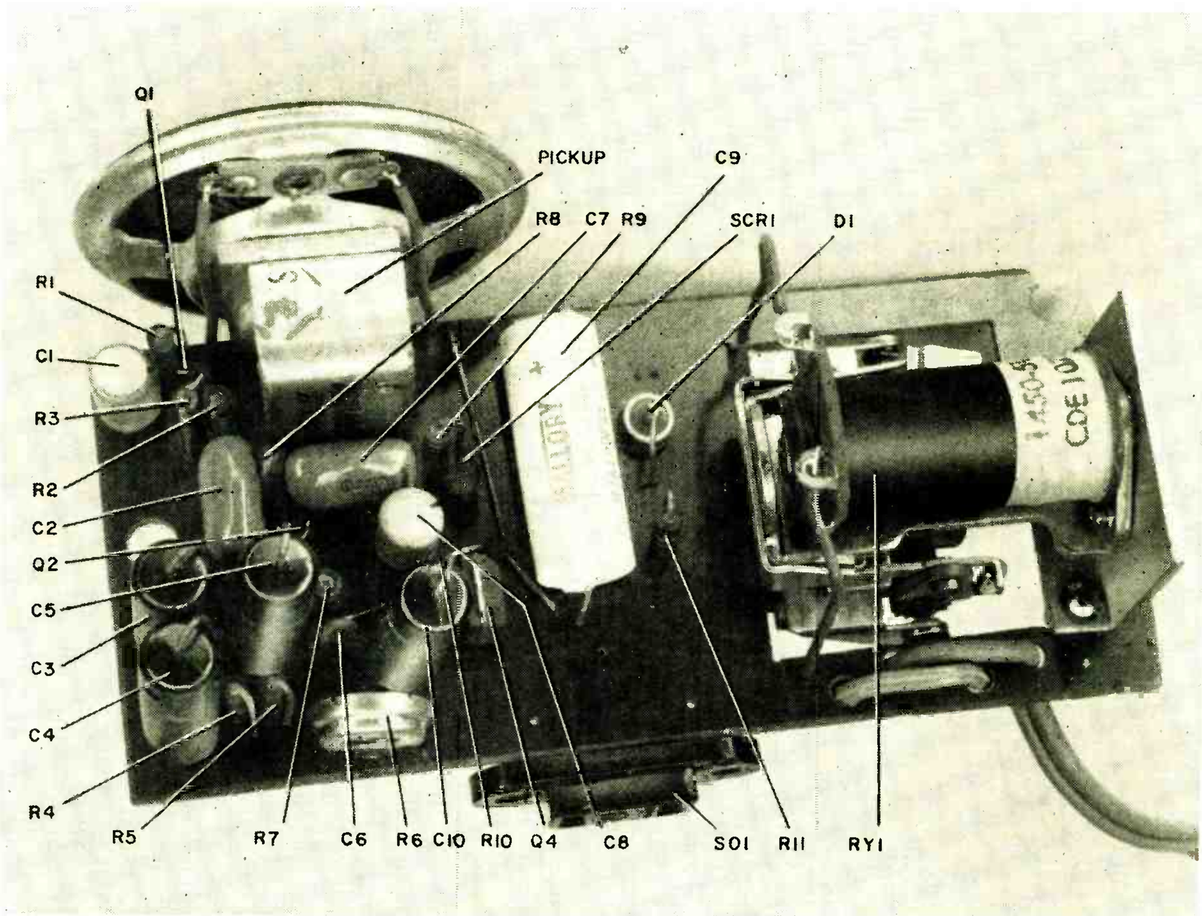
* .0033-.01 DEPENDING ON OPERATING FREQUENCY – SEE TEXT

Fig. 1—Signal from pickup speaker is amplified by Q1 and fed to Q2, whose input impedance and an RC network form a filter.

You may need a little practice to hit the right pitch on the first try as the filter is very sharp.

If you're too lazy to practice, try my method—just "hoot." You can pack a lot more energy into a "hoot" and the richer harmonic content of the "hoot" usually will trigger the relay. You can also tune a dime store whistle to the relay frequency. Get a "calliope" type whistle (the kind with a piston to vary the pitch) and adjust the slide until the relay operates from across the room. Glue the slider in place with cement. This makes a useful transmitter for those who can't whistle the same note twice.

I have made several Sonic I's and attached them to my TV set and table lamps. Tuned to different frequencies, I can control a whole room full of equipment just by whistling the right "tune." Your imagination can find many other uses for the Sonic I. **R-E**



Chassis-view of the Sonic I. RY1 is a modified C-D program relay. Similar types listed in parts list may be substituted.

MAKE AN R-E REFERENCE MANUAL

This issue, starting on the facing page is a very special series of articles on Tools For Electronics. The complete series will cover every tool you are likely to run into while engaged in the many varied facets of electronics.

Other material including nomographs, special subject reports and important reference tables and charts, will be published in the same format in future issues. Each month we will present 8 new pages for your manual. To put your book into shape cut out the next four pages (two sheets) following the dashed lines. Then arrange the pages in the proper order (follow the numbers at the bottom of each page). Next fasten them together at the top.

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, 27 Slate Lane, South Hauppauge, N. Y.

TOOLS FOR ELECTRONICS

PLIERS AND CUTTERS

by THOMAS R. HASKETT

If you work or play in electronics, you use hand tools. They are the common denominators between hobbyists and do-it-yourselfers, home-entertainment and industrial service technicians, hams, audiophiles, and broadcast engineers.

How much do you know about the tools you use perhaps every day? Do you know the many kinds of tools available today and why they are all useful? Do you know what to look for when buying tools? Do you know how to care for your tools to get the best use and longest life from them? This series will provide the answers to those questions.

People in electronics use many different kinds of tools. Why the different types? Simply because each tool is designed to do a specific job, or a limited number of similar and related jobs. The most precise and efficient tool is the one which has been designed for the most narrow function. On the other hand, a multiple-purpose tool is usually the least precise and least efficient, due to design compromises. You gain functional **variety** at the expense of functional **efficiency**. Another important point: Use each tool **only** for its intended purpose; misuse will probably damage the tool, and perhaps you, not to mention the work. For instance, don't use a screwdriver as a chisel; you'll probably ruin the blade, and maybe the handle. And remember that you can tell a good workman by the condition of his tools.

Pliers

One of the most common of all tools, **pliers** are used to apply compression, for bending or twisting wires around terminals, or merely for holding work during some other operation. A pair of pliers consists of two separate, long pieces of metal bolted together. The junction is made not at the midpoint of the length, but rather nearer one end than the other, as you can see in Fig. 1. This junction is called the

long-nose pliers. Needle-nose pliers are ideal for TV tuner work, narrow i.f. cans, and rotary gang switches, where a nest of wiring often blocks other tools. Also, having both long- and needle-nose pliers on hand is useful when you have to perform a two-handed job in tight quarters.

Specific plier features

Long- and needle-nose pliers are available in many styles with different features. Most of these features are useful in various kinds of electronic work.

You can get long-nose and needle-nose pliers with either **milled (serrated)** or **plain (flat)** jaws. Most technicians like milled jaws because they offer a more positive grip on the work. For fine work or with soft materials, plain jaws are used since they don't mark the work.

On some long-nose pliers, the shanks are hollowed out and side-cutting edges are provided near the joint (Fig. 3). Although this feature saves time when cutting wires, it can't be used for some jobs, as the jaws get in the way of the work. However, side-cutting long-nose pliers can often save you time in assembly or parts replacement, as you can wrap the wire around a terminal and then cut off the excess with the same tool in your hand. You don't have to stop and pick up another tool.

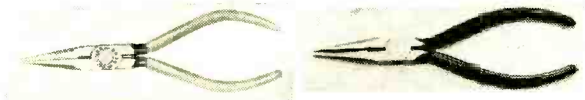


Fig. 3—A combination of long-nose and cutting pliers can be extremely handy. Two examples of such pliers are shown here. At the left is a VACO 8102 and on the right a Boker model 93.

Some long- and needle-nose pliers have **curved jaws** (Fig. 4). Such a tool is useful if you have to work around a corner in a chassis.

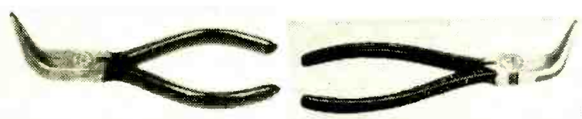


Fig. 4 — Sometimes the only way around a tight chassis corner is a long-nose pliers with curved jaws. The Husky model P-102-6B (left) and the Crescent model 888 (right) are two versions of this handy, in the corner, tool.

The jaws of various types of long and needle-nose pliers take many different configurations. Most common is **chain nose** (or **snip nose**), which

pivot or **joint.** The short ends are the **jaws;** the long ends are the **handles.** Each handle is curved slightly and the jaws are parallel when they meet. The joint is actually a common fulcrum for each half of the pliers. When you squeeze the handles together, a simple law of mechanics operates, and the force is multiplied by the fulcrum and the ratio between the length of the handles and that of the jaws. Hence, the compression at the point the jaws meet is several times the force originally exerted by your hand.

Probably most useful in electronics are **long-nose** (or **chain-nose**) **pliers,** shown in Fig. 1. Most types are from 4" to 6" in length, and

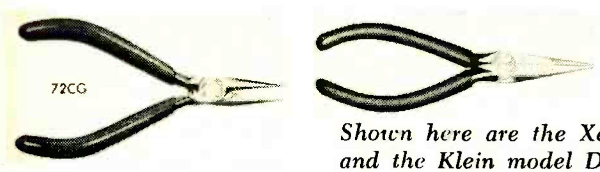


Fig. 1 — Long-nose pliers are probably one of the most useful types of pliers. Shown here are the Xcelite model 72CG (left) and the Klein model D-301-6 (right).

their jaws taper from points back to rather thick shanks near the joint. The 4" length is useful in transistor work, while the 6" length is useful for other work. Of course, if you have small hands you'll probably want smaller pliers than someone with larger hands.

Long-nose pliers are used probably more than any other electronics tools, chiefly for bending and guiding small wires and leads into and through terminals, placing and removing small components, and other close jobs where moderate grasping or bending pressure is required. The jaw points get into fairly small openings, but they won't work down too deep, due to the tapered shanks.

Almost identical to long-nose pliers, and made in the same sizes, **needle-nose pliers** have long, thin jaws which taper very slightly (if at all). See Fig. 2. Such thin jaws limit the grasping pressure, so that they're

Fig. 2—Needle-nose pliers are very similar to long-nose types, but their jaws are much longer. Shown are the Boker model ST-903-6 (left) and the Xcelite model 56CG (right).

really only practical to work with small wire or other objects. But this feature lets you in smaller and deeper spaces than is possible with

are available either milled or plain. Chain-nose pliers are used for most general work involving bending, gripping, and manipulating wire and metal objects. **Flat-nose pliers,** also available with either milled or plain jaws, are useful for gripping and holding flat or square objects, and for making angular bends. **Round-nose pliers** (Fig. 5) available only plain, are used

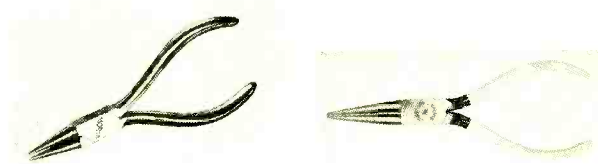


Fig. 5 — Round-nose pliers are another close relation to long-nose units. Their jaws, however are perfectly round and are handy for bending wire. Vigor model PL-304 (left) and Lindstrom model 36-182 (right).

for making bends, loops, circles, or coils of wire or sheet metal.

Some long- and needle-nose pliers have **radius-edge** (**rounded-edge**) jaws. Small, delicate wires can be nicked by the sharp jaw edges of ordinary pliers, thereby weakening the wires. Radius edges won't nick wire.

How the joint of a plier is made is important. Two types of joint construction are used, as shown in Fig. 6. **Lap joints** are more common,

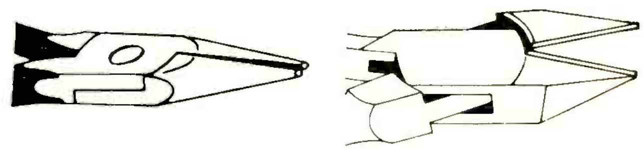


Fig. 6—Lap joint (left) or box joint (right)? The lap joint is the most common type used and can develop wobbles and result in jaws getting out of alignment. Box joints are more costly, but do last longer.

and less expensive. The technique is used in nearly all size pliers, especially in larger pliers where the fulcrum should be near the jaws to give greater leverage. Eventually a lap joint becomes loose, and the jaws wobble. **Box joints** are more expensive to make, but have the advantage that the jaws don't get out of alignment or wobble, even under strain.

Dowel pins are furnished in the jaws of some few needle-nose pliers. They keep the tips in perfect alignment, which can be important when doing precision work with small parts.

Some pliers have a **coiled spring** just inside the handles near the joint (Fig. 7). The spring keeps the handles open unless you compress

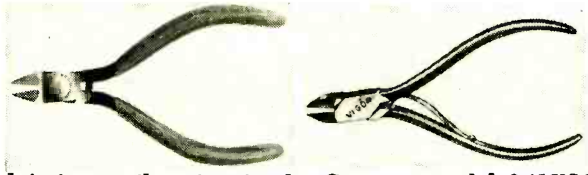


Fig. 7—If you often find yourself doing a lot of cutting use a pliers with a spring in the handle to keep the jaws open. At the left is a coil spring in the Crescent model 941KSC and on the right a leaf-spring in a Vigor diagonal cutters.

them. That means you don't have to pull the handles open when using them—they come open automatically when you release them.

Most plier handles are curved, as you've seen so far. But special types are available (Fig. 8) with other shapes. Such handles are more

Fig. 8—Curved pliers handles can improve comfort and reduce fatigue when pliers are used for long periods. In the Klein model D-366-6C shown you can also note the coil spring that keeps its jaws open. The thumb rest is an extra not always found in tools.

comfortable and can reduce fatigue where pliers are used for long periods.

Larger pliers

Where more compression is needed than is obtainable with long-nose or needle-nose pliers, **slip-joint** (or **gas**) pliers are commonly used. Usually made in lengths from 5" to 10", the jaws are blunt and thick, with concave, serrated inner surfaces (Fig. 9). This last feature gives

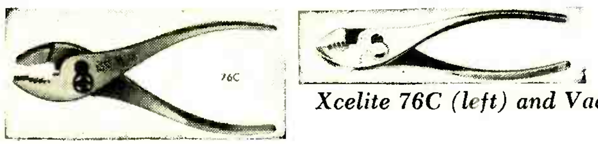


Fig. 9 — Slip-joint pliers are useful where high-compression is needed. An Xcelite 76C (left) and Vaco 8401 (right) are shown.

the jaws a firm grip on the work, but it has the disadvantage of cutting into and marring soft metals, wood, and plastic. For this reason slip-joint pliers aren't used for delicate or finished work. They are capable

Duckbill (or **flat-nose**) **pliers** are approximately the same length as lineman's pliers (8" to 10") but lighter in construction (Fig. 12).

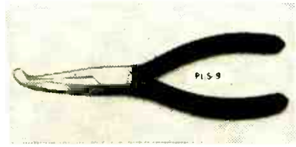


Fig. 12—Duckbill pliers have wide flat lips like the unit shown here. Normally there is no offset to the tips, but it is available in the Williams model PL-10.

Their jaws are short, thin, and flat—like a duck's bill! They have less strength than lineman's pliers, but about as much as slip-joint pliers. Their principal value is that because of their flat jaws, they can be used in places where thick-jawed pliers cannot be used. Duckbill pliers are particularly valuable in installing or dismantling metal-can electrolytics mounted on a chassis. Long-nose pliers don't have the compressive strength to twist those little metal ears on the can, and slip-joint pliers, while strong enough, are too bulky in the jaws to penerate the jungle of under-chassis wiring and components. Duckbills get right in and twist the ears without difficulty.

In the pliers family, just about the longest and largest types are called **tongue-and-groove** (or **waterpump**) **pliers.** They are commonly

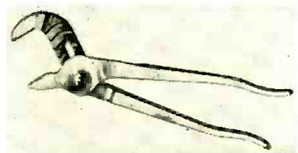


Fig. 13—Tongue-and-groove pliers are really extensions of the slip-joint plier principle. The important point is that the jaws stay parallel even when large diameter nuts have to be held firmly. The unit shown is made by Owatonna Inc.

made from 9" to 16" long (Fig. 13). Their principle is really an extension of the slip-joint pliers' variable-fulcrum idea: A multiple fulcrum is provided by a tongue and a set of grooves which enable the jaws to be spaced widely. Hence it is possible to grasp an object up to about 2" or 3" thick. To provide comfortable leverage at such an expansion, the handles are very long. The jaws are serrated and concave, like those of slip-joint pliers, and they are bent to about a 45° angle from the plane of the handles. Tongue-and-groove pliers can be used for a wide range of medium to large jobs; they are capable of more compression than anything described so far. The antenna man's favorite, they are helpful for installing screw-type 300-ohm-lead standoff insulators, twisting guy wires, and handling antenna crossbars and masts, as well of exerting more pressure than long-nose pliers, and because of their concave, notched jaws it is possible to grasp rounded or square objects. They also have a double fulcrum. One half of the pliers can be spaced farther from or closer to the other half, by means of a slot in one handle for the bolt. It is therefore possible to use the jaws closely set, for small work, or widely set, for large work. Slip-joint pliers are useful for a great many general-purpose jobs—tightening or loosening large objects, turning TV channel-selector shafts when no knob is available, and unscrewing bolts with mutilated heads. Slip-joint pliers should **never** be used for removing properly, shaped bolts or nuts, as the bolt heads will be wrecked. Round-nose slip-joint pliers as well as thin-nose types are also available, as shown in Fig. 10 These are useful

Fig. 10 — Thin-nose slip-joint pliers let you get a heavy-duty unit into cramped quarters. P&C model 1202 (left); Crescent model L26 (right).

for working in crowded spaces. Some slip-joint pliers have side cutters.

Lineman's (or **electrician's**) **pliers** are usually larger still, and capable of exerting even more pressure than slip-joint pliers, and are found in sizes from 6" to 10" long (Fig. 11). Their jaws are relatively

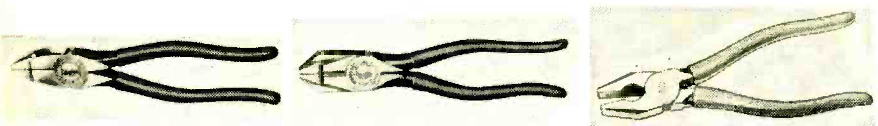


Fig. 11—Here is a grouping of Lineman's or Electrician's pliers. Note the short, square, blunt tips and built-in side cutters. The two units shown are the Hunter model A60 (left) and the Klein model 201-8 (right).

short, square, and blunt, with flat, opposing surfaces. Although these inner surfaces are scored lightly, they are not ridged as deeply as those of slip-joint pliers, and will mark the work only slightly. Lineman's pliers usually have side cutters, and because of their relatively long handles, their cutting strength and grasping pressure is fairly large. They are especially useful in flattening or straightening a bent piece of metal (such as a damaged chassis), for bending heavy wire or busbar, or for holding some flat object firmly during drilling, grinding, etc.

as fair-sized pipes. Because of the notched jaws they will gouge and mark the work, and so can't be used where delicacy is important.

Lockwrench pliers are made with an internal lever which multiplies compression at the jaws (Fig. 14). The lever locks when the handles

Fig. 17—Lever wrench pliers are great if you want to loosen a nut that has rounded corners as well as items that are normally round. P&C model 1219-R.

New geared level wrench by VACO combines the features of a lever wrench and a monkey wrench. This is one worth looking at in the local parts shop.

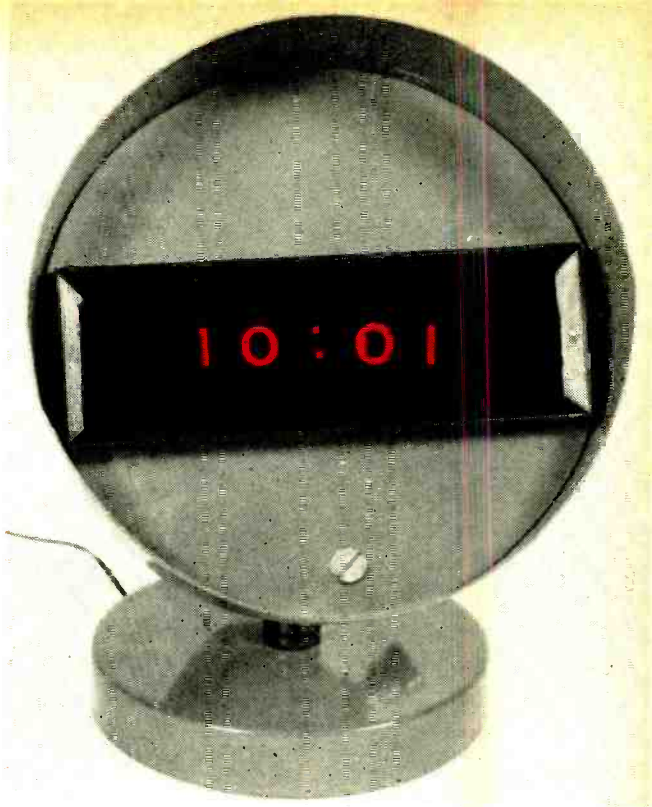
are squeezed, and another lever releases them. There is a wormscrew adjustment which varies the jaw spacing. Like tongue-and-groove pliers, the jaws are serrated, slightly concave, and offset from the plane of the handle. Lockwrench pliers have about the same range of expansion as tongue-and-groove pliers, and their overall size is about the same. There is really only one handle, however, as the lever and spring work internally to execute the compression at the jaws.

In practice, you open the lever, and turn the wormscrew adjustment (at the end of the handle) until jaws just clear the work. Then you close the lever against the handle. This operates the internal spring-and-lever mechanisms, applying tremendous pressure at the jaws. Furthermore, the jaws are **locked** on the work, and can be released only by tripping the release lever. Except for the rather short handle, lockwrench pliers can do about the same jobs a pipe wrench or tongue-and-groove wrench can do, with the added locking feature, of course. This extreme compressive power must be used with care, as some work can literally be pulled apart or chewed up by the jaw teeth if you aren't careful. Lockwrench pliers make excellent temporary clamps for large work, and because of the locking feature and much compression, can be used for loosening frozen pipes, antenna masts, and other large, threaded or wedged-on pieces.

(to be continued)

COVER STORY

BUILD R-E's IC Digital Clocks



Decorators wild! Pick your style, build the kind of clock you like best

by **ED LORD**

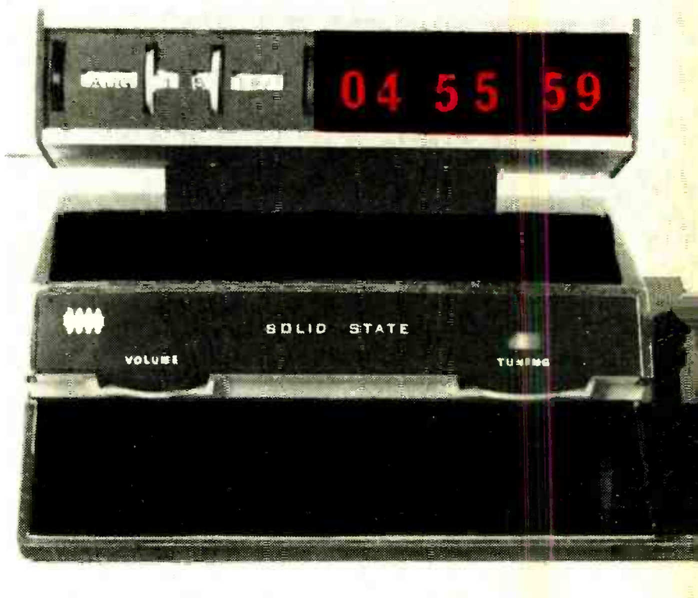
BUILDING A DIGITAL CLOCK IS A GREAT PROJECT WITH A REWARDing climax. The 6-digit clock described here besides being a great conversation piece, will make an outstanding piece of furniture for your desk or living room.

Digital clocks, like most accurate instruments, are expensive. However, since the advent of IC's and with advances in the state-of-the-art a digital clock can be a reality. This clock can be built for about $250.00 with six digits as described here. For the more economically minded, a four digit model can be made for considerably less leaving out IC10 and IC8, V5 and V6. A little scavaging (like we all seem to be masters at), and a well stocked scrap barrel can also do wonders in saving the bank roll.

The NIXIE tube readouts can be remoted. This gives the builder the utmost in freedom of design. Two of the clocks on the cover are good examples of this technique. The black desk-set clock was originally a desk radio that was redesigned and converted to a six-digit clock. Its electronics are packaged separately and can be unobtrusively secured to the side of a desk. The cramped space dictated the use of rectangular NIXIE tubes type B.

The red clock started its life as a bed lamp. After a trip to a junk shop it was resurrected and now is a four-digit clock with the electronics mounted behind the bezel. A friend of mine packaged the readout for his clock in a roll-on deoderant can and mounted it on the neck-piece of a broken goose neck lamp. He packaged the electronics in the base. It's real Buck Rogers masterpiece that fits well into his modern home furnishings. A trip through a second-hand junk store or your local drug store will give you many great ideas for a great new and original digital clock design.

The two most important ingredients in my clock, the IC's and readouts, were chosen very carefully. The IC's are the heart of the clock so I was especially careful here. I use SN7490N counters and SN7441N NIXIE tube drivers made by Texas Instruments. They have good noise immunity for a 5V IC and can be counted on for reliability and long life. The Burroughs B-5750S NIXIE tubes were chosen because they were originally designed for a calculator market as a high pressure tube and they are the best available when one digit must remain on for any length of time. (The 0 in the first digit is on for 9 hours at a time, the 1 is on for 3 hours.)



How it works

Clock operation can be broken down into basic subsystems—the 13 o'clock reset circuit, the basic counting circuits, the timing circuits and, of course, the power supply.

The power supply is a simple half-wave rectifier that provides pulse input to the timing circuits. Also provision is made through transistor Q5 and the 6.3V Zener diode for 5.6 volt V_{cc}. Also B+ is tapped from the 117 Vac input and converted to +170 Vdc by the voltage booster D9, R16, and C1. Capacitor C12 is installed across the secondary to remove line transients on the input pulse (see Fig. 1).

Timing circuit

The half-wave 60-Hz input to the timing circuit is shaped to positive square wave pulses by Q4 and associated circuitry (see Fig. 5 and Fig. 3). The resulting 60-Hz square wave is applied to pin 14 of the divide by 10 counter. IC 12. These counters count on the negative going side of the square wave. Output from IC 12 a 6 pps square wave is applied to pin 14 of ICC 13, a divide by 6 counter. IC 13's output is a 1 pps square wave which is applied to pin 14 of IC 11. The counter is wired in a divide by 10 configuration. It resets when 9 is displayed and the square wave goes negative. The counter outputs standard 8421 BCD which is applied to readout driver IC 10. Basically IC 10 is a BCD to decimal decoder driver with output transistors that can handle enough current to directly drive the NIXIE tube. It provides the first seconds digit for a 0 through 9 readout. When the 9 is displayed on the first NIXIE tube, V6, codes D and A (see logic table) go high as the counter resets to zero and D goes low. IC 9, the divide by six counter, is pulsed. The BCD output of this counter is decoded and displayed on V5 the second significant digit in the clock. This cycle repeats with IC 9 counting once for each 10 counts of IC 11.

When IC 9 reaches 5, logic codes C and A are high. C (pin 8) is connected to the input pin (14) of IC 7 which is the first digit of the "minutes" section of the clock. IC 7 and its associated decoder driver, IC 6, are wired in the same configuration as the 0-9 indicator in the seconds section (IC 11, IC 10 and V6). Operating IC 7 and IC 6 cause 0-9 (minutes) to be displayed on V4. When 9 comes up logic D and A are high and cause an input to be felt at pin 14 of IC 5, the 0-5 portion of the minutes indicator. (Remember, the count occurs as the pulse goes toward negative in these counters.) The minutes 0-5 is wired exactly the same as the seconds 0-5 section and operates in a similar manner. When 5 is displayed on V3 and logic C and A is high, the C is felt on pin 14 of the divide by 10 counter, IC 3. This counter counts once each time IC 5 resets and is wired similarly to IC 7 and IC 11 with the one important difference described in the next paragraph.

Reset circuit

The problem in the hours circuit is that V2 must count from 1 o'clock to zero as V1 indicates a 1 for 10 o'clock. V2 must then count 1 and 2, then reset to 1 o'clock. This done by wiring decoder driver IC 2 so it thinks it is displaying a 0 on V2 when it actually is displaying 1. When it thinks it is displaying a 1, it is actually showing a 2 and so until it displays a 0 which the decoder driver thinks is a 9. After the zero is displayed the counter resets to zero, logic D and A are high causing flip flop IC 1 to change state and turn off Q1 and turn on Q2 which extinguishes the 0 displayed on V1 and lights the 1. (See Fig. 2).

As V2 counts to a 3 (would appear as 13 on hours indicators V1 and V2) logic B goes high which causes pin 2 of IC 2 to go high. Simultaneously current flow through D2 is routed from B to E of Q3 causing pin 2 of IC 1 to go low and reset the flip flop. The result is that 0 lights on V1, pins 2 and 3 in IC 3 are high and IC 3 resets to 1. The count cycle

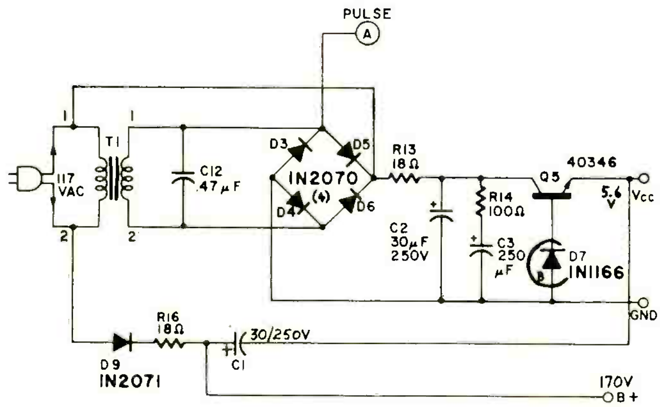


Fig. 1—The power supply. B-plus is boosted by tying it to V_{cc} supply.

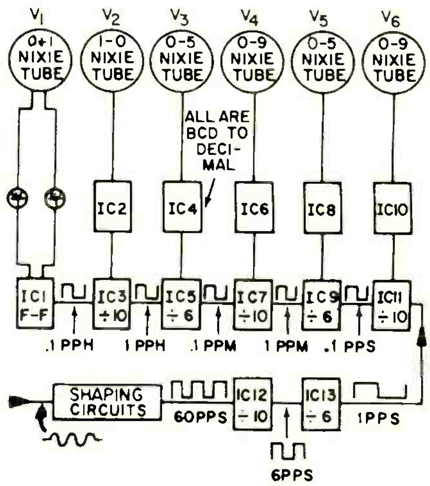
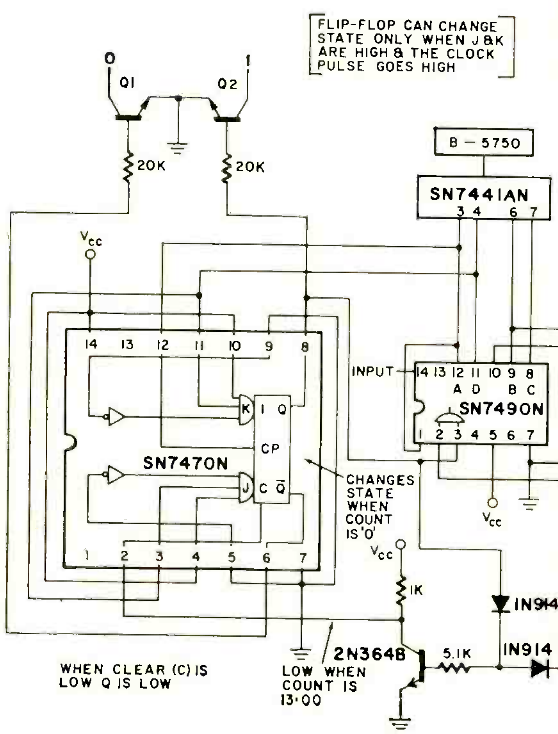


Fig. 3—The timing circuit uses IC frequency dividers and B5750-S readouts.

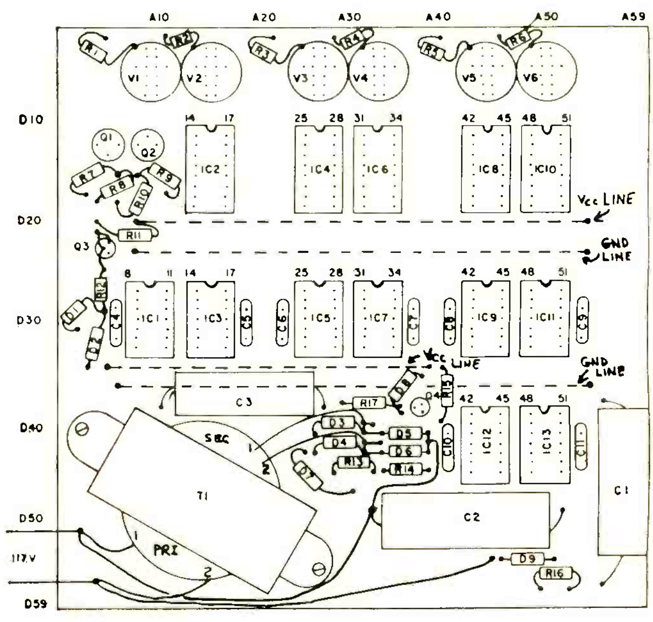


LOGIC

#	D	C	B	A
1	0	0	0	0
2	0	0	0	1
3	0	0	1	0
↕				
0	1	0	0	1

Fig. 2—One o'clock reset circuit operates once each half of a 24-hour day.

Fig. 4—Circuit board layout. Wiring table gives details.



1-0 begins again for the second half of the 24-hour day.

Construction tips

Assembling this project can be extremely complicated because of the number of IC's and associated components. To simplify procedures a bit I strongly recommend using IC sockets. There are two reasons. First and foremost, if you apply too much heat to an IC lead, chances are you'll zap the IC and when you consider you will be soldering upwards of 180 IC leads your odds are short on a perfect job. Second and of paramount importance from an operational standpoint, is the fact that IC characteristics will vary somewhat and a quick switch of IC's may solve a problem that otherwise might have to be corrected by a value change in the associated circuitry.

Tables are provided for both component to component and point-to-point Vector board wiring. Either method is effective. However, if you are not an experienced builder with many "projects" under your belt I'd suggest using the Vector board chart as it is the simplest and most straightforward.

Follow the steps in the order listed and you will be home free after a few evenings of enjoyable labor.

1. Select a high quality IC compatible Vector board and cut it so you have exactly 59 holes across and down. This will give you a 6-inch square board. The transformer gives the unit a height of 2¼". If you are going to remote your readout cut the Vector board down to 52 holes on the D side and run the wires directly from the IC socket pins to your readout. However, you might be better off wiring the board before you cut it, otherwise you will have to convert the wiring table to your board layout. Remember if you are using other than B-575OS readout tubes you will have to convert to the pin layout of the tube you are using. Burroughs Corporation, Box 1226, Plainfield, New Jersey will send free their spec sheets for the tube you are using.

2. Mark the Vector board at 10 hole intervals with a felt marking pen. This will make hole identification easier when you begin assembly.

3. Insert tube sockets, IC sockets, and components as in Fig. 4. Do not insert the IC's or readouts into their sockets until wiring is completed.

LOGIC TABLE

DISPLAYED NO.		LOGIC			
V_2	V_3-V_6	D	C	B	A
1	0	0	0	0	0
2	1	0	0	0	1
3	2	0	0	1	0
4	3	0	0	1	1
5	4	0	1	0	0
6	5	0	1	0	1
7	6	0	1	1	0
8	7	0	1	1	1
9	8	1	0	0	0
0	9	1	0	0	1

PARTS LIST

Capacitors
C1—30-μF, 250V electrolytic
C2—500-μF, 25V electrolytic
C3—250-μF, 25V electrolytic
C4-C11—0.1 μF, 50V
C12—47 μF, 50V

All resistors 10% or 5%
R1-R10—10,000 ohms, ¼W
R11—1000 ohms, ½W
R12—5100 ohms, ¼W
R13, R16—18 ohms, ¼W
R14—100 ohms, ½W
R15—100,000 ohms, ½W
R17—10,000 ohms, ½W

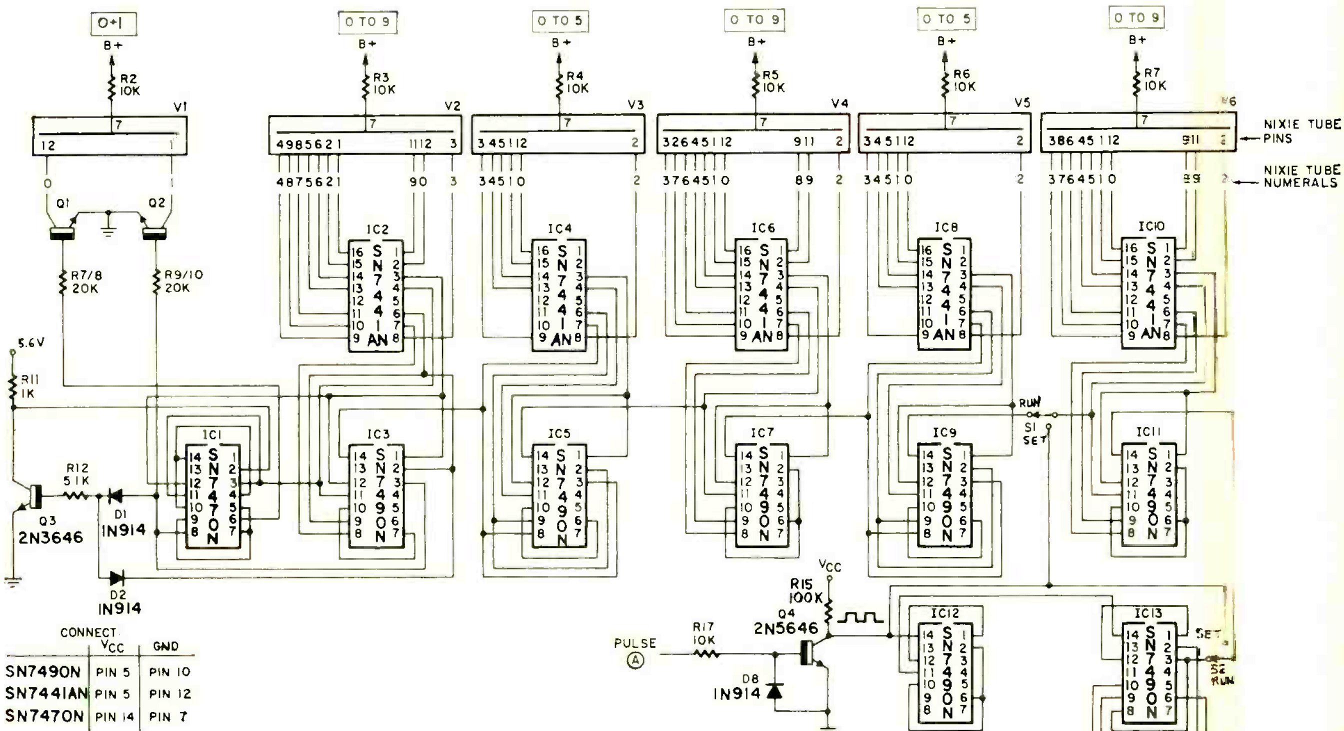
Semiconductors
D1, D2, D8—1N914 diode (G.E.)
D3, D4, D5, D6—1N2070 diode (T.I.)
D7—1N1766 diode (G.E.)
D9—1N2071 diode (T.I.)
Q1, Q2, Q5—40346 (RCA)
Q3, Q4—2N3646 (Fairchild) or MPS3646 (Motorola)

Integrated Circuits
IC1—SN7470N (T.I.)
IC3, IC5, IC7, IC9, IC11, IC12, IC13—SN7490N (T.I.)
IC2, IC4, IC6, IC8, IC10—SN7441AN (T.I.)

Other parts
T1—Filament transformer, 12.5V ct, 1.5A (Triad F-25X)
V1-V6—B5750S tubes (Burroughs)
S1, S2—spst switch
MISC—6 Nixie tube sockets (Burroughs SK-207), 13 dual in-line IC sockets.

Note: Components not found through normal sources may be ordered from the 1969 Allied Industrial Electronics Catalog (100 N. Western Ave., Chicago, Ill. 60680) or the 1969 Newark Electronics Corp. catalog (500 N. Pulaski Road, Chicago, Ill. 60624).

Burroughs Nixie tubes may be obtained from local Burrough distributors or write Burroughs Corp., Electronic Components Division, Box 1220, Plainfield, N.J. 07061 for distributors.



CONNECT	V_{CC}	GND
SN7490N	PIN 5	PIN 10
SN7441AN	PIN 5	PIN 12
SN7470N	PIN 14	PIN 7

Fig. 5—Schematic of the shaping, counting and readout circuits. The power supply and parts layout are on page 44.

4. Insert the four ground standoffs into position and wire them together with bare wire.
5. Insert the four V_{cc} standoffs into position as in Fig. 4 and wire them together with bare wire. You will have to insulate V_{cc} from ground after wiring is complete. This is done with strips of plastic electrical tape.
6. Make the wiring connections as shown in the Table below. end of this article.
7. Insulate V_{cc} from ground as described in step 5.
8. Insert the IC's and readout tubes into their sockets. The notch on the IC's should be pointed toward the front of the clock.
9. Recheck your wiring and you're all set for years of accurate time telling.

COMPONENT AND VECTOR BOARD WIRING

COMPONENT From	COMPONENT To	VECTOR BOARD From	VECTOR BOARD To
IC1-2	Q3-C/R11	A11, D28	A4, D20
IC1-3	IC3-11	A11, D29	A14, D30
IC1-3	IC1-11	A11, D29	A8, D30
IC1-4	IC1-14	A11, D30	A8, D27
IC1-4	IC1-10	A11, D30	A8, D31
IC1-5	IC1-7	A11, D31	A11, D33
IC1-5	GRD	A11, D31	GRD
IC1-5	IC1-9	A11, D31	A8, D33
IC1-6	R8	A11, D32	A4, D18
IC1-8	IC3-3	A8, D33	A17, D29
IC1-8	D1	A8, D33	A2, D31
IC1-8	R10	A8, D33	A6, D18
IC1-12	IC3-12	A8, D29	A14, D29
IC1-12	IC3-1	A8, D29	A17, D27
IC1-12	IC2-3	A8, D29	A17, D13
IC1-14	C4	A8, D17	A6, D29
IC3-2	D2	A17, D28	A3, D35
IC3-2	IC3-9	A17, D28	A14, D32
IC3-2	IC2-6	A17, D28	A17, D16
IC2-1	V2-11	A17, D1	A15, D6
IC2-2	V2-12	A17, D12	A15, D7
IC2-4	IC3-11	A14, D17	A15, D4
IC2-5	VCC	A17, D14	A14, D30
IC2-7	IC3-8	A17, D15	VCC
IC2-8	V2-3	A17, D17	A14, D33
IC2-9	V2-4	A17, D18	A16, D5
IC2-10	V2-9	A14, D17	A15 D4
IC2-11	V2-8	A14, D16	A15, D3
IC2-13	V2-5	A14, D14	A16, D3
IC2-14	V2-6	A14, D13	A16, D2
IC2-15	V2-2	A14, D12	A16, D16
IC2-16	V2-1	A14, D11	A16, D17
IC2-12	GND	A14, D15	GRD
IC3-5	C5	A17, D31	A14, D29
IC3-7	IC3-10	A17. D33	A14, D31
IC3-10	GND	A14, D31	GRD
IC3-14	IC5-8	A14, D17	A25, D33
IC3-14	IC5-3	A14. D17	A28, D29
IC3-14	IC4-7	A14, D17	A28, D17
IC4-3	IC5-1	A28, D13	A28, D27
IC4-3	IC5-12	A28, D13	A25, D29
IC4-4	IC5-11	A28, D14	A25, D30
IC4-5	VCC	A28, D15	VCC
IC4-6	IC5-9	A28, D16	A28, D33
IC4-6	IC5-2	A28, D16	A28, D28
IC4-8	V3-2	A28, D18	A27, D6
IC4-9	V3-3	A25, D18	A27, D5
IC4-12	GND	A28, D15	GRD
IC4-13	V3-4	A25, D14	A27, D4
IC4-14	V3-5	A25, D13	A27, D3
IC4-15	V3-1	A25, D12	A27, D7
IC4-16	V3-12	A25, D11	A26, D7
IC5-5	C5	A28, D31	A19, D29
IC5-6	IC5-10	A28, D32	A25, D31
IC5-10	GND	A25, D31	GRD
IC5-14	IC7-11	A25, D27	A31, D30
IC5-14	IC6-4	A25, D27	A34, D14
IC6-1	V4-9	A34, D11	A32, D4
IC6-2	V4-11	A34, D12	A32, D6
IC6-3	IC7-1	A34, D13	A34, D17
IC6-3	IC7-12	A34, D13	A31, D29
IC6-5	VCC	A34, D15	VCC
IC6-6	IC7-9	A34, D16	A31, D32
IC6-7	IC7-8	A34, D17	A31, D33
IC6-8	V4-2	A34, D18	A33, D6
IC6-9	V4-3	A31, D18	A33, D5
IC6-10	V4-8	A31, D17	A32, D3
IC6-11	V4-6	A31, D16	A33, D2
IC6-12	GND	A31, D15	GND
IC6-13	V4-4	A31, D14	A33, D4
IC6-14	V4-5	A31, D13	A33, D3
IC6-15	V4-1	A31, D12	A33, D7
IC6-16	V4-12	A31, D11	A32, D2
IC7-2	IC7-6	A34, D28	A34, D32
IC7-2	IC7-10	A34, D28	A31, D31
IC7-5	C7	A34, D31	A36, D29
IC7-10	GND	A31, D31	GND
IC7-14	IC9-3	A31, D27	A45, D29
IC7-14	IC8-7	A31, D27	A17, D45
IC7-14	IC9-8	A31, D27	A42, D33
IC8-3	IC9-1	A45, D13	A45, D27
IC8-3	IC9-12	A45, D13	A42, D28
IC8-4	IC9-11	A45, D14	A42, D30
IC8-5	VCC	A45, D15	VCC
IC8-6	IC9-9	A45, D16	A42, D32
IC8-6	IC9-2	A45, D16	A45, D28
IC8-8	V5-2	A45, D18	A44, D6
IC8-9	V5-3	A42, D18	A44, D5
IC8-12	GND	A42, D15	GND
IC8-13	V5-4	A42, D14	A44, D4
IC8-14	V5-5	A42, D13	A44, D3
IC8-15	V5-1	A42, D12	A44, D2
IC8-16	V5-12	A42, D11	A43, D7
IC9-5	C8	A45, D31	A40, D29
IC9-6	IC9-10	A45, D32	A43, D31
IC9-10	GND	A42, D31	GND
IC9-14	S1	A42, D27	
IC10-1	V6-9	A51, D11	A49, D4
IC10-2	V6-11	A51, D12	A49, D6
IC10-3	IC-11-1	A51, D13	A51, D27
IC10-3	IC11-12	A51, D13	A48, D29
IC10-5	VCC	A51, D15	VCC
IC10-6	IC11-9	A51, D16	A48, D32
IC10-7	IC11-8	A51, D17	A48, D33
IC10-8	V6-2	A51, D18	A50, D6
IC10-9	V6-3	A48, D18	A50, D5
IC10-10	V6-8	A48, D17	A49, D3
IC10-11	V6-6	A48, D16	A50, D2
IC10-12	GND	A48, D15	GND
IC10-13	V6-4	A48, D14	A50, D4
IC10-14	V6-5	A48, D13	A50, D3
IC10-15	V6-1	A48, D12	A50, D7
IC10-16	V6-12	A48, D11	A49, D7
IC11-2	IC11-6	A51, D28	A51, D32
IC11-2	IC11-10	A51, D28	A48, D31
IC11-5	C9	A51, D31	A53, D29
IC11-10	GND	A48, D31	GND
IC11-11	IC10-4	A48, D30	A51, D14
IC11-11	S1-NC	A48, D30	
IC11-14	S2	A48, D27	
IC12-1	IC12-12	A45, D40	A42, D42
IC12-2	IC12-6	A45, D41	A45, D45
IC12-2	IC12-10	A45, D41	A42, D44
IC12-5	C10	A45, D44	A40, D42
IC12-14	S2	A42, D40	
IC12-14	Q4-C	A42, D40	A37, D40
IC12-11	IC13-14	A42, D43	A48, D40
IC13-1	IC13-12	A51, D40	A48, D42
IC13-2	IC13-9	A51, D41	A48, D45
IC13-3	IC13-8	A51, D42	A48, D46
IC13-3	S2	A51, D42	S2
IC13-5	C11	A51, D44	A53, D42
IC13-6	GND	A51, D45	GND
IC13-6	IC13-10	A51, D45	A48, D44
R8	R7	A6, D15	A6, D15
R7	Q1-B	A3, D17	A5, D13
Q1-C	V1-12	A4, D12	A9, D7
Q1-E	GND	A6, D12	GND
R10	R9	A8, D15	A8, D15

(continued on page 88)

NEW R-E EXCLUSIVE

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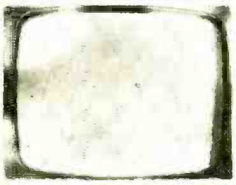
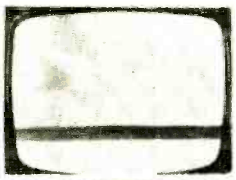
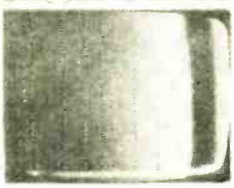
SCREEN SYMPTOMS AS GUIDES		WHERE TO CHECK FIRST		
SYPMTOM PIC	DESCRIPTION	VOLTAGE	WAVEFORM	PART
	Waving; symptoms of AGC overload; buzz in sound sometimes.	not much help	WF3 WF4	C4 C5 R11
	Video mostly washed out; some smearing.	all voltages above normal	WF3	R10 open
	Picture almost solid ringing; sync poor; signs of overload.	Clamp voltage doesn't reach V1-grid-pin-1	not much help	R3 open
	Complete white-out; only sometimes is slight hint of picture visible.	V1-plate-pin-5 V2-plate-pin-5	whichever is at zero V p-p	supply resistors or transformer primaries
	Ringing ghosts in picture; video often very weak; fine tuning affects ringing strongly.	not conclusive	WF3 WF4	R4 plus all capacitors.
	Washed-out picture; vertical sync very poor; smear.	V2-grid-pin-1 V1-plate-pin-5	not much help	R11
	Ringing in pic; sometimes weak video; sometimes overload.	Clamp voltage doesn't reach V1-grid-pin-1	WF3 WF4	C4 C5
	Pic video washed out; blanking bar visible at right; foldup at bottom.	not much help	not much help	C5

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Use this Guide *to help you find which key voltage or waveform to check first.*

Study the screen with receiver operating "normally."

Most helpful clues to fault are found at key test points indicated.

Make voltage or waveform checks as indicated for screen symptoms.

Use Voltage Guide *or* Waveform Guide *to analyze results of tests.*

For quick check, test or substitute parts shown as most likely cause of symptom.

The Circuits

MANY MODERN CHASSIS, INCLUDING COLOR SETS, USE this arrangement for first and second IF stages. For all practical purposes, the cathode-plate paths inside the two tubes are in series with each other across the B+ line. Plate current in one is about the same as in the other. AGC can thus control both stages; cutting down gain in one also reduces gain of the other. Most of the set's alignment adjustments are in these two stages, including traps. Major task of the stages is to amplify video-modulated IF signal. Sound-carrier IF is reduced by a trap, to avoid beat interference that might reach the CRT.

Signal Behavior

IF signal is coupled through C1 and C2 to T1. Absorption trap L1 shunts adjacent-channel picture-IF carrier to ground through C3. T1 couples IF signal to V1. A trap in T1 attenuates the IF sound carrier, to give the response curve of the IF strip the best shape. Absorption trap L2 shunts adjacent-channel sound carrier to ground through C4. R3 and C5 are decoupling for the AGC line. R1 loads the primary of T1 and R2 loads the secondary; both broaden the tuned-circuit responses.

The amplified output of V1 is coupled by T2 to the grid of V2. C6 decouples T2 from the plate supply line and grounds V1's screen for RF. R5 damps any tendency to parasitic oscillation. T2 has an internal adjacent-channel picture-carrier absorption trap. R6 broadens the response of T2. C7 decouples T2 from the supply line, grounding the bottom of the T2 secondary for RF.

C8 is RF ground for the cathode of V2, leaving R8 unbypassed. V2 amplifies IF signal and T3 couples it to the third IF amp stage (not shown). C9 is screen bypass and decoupling for the T3 primary.

DC Distribution

DC plate current flows up through R4 to the V1 cathode, through V1, the primary of T2, R7, R8, V2, the primary of T3, R12, and to the B+ line. Also, R9-R11 are parallel with R8-V2-T3-R12. To further complicate, R10 makes a divider with R11. However, main DC path is through the two tubes. Other versions have other odd parallel DC circuits.

DC control voltage from the AGC line reaches the V1 grid through R3, L2, and the T1 secondary. Some cathode bias is supplied by R4, but AGC has most control of plate-current flow. Screen supply path is through R5.

Bias path for V2 includes R8, R9, and the secondary of T2. Divider R10-R11 stabilizes voltage at key-point-A. Voltage at the cathode of V2 depends on conduction of both V1 and V2. It's always a few volts less positive than the grid, and varies with signal because of AGC. V2 screen is fed by R12.

Station and Control Effects

Tuning in a station has considerable effect on DC voltages. AGC voltage drives the grid of V1 further negative. This bias cuts down plate current, and plate voltage goes up. That raises the positive voltage on the cathode of V2. That biases V2 more heavily and cuts down its plate current. Plate and screen voltages rise.

Similar voltage shifts take place when the AGC control is turned, if the set has one. In noise-canceling AGC/sync stages, setting the noise-immunity control can also affect AGC voltage and thus the DC voltages.

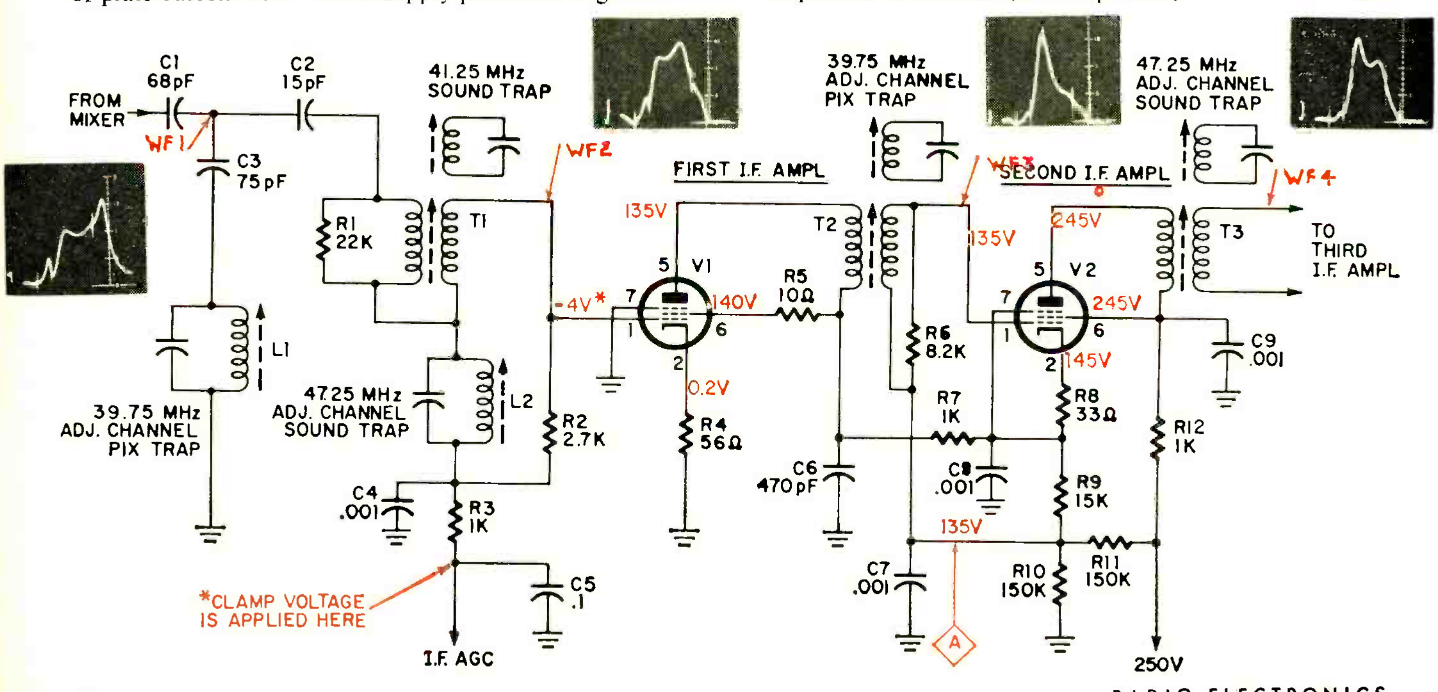
Quick Troubleshooting

First thing to do is overcome external effects. Clamp the AGC line at whatever negative voltage value is recommended by the manufacturer for alignment. That's what has been done for these *Kwik-Fix*™ guides.

Next check out all DC voltages. If some are wrong, use the DC Voltage Guides to pin down and clear up that trouble. If all DC circuits check okay, the trouble is probably a signal fault.

Alignment is the most sure way to find signal-circuit ailments in IF stages. That's why the Waveform Guides in this *Kwik-Fix*™ are sweep-response curves. Set up the sweep generator for alignment as the manufacturer recommends. Best results are with post-injection markers. Feed the sweep signal into the mixer test point in the tuner, and keep its output as low as will make a curve on the scope. Quickly go through the alignment. If the curves don't work out right, move on to the troubleshooting procedure using the *Waveform Guides.*

With the *Guides,* don't scope the response curve at the output of the video detector as usual. Instead, use a demodulator probe to scope points WF1 through WF4. You'll be surprised how quick and dependable this method of servicing is. The "Shape Changed" waveforms in the *Guides,* if you compare peaks and dips with the marker positions, even show which frequencies in the response are deficient (or overpeaked). **R-E**



DC VOLTAGES AS GUIDES

Voltage change →	to zero	very low	low	slightly low	slightly high	high
Key-point-A Normal 135 V	C7 short		C6 short, lky C7 leaky C8 short C9 short R8 open	C4 short C5 short C8 leaky	R7 open	R4 open, hi R10 open
V1-cathode-pin-2 Normal 0.2 V	C6 short C7 short C8 short C9 short R5 open R7 open R8 open R10 low	R12 open	C8 leaky R7 high R11 open R12 high		C5 leaky R10 high	C4 short C5 short R4 open, hi R10 open R11 low
V1-plate-pin-5 Normal 135 V	C6 short C8 short R7 open T2 pri open	C7 short C8 v. leaky	C4 short C5 short C6 leaky C7 leaky C8 leaky C9 short R8 open R11 open R12 open, hi R10 low	C8 slt lky R9 open	R10 high	R4 open, hi R5 open R10 open R11 low
V1-screen-pin-6 Normal 140 V	C6 short C8 short R5 open R7 open	C7 short C8 v. likely	C4 short C5 short C8 leaky C9 short R7 high R8 open R11 open, lo R12 open, hi R10 low	C8 slt. lky R9 open	R10 high	R4 open, hi R10 open R11 low
V2-grid-pin-1 Normal 135 V	C7 short T2 sec open	C6 short	C6 leaky C7 leaky C8 short C9 short R7 high R8 open R10 low R11 open R12 open, hi	C4 short C5 short C8 leaky C9 leaky R8 high R9 open	R10 high	R4 open, hi R5 open R10 open R11 low
V2-cathode-pin-2 Normal 145 V		C6 short C7 short	C6 leaky C8 short C9 short R8 open R10 low R11 open R12 open	C4 short C5 short C8 leaky C9 leaky R8 high R9 open	R10 high	R4 open, hi R5 open R10 open R11 low
V2-plate-pin-5	C9 short R12 open T3 pri open	C9 leaky	C6 short C8 short C9 leaky			

Use this Guide *to help you pinpoint a faulty part.*
Measure each of the seven key voltages with a vtvm.
For each, move across to the column describing the change you find.
Notice which parts might cause each change. Then notice which parts are repeated in whatever combination of voltage changes you observe.

Test those parts individually for the fault described.
NOTE: In ordinary operation, all dc voltages in these two stages vary with signal strength. Surest way to test is with agc clamped as described in text.

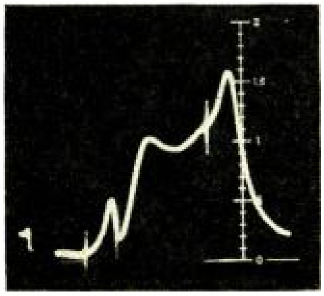
NOTE: For more guides to narrow down the faulty part further, see Waveform Guides.

WAVEFORMS AS GUIDES

IMPORTANT: For all waveform guides, a sweep signal is fed into the mixer test point on the tuner. Center frequency is about 43 MHz, sweep width about 10 MHz (from 38 to 48 MHz). The IF AGC is kept at all times clamped to whatever voltage is recommended by the manufacturer; in this stage, it is −4 volts.

A demodulator probe is used to scope each key test point. The scope's vertical input is switched so that 2 volts peak to peak fills the graticule. The height of the sweep response curve is controlled by adjusting sweep generator output. Most curves shown are 1.5 volts.

The multiple markers are your key to analyzing the shape of a curve. Notice where each peak and dip is in relation to the markers. The B & K model 415 alignment generator has been used here, because it can display several post-injection markers simultaneously. When needed, the model 415 can show markers horizontally so you can see them easier (see "WF4, R2 open"). At each key test point, only significant markers are used. The curves that show symptoms always include exactly the same markers as the "Normal" version, so you can analyze the shape more accurately.

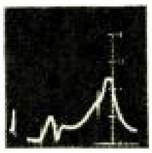


WF1 Normal

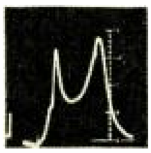
Markers:
39.75 MHz
41.25 MHz (Snd)
45.75 MHz (Pix)

Taken just past the DC-blocking capacitor at the input to the IF stage. The dipping effect of the 39.75-MHz adjacent-channel picture-carrier trap is obvious—the curve is right down on the base line at that marker. The effect of the 41.25-MHz sound-carrier absorption trap is apparent, too; notice the definite dip of the curve at that marker. The high peak in this response curve is somewhere above 45.75 MHz, since it is to the right of the 45.75-MHz picture-carrier marker. Its position is a result of tuned circuits in the mixer output (in the tuner). Amplification at lower frequencies (to the left of the peak) is boosted by tuned circuits farther along in the IF section.

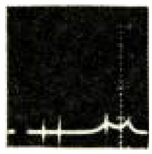
V p-p low	V p-p high	V p-p zero
		C1 open



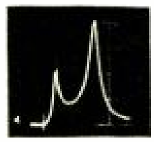
C1 short



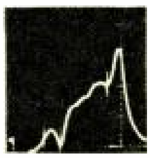
C2 short



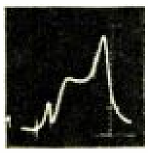
C1 open



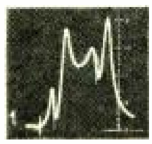
C2 open



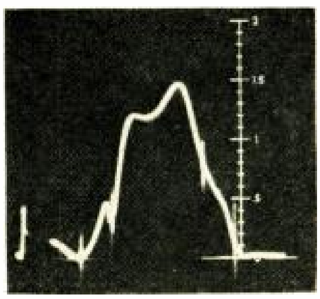
C3 open



C6 open



R2 open

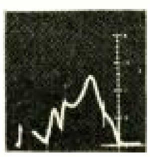


WF2 Normal

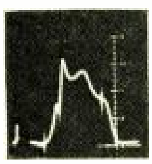
Markers:
39.75 MHz
41.25 MHz
45.75 MHz
47.25 MHz

Response curve at grid of first amplifier. Effects of both input traps are more pronounced; see the well defined dips in the curve at the first two markers. Main peak is now well to left of 45.75 MHz marker, due to effects of transformer T1 and 47.25-MHz adjacent-channel sound-carrier trap through which sweep signal has now passed. You'll also notice you have to turn down generator output signal some, to make display fit on scope screen. There's an extra marker—at 47.25 MHz—and curve is way down at that point. That's because of trap L2.

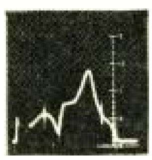
V p-p low	V p-p high	V p-p zero
		C1 open C2 open



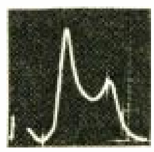
C1 short



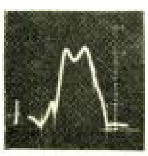
C2 short



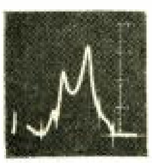
C3 short
C3 open



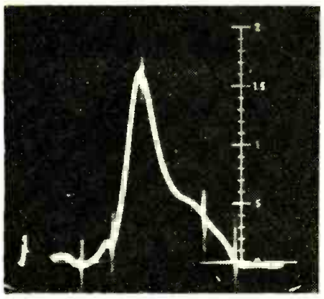
C4 open



R4 open



R2 open

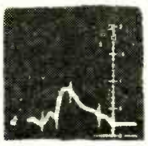


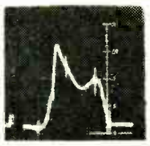
WF3 Normal

Markers: 39.75 MHz, 41.25 MHz, 42.5 MHz, 45.75 MHz, 47.25 MHz

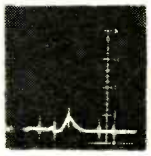
This curve includes the effect of tuned circuit T2, evidenced by the tall peak at the 42.5-MHz marker. That's the resonant frequency of T2. There's also a noticeable flattening near the first marker, because a second 39.75-MHz trap is part of T2. The curve is also relatively lower at the 45.75-MHz marker because amplification by V1 has been concentrated heavily at the resonant frequency of its output load, T2. You find it necessary to turn the sweep-generator output down when moving your demodulator probe from WF2 to WF3; the tube has added considerable gain. At this point, you're looking at the combined effects of many tuned circuits: the mixer coils (not visible in the schematic), L1, T1, L2, and T2; that includes the traps in T1 and T2.

V p-p low	V p-p high	V p-p zero
C6 leaky	C4 short	C1 open
C7 slt lky	C5 short	C2 open
C8 leaky	R3 open	C6 short
C9 leaky	R10 open	C7 short
R5 open		C8 short
R11 open		C9 short
		R4 open
		R7 open


C1 short


C2 short


C5 short


C6 leaky
C7 leaky
C8 leaky
C9 leaky


C6 short
C7 short
C8 short
C9 short


C4 open


C6 open
C9 open

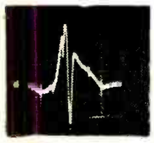

C7 open

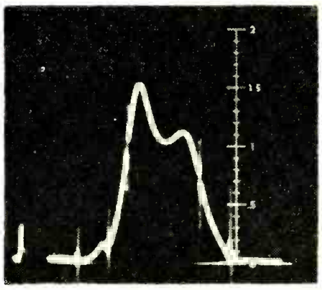

R2 open


C8 open


R10 open


R12 open


R8 open

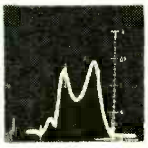


WF4 Normal

Markers: 39.75 MHz, 41.25 MHz, 42.17 MHz (Color), 45.75 MHz, 47.25 MHz

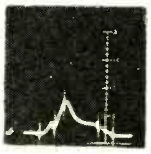
Curve here is beginning to take on look of overall bandpass response. Effect of T3 is to pull up right side of curve, just down-frequency from (to the left of) 45.75-MHz marker. (Compare with WF3.) Sweep-generator output is about same as for WF3. Color-carrier marker at 42.17 MHz is added to show its position on down-frequency (left) slope. Upper-frequency slope is steeper near base line, due to effect of another 47.25-MHz adjacent-channel sound-carrier trap which is part of T3.

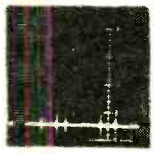
V p-p low	V p-p high	V p-p zero
C6 leaky	C4 short	C1 open
C8 leaky	C5 short	C2 open
C9 leaky	C6 slt lky	C7 short
	R3 open	C8 short
	R10 open	C9 short
		R4 open
		R5 open
		R7 open
		R8 open
		R11 open


C1 short

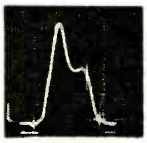

C2 short


C5 short


C6 leaky
C7 leaky
C8 leaky
C9 leaky

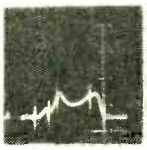

C6 short
C7 short
C8 short
C9 short

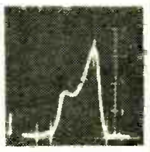

C3 open

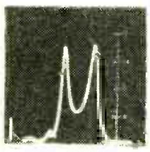

C4 open

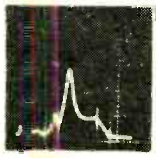

C6 open


C7 open


C8 open


C9 open


R2 open


C10 open

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

With a demodulator probe, check the four key response curves.

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

Note curve shape, particularly height and slopes of curves at markers. If there's a change, compare with the guides and change the parts suggested.

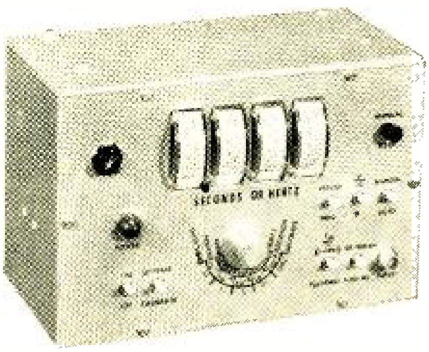
BUILD

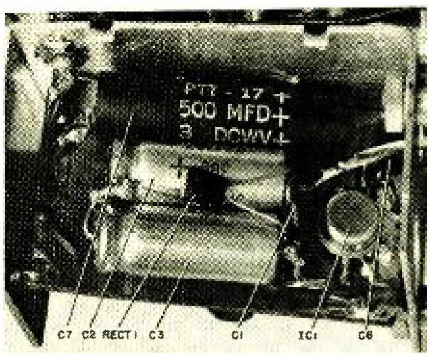
Digital RTL Frequency Counter

Here's the data you need to complete the counter. You'll enjoy the four digit readout too.

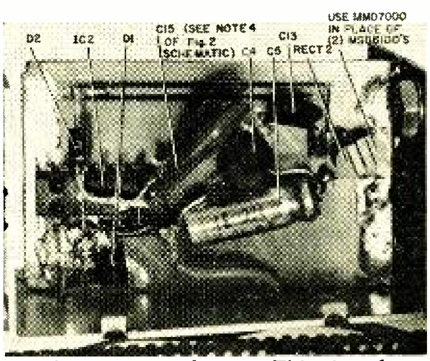
by **BOB BOTOS**

LAST MONTH WE STARTED YOU OFF building this counter. But the article was so long we could not get it into one issue. Here's the rest of the information you need to complete your counter. So now get to work, finish the job and put it on your bench. One point. The right hand column of the table in Fig. 1 which we published last month has an error—it is transposed top-to-bottom.


The completed counter looks like this.



Closeup of the preamp as seen from the prescaler side of the circuit board.



Another preamp closeup. This time from the other side—the predriver section.

The period selector

The period selector selects one and only one period of either the incoming signal to the counter, with the counter in the PERIOD mode, or of the oscillator, with the counter in the FREQUENCY mode. The period selected, in the form of a low or logical zero, is then used as the gate time for the NOR logic count gate. In the period mode, the count gate allows passage of the oscillator signal for one period of the incoming signal. In the frequency mode, the count gate passes the incoming signal for one period of the oscillator signal.

The period selection is accomplished by using a dual J-K flip-flop (IC 15) connected as in Fig. 2. The initial state is preset (during the reset cycle) so that the Q outputs of both devices are in the low state. The first negative transition of the incoming signal causes Q_A to go high. The second negative transition causes Q_A to go low, which in turn causes Q_B to go high. Q_B's high is passed by the series-connected NOR gates (IC 14) to the direct clear of A, which inhibits any further transitions until the devices are reset. The high condition of the Q output of flip-flop A exists only during one complete period of the input to the period selector. This high state is inverted and becomes the gate timing signal.

At first glance it appears that the $\overline{Q}_A$ output could be used directly and eliminate the need for the inversion. However, an RTL J-K flip-flop behaves in the following way: As the toggle input is clocked, the negative transitions actually cause the $\overline{Q}$ output, when high, to attempt to go low. Since the direct clear is held high, $\overline{Q}$ immediately returns to the high state. Consequently, the $\overline{Q}$ output will have a negative spike appearing at each negative transition of the toggle input.

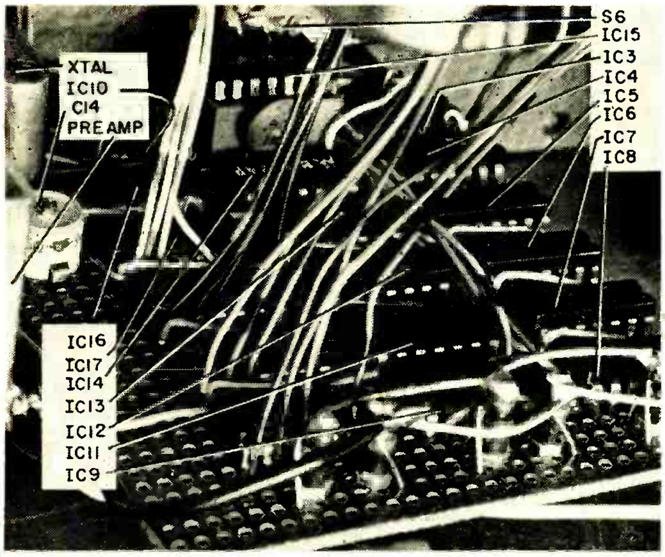
On the other hand, a high on the direct clear insures that the Q output remains low during the toggle input transitions. Therefore, it is desirable to use the Q output and to invert, rather than cope with negative spikes on the $\overline{Q}$ output.

During the normal operating sequence of the period selector, C_{DB} must be kept low and C_{DA} must be connected to Q_B. To reset the selector, both C_{DA} and C_{DB} must go high. A dpdt switch could perform this function, were it not for contact bounce. This problem is described in the following section.

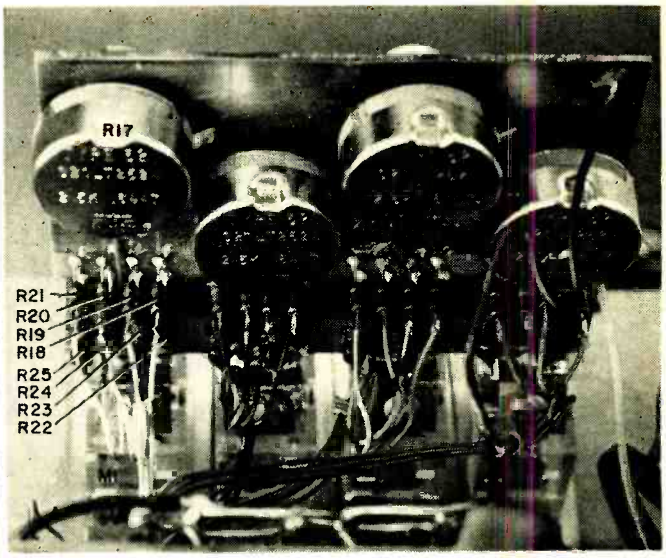
Manual reset

The counter is reset by setting the Q outputs of all flip-flops to the low state. This is accomplished by making all direct clears high. Here, a simple switch is inefficient because if contact bounce is present, malfunctioning results.

The circuit used is independent of contact-bounce duration, and is in essence a bistable multivibrator (IC 16) connected as in Fig. 2.



Most of the IC's are located on this perforated phenolic board. This "in tight" photo shows exactly how they are arranged.



Four decimal readouts all in a row. The components for only one readout are labeled, the others simply repeat.

PARTS LIST

Capacitors
C1, C4, C6, C16—0.01 μF
C2, C3—50-μF, 50V electrolytic
C5—10-μF, 6V electrolytic
C7—500-μF, 3V electrolytic
C8—30 pF
C9—0.0015 μF
C10, C11—1000-μF, 25V electrolytic
C12—0.5 μF
C13, C15—0.1 μF
C14—9–35 pF

All resistors 10% unless noted
R1, R13—10,000 ohms, ¼W
R2—2200 ohms, ¼W
R3, R5, R14, R18
R19, R20, R21—1000 ohms, ¼W
4—68 ohms
R6, R7, R11—56,000 ohms, ¼W
R8, R9, R10—3900 ohms, ¼W
R12—240 ohms, 1W
R15, R16—500-ohm, ½W linear potentiometer
R17—2500-ohm, ½W linear potentiometer
R22—3320 ohms, ½W, 1%
R23—1500 ohms, ½W, 1%
R24—825 ohms, ½W, 1%
R25—392 ohms, ½W, 1%

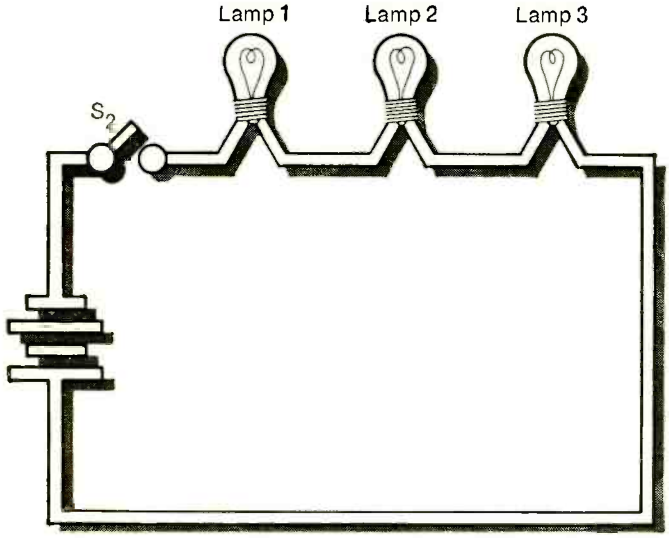
Semiconductors ("M" prefix indicates Motorola)
RECT 1—MSD6102
RECT 2—MMD7000
RECT 3—MDA920-1
D1—MSD6102 (one-half used)
D2, D3, D4—1N4001
D5—MZ500-11
Q1, Q4—MJE520 transistor
Q2, Q3, Q5, Q7, Q8, Q9, Q10—MPS2923 transistor
Q6—MPS6517 transistor

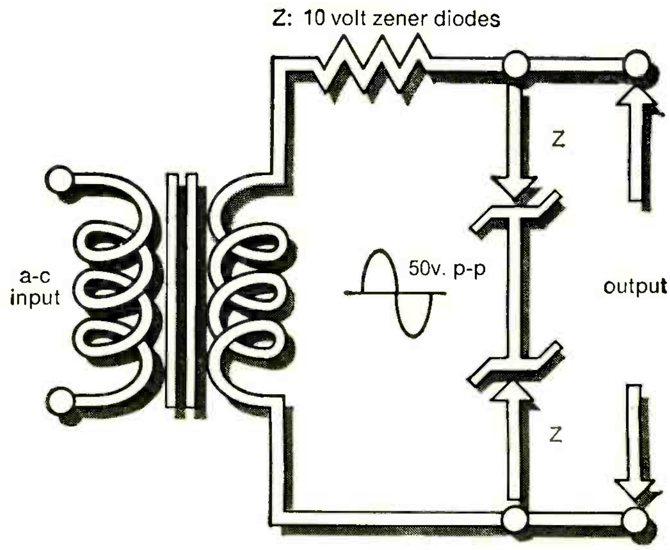
Integrated Circuits
IC1—MC15552G
IC2—MC838P
IC3—MC789P
IC4—MC788P
IC5, IC6, IC7, IC8, IC9, IC11, IC12, IC13, IC17—MC790P
IC10, IC14, IC16—MC724P
IC15—MC790P

Other parts
T1—filiment transformer, Triad F-25X or equal
L1—100-mH inductor
XTAL—1-MHz crystal
LM1—NE-51 neon lamp
F1—0.25A, slow-blow fuse
M1—0-10 mA meter. Note: The readout module described in the November 1968 issue is available as a $10 kit from Southwest Technical Products Inc., 217 West Rhapsody, San Antonio, Texas 28216. Also: M1 with special scale $2.25, or the module PC board (etched and drilled), $1.00.
S1, S2, S3, S4, S7, S9—spdt switch
S6—2P, 5-position roatary switch
SW8—spdt switch (may be snap-action push-button type)
MISC—9 x 6 x 5-inch (LHW) chassis, J1 connector

	COUNTER SPECIFICATIONS
Waveforms measured:	sine, square, or negative pulses with greater than 30 nanosecs duration
Type of measurement:	frequency, period, random pulse counting with selected gate times
Input impedance:	10,000 ohms typical, 7000 ohms minimum (ac impedance in the sensitive voltage range depends on the forward conductance of the input protection diodes, and diminishes rapidly under overdriven conditions)
Input frequency range:	10 Hz–20 MHz guaranteed; 4 Hz–30 MHz typical
Input period range:	50 nsecs to 100 msecs
Gate time selection:	1 msec to 10 secs in decade steps
Input protection:	±50 Vdc; 1 volt peak in the unattenuated position; conservatively up to 200 volts peak in the attenuated position
Input sensitivity:	50 mV rms guaranteed, 25 mV rms typical
Readout:	4-digit decimal; fixed decimal point location; ranging accomplished by rotary switch
Accuracy:	±0.05%, ±1 count; with self-calibration using line frequency, to ±0.1%
Resetting:	manual or automatic

Can you solve these two basic problems in electronics?





This one is relatively simple:

When Switch S_2 is closed, which lamp bulbs light up?

Note: If you had completed only the first lesson of any of the RCA Institutes Home Study programs, you could have solved this problem.

ANSWERS: Problem 1—they all light up
Problem 2—20 Volts (p–p)

This one's a little more difficult:

What is the output voltage (p–p)?

Note: If you had completed the first lesson in the new courses in Solid State Electronics, you could have easily solved this problem.

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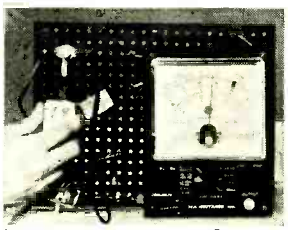

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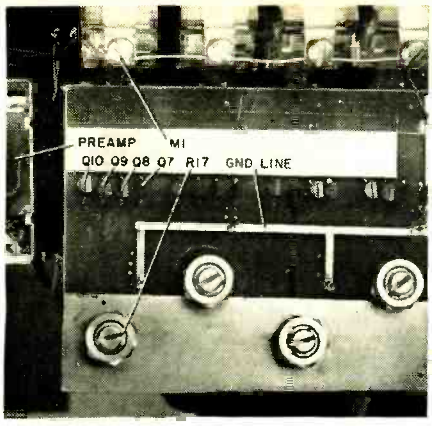
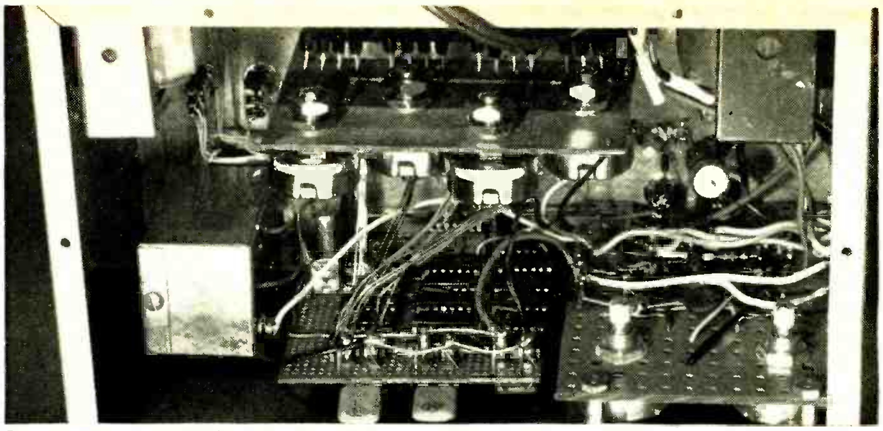
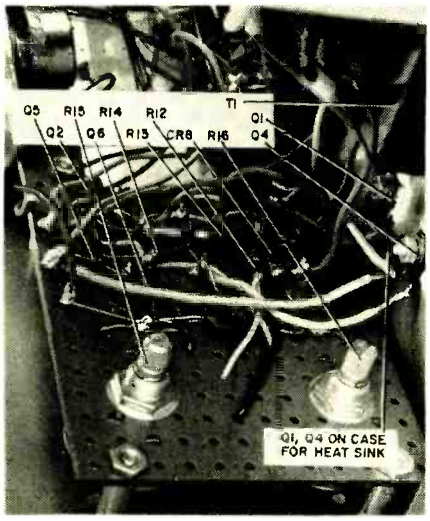


Readout adjustments are back here. All four are alike so only one is identified in detail.



Composite view of the interior of the counter. Look carefully and you will be able to identify to location of all the parts shown in the other photos on these pages.



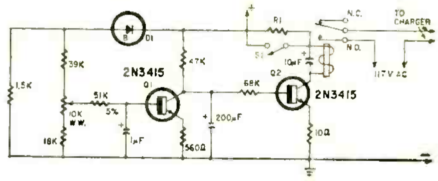
Readout calibrator circuit. Note that transistors Q1 and Q4 are mounted on the chassis to provide proper heat sinking.

BATTERY CHARGER REGULATOR

I have a 12-volt storage battery that I use for an occasional auto radio service job and for powering a camp light during the summer. To keep it charged I use the regulator circuit shown. It turns the charger on when the battery drops to 12.8 and off when it rises to 13.2.

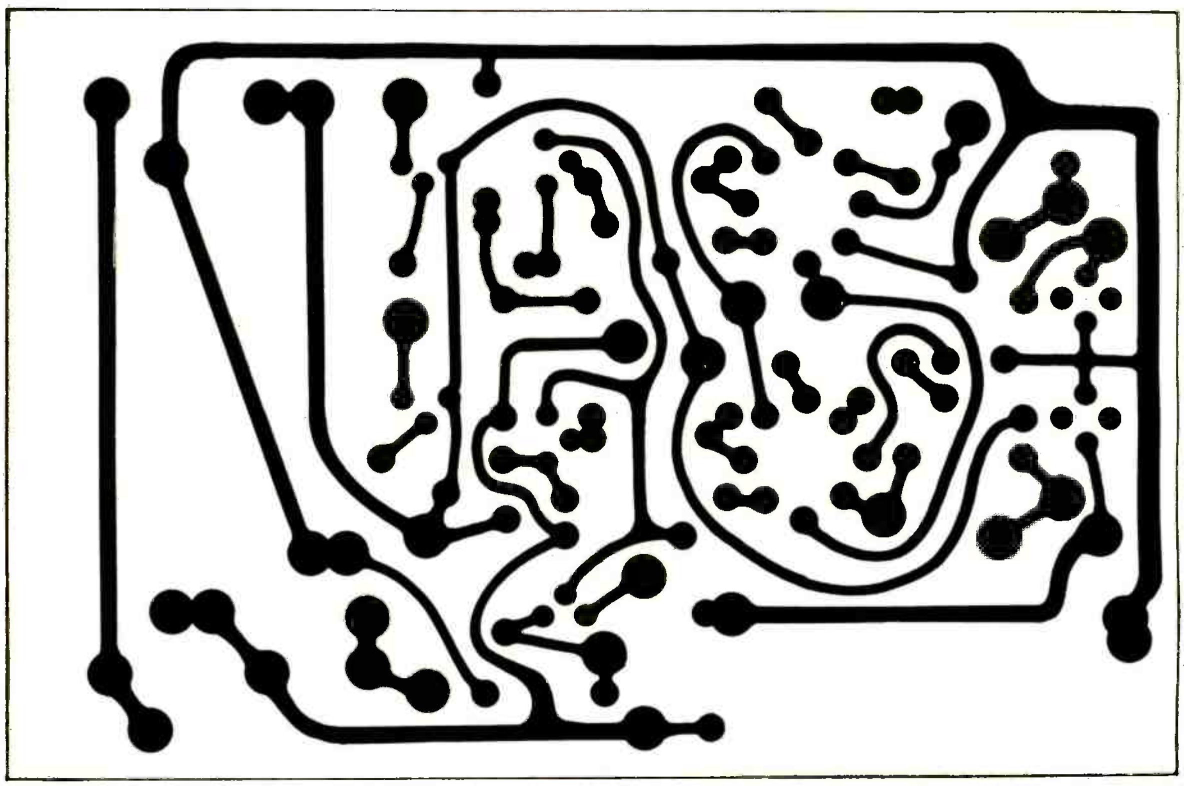
The battery voltage is applied across a voltage divider consisting of D1, an 8–12-volt Zener diode, and the 1500-ohm resistor. The voltage across this resistor depends on the charge on the battery. This variable voltage is tapped off and fed to the base of Q1 through an adjustable voltage divider. The 10,000-ohm pot is adjusted just to the point where the relay drops out when the battery is fully charged.

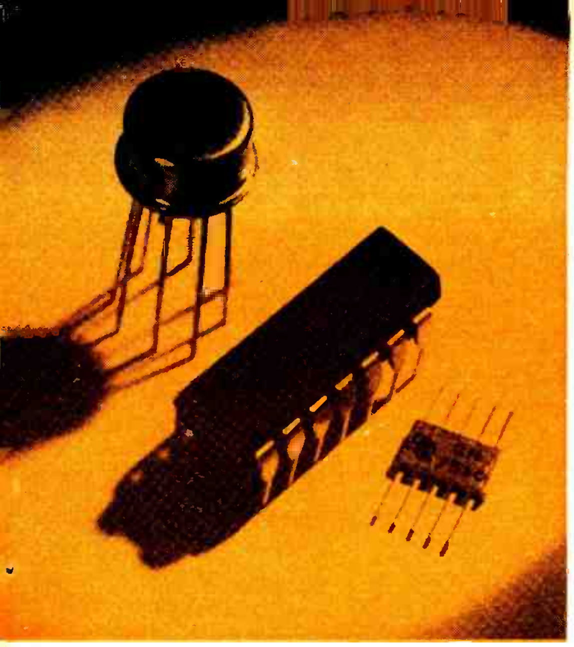
The relay can be any type that will pull in at 10 volts. I used an old telephone relay that needs about 25 mA.



Switch S1 and R1 may be omitted if the regulator is to be in continuous operation. If S1 is a pushbutton or momentary toggle or slide switch, closing it will cause the relay to pull in and keep the charger on the line until the battery is fully charged. If S1 is a normal switch, closing it will permit the charger to recycle as often as the battery voltage drops below a preset level. The value of R1 should be selected for the relay being used.—*C. J. Erksend*

This is a full size view of the circuit board for the Anderson Lab Power Supply





IC LOGIC FAMILIES

What They Are— How They Work—

Learn the ins and outs of digital IC logic gates in this continuing series—Part 4

by BOB HIBBERD

TEXAS INSTRUMENTS, DALLAS, TEXAS

A LOGIC SYSTEM TO DO A PARTICULAR JOB can be designed using "black boxes" which have defined input and output conditions. From the viewpoint of the logic system, it does not matter what is in a box, only what it does. Integrated circuits are the accepted choice for the logic circuits inside the boxes, but there are many ways to use them. Different manufacturers have adopted different approaches to circuit design. These families of logic circuits—RTL, ECL, DCTL, DTL, TTL, etc.—may have bewildered and confused those not intimately concerned with integrated circuits.

This issue, the "classic" families of integrated logic circuits are described, to help the nonexpert engineer and technician to become more familiar with their operation and with the differences between the several types. No attempt is made to present detailed, specific information on any of the types. If you understand the basic design and operation, the details of a particular type are best obtained from the manufacturer's data.

Early digital IC's were based on discrete component circuit designs, and were not necessarily the best arrangement. They were followed by better types, designed to use the capabilities and economical considerations of monolithic integrated circuit techniques. Although some of the earlier types are now tending to drop out, they are included here to present a complete picture.

Most digital IC's operate between cutoff and saturation, and the various types differ in the logic coupling between inverter stages to give NOR or NAND circuits with the required fan-in and fan-out properties.

IC logic gates

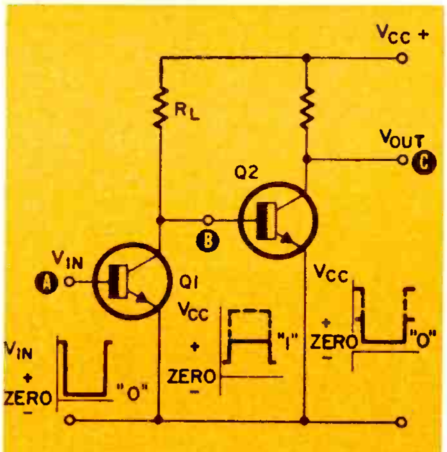
Before describing the various families, let's look at the general characteristics of integrated circuit logic gates.

Logic circuits are normally connected in cascade—the output of one gate is connected to the input of one or more subsequent gates, and so on. Thus, the switching action of one circuit depends, not only on its own output characteristic, but also on the input characteristic of the next gate. Consider the simple case of one inverter circuit driving another (Fig. 1). Assume that the input of the first stage is initially positive (logic 1) and is pulsed almost down to zero (logic 0). With the second transistor not connected, the first-stage output voltage at **B** will swing from $V_{CE(sat)}$, about 0.2 volt (logic 0) to V_{CC} (logic 1).

Now consider what happens if the second stage is connected. When the input voltage to the first transistor falls, its collector voltage starts to rise toward V_{CC}, but when it reaches about 0.7 volt, the base–emitter junction of the second transistor starts to conduct, and current flows down through R_L into its base. Then the voltage at Q1's collector is held at Q2's base–emitter diode voltage and does not rise above about 0.9 volt. Thus, the voltage swing at Q1's output is from 0.2 volt (logic 0) to 0.9 volt (logic 1). The value of R_L is such that the current flowing into Q2's base drives Q2 into saturation, and its collector voltage falls to $V_{CE(sat)}$ to give a logic 0 at the output of the second stage.

Load resistance R_L and the input characteristic of Q2's base–emitter junction result in a combined load line for transistor Q1, as in Fig. 2-a. The forward-voltage transfer characteristic is now as shown in Fig. 2-b. You can see that the output swing of transistor Q1, from 0.2 volt (logic 0) to 0.9 volt (logic 1), gives satisfactory operating points for the input of transistor Q2, which in turn gives the same swing at its output when it is connected to the input of the next stage.

The conditions for satisfactory switching between the two states are these: When Q1 is saturated, its collector voltage must be low enough to keep Q2 cut off. And when Q1 is cut off, the base current flowing into Q2 must be high



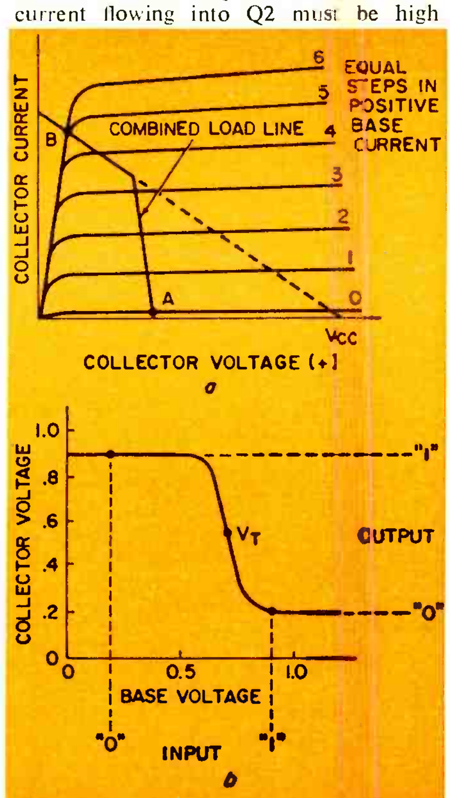


Fig. 1 (above)—Direct-coupled inverter *arrangement generates a logic 0 output similar to the input at Q1 when Q2 is driven to saturation by Q1's "1" output. Fig. 2 (right)—Combined load line for Q1 is shown in* a, *while the voltage transfer characteristics is drawn in* b.

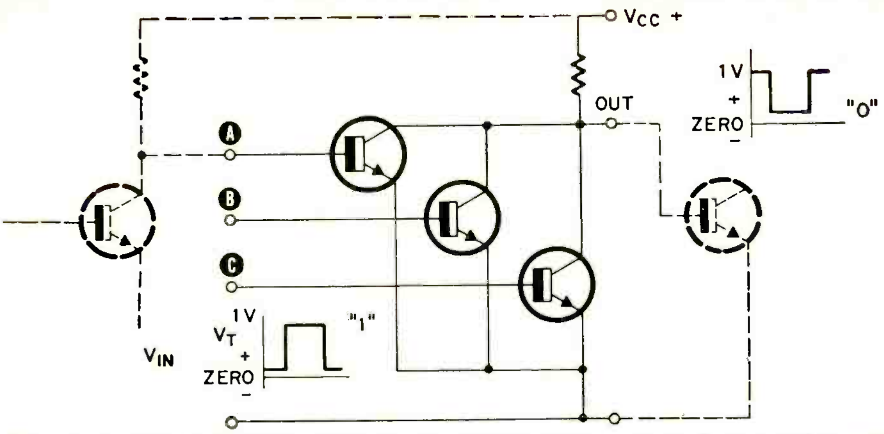


Fig. 3—A logic 1 (positive) input *to this DCTL NOR gate at A, B or C causes a logic 0 output. However, transistor variations can hinder this type of circuit.*

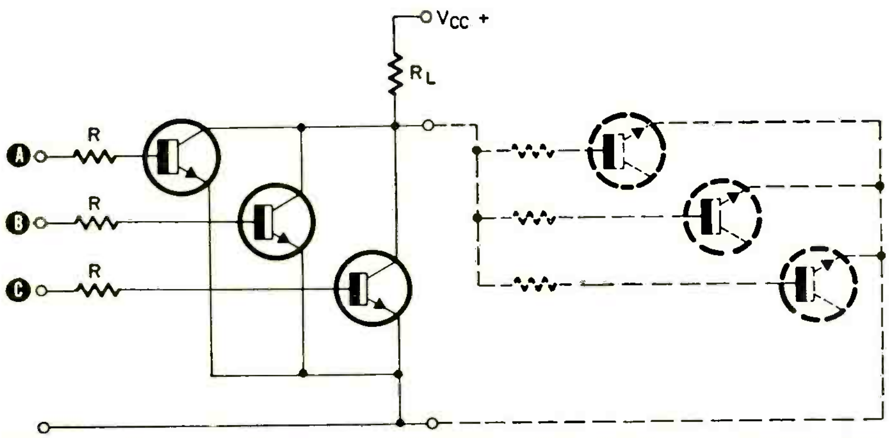


Fig. 4—Adding base resistors *to this basic DCTL circuit reduces current-hogging effect of setup in Fig. 3, but added RC value lowers switching speed.*

enough to saturate Q2. The two operating points with this simple direct-connected circuit are well defined, the 0 state by the collector saturation voltage of the transistor, $V_{CE(sat)}$; and the 1 state by the base–emitter diode voltage of the transistor in the saturated condition, $V_{BE(sat)}$.

Threshold voltage

The voltage level at the input of a circuit, at which the circuit changes from one state to the other, is called the *threshold voltage*. One approximation to this is the voltage at the midpoint of the transition between the two states. This is the point V_T in Fig. 2-b, the threshold voltage in this example being 0.7 volt.

In many logic circuits, the value of threshold voltage is partly dependent on the base–emitter diode characteristics. Since these change with temperature, the threshold voltage also changes with temperature. The detailed circuit design must allow for this. Later we will see how the value of threshold voltage also depends upon the circuit arrangement.

Noise margin

In logic systems, "noise" refers to any unwanted voltage at the input of a circuit. If such a noise voltage is high enough, it could cause the circuit to change state with no change in signal voltage, causing false operation. The difference between the operating point and the threshold voltage gives a measure of the noise margin of the circuit—the maximum value of noise voltage that the circuit can tolerate without changing states. The operating points are usually dependent on temperature, in addition to the threshold voltage, so the noise margin of the circuit is also temperature-dependent in operation.

It is relatively straightforward to specify the dc noise margin of a circuit, but more difficult to define and specify ac noise margin because of transient effects. More will be said about noise immunity later during the description of the various logic families.

Operating speed

It takes a finite time for a circuit to change from one state to the other. In a transistor, this is the time required for the base current to supply charge to, or remove charge from, the capacitive elements associated with the transistor structure, to produce the required voltage change at the output. In a circuit, additional time is required to charge any capacitance associated with the load. Thus there is a time delay between the application of a signal at the input, and the change of state at the output. This time delay is called the *propagation delay* of a circuit.

Values of delay vary considerably, depending on the particular circuit and transistor structure, but with integrated logic circuits are usually in the range of 5 to 50 nsec per gate (a nanosecond is 10^{-9} sec). In a complete logic system, a number of gates are connected in series, and the overall propagation delay is the delay per gate multiplied by the number of gates in series.

An electric current propagates along a wire at a rate of about 9 inches per nanosecond. With discrete component circuits, the time delay due to the current traveling along the interconnecting wires could be comparable to the circuit delay. With IC's, the interconnections are very short, and the time delay due to current propagation is usually negligible compared with the circuit delay.

Fan-in and fan-out

The fan-out is the number of circuits a gate can drive from one state to the other simultaneously. Each circuit has an associated input resistance and capacitance, and the driving gate must be designed so its internal impedance allows sufficient voltage swing to be produced at its output with all load circuits connected.

The fan-in is the number of inputs a gate is designed to accommodate.

Operating temperature

All semiconductor devices are temperature-sensitive, and a circuit can operate satisfactorily only over a certain temperature range. The IC manufacturer designs his circuits according to their intended application, and specifies their operating temperature range in his data sheets. Military types are generally specified to operate between −55°C to +125°C and industrial types between 0°C to +70°C.

Power dissipation

The power dissipation of a logic circuit is usually defined as the supply power required for the gate to operate with a 50% duty cycle, that is, equal times in the 0 to 1 states. The power dissipation of typical logic integrated circuits ranges from a few milliwatts to about 50 mW per gate, depending on the type of circuit. In general, high-speed circuits with short propagation delay require higher power.

Digital logic circuit families

As stated earlier, there are several logic circuit groups or families, based mainly on different methods for carrying out the logic and coupling to inverter stages. For example, in Direct-Coupled Transistor Logic (DCTL), transistors are used for the logic with direct coupling between stages. With Resistance Transistor Logic (RTL), series resistors are included in a DCTL circuit. Diode Transistor Logic (DTL) uses diodes as logic elements, and Transistor Transistor Logic (TTL) uses a multi-emitter transistor instead of the diodes. In Emitter-Coupled Logic (ECL), the circuits are coupled by a common-emitter resistor, and Complementary Transistor Logic (CTL) uses a combination of pnp and npn types of transistors.

For each family, variations of a basic gate circuit are used to design a range of logic circuits with compatible input and output logic levels. In a complete logic system, it is generally necessary to use logic circuits of one family only.

Direct-coupled transistor logic (DCTL)

In the DCTL system, the output of a gate is directly connected to the input of the next gate. A DCTL NOR gate is shown in Fig. 3. The input voltage is normally derived from the collector of the previous gate and the output connects directly to input of the following gate as indicated by the dotted circuits.

If a positive voltage (logic 1) is connected to input A or B or C, the respective transistor saturates and the output voltage drops to the saturation voltage of the transistor to give a logic 0 output. With the dotted driving and load gates connected, the logic voltage swing at both input and output of the NOR gate is approximately from 0.2 volt for logic 0, to 0.9 volt for logic 1, as previously described with reference to Fig. 2. The threshold voltage will be about 0.7 volt.

The advantage of the system is its simplicity, but the problem is that its operation is affected by slight differences between the characteristics of different transistors. If one transistor has a base–emitter voltage slightly lower than others in parallel, it takes most of the available current and prevents proper overall operation of the circuit. This is called *current hogging*. To reduce the effect, resistors are included in series with each base lead, so that the base current is less dependent on the individual base–emitter characteristics. The circuit is then known as *Resistor Transistor Logic*. The simple DCTL circuit is now rarely used and will not be discussed further.

Resistor transistor logic (RTL)

Resistor transistor logic was the first family of logic circuits established as a standard catalog line. The basic arrangement is in Fig. 4. Here you can see the series resistors added to each transistor. By reducing the current-hogging effect, the use of the resistors allows a larger fan-out. Against this, the series resistors have an adverse effect on the switching speed of the circuit, since the input capacitance of the transistors must now be charged and discharged through additional resistance which gives the circuit an increased time constant. Thus with RTL, there must be a compromise between fan-out and switching speed.

Typical values are a fan-out of 4 or 5 with a switching delay of 50 nsec. The operating points and logic voltage swing are similar to those for the DCTL circuit. The RTL circuit has a relatively poor noise immunity. The noise margin from the logic 0 state to the threshold voltage is about 0.5 volt, but from the logic 1 state to the threshold voltage it is only 0.2 volt.

Switching speed of an RTL circuit can be improved by adding a capacitor in parallel with the series resistor. This variation is called *Resistor–Capacitor Transistor Logic (RCTL)* and is shown in Fig. 5. The capacitor lets leading and trailing edges of a signal pulse bypass the resistor so the transistor input capacitance charges more quickly. The use of the capacitor also allows higher values of resistor, with the possibility of lower

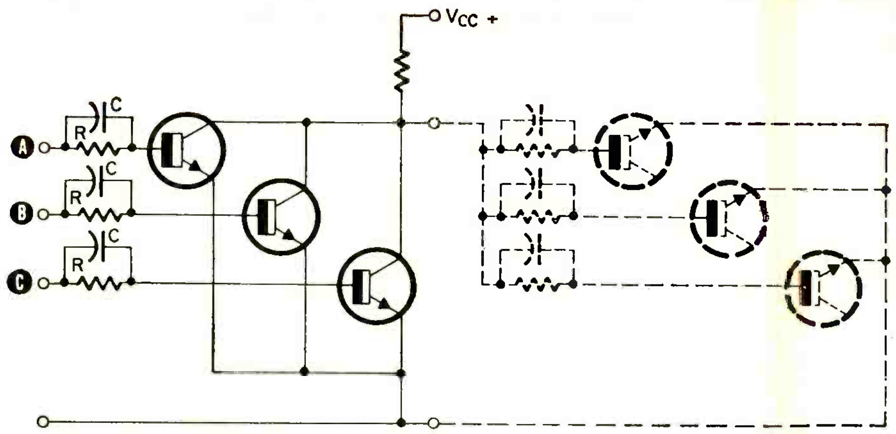


Fig. 5—Faster switching speed *can be gained in RTL circuits by paralleling series resistors with capacitors to bypass leading and trailing pulse edges.*

power dissipation per gate. The RCTL circuit, however, is not ideal from the IC viewpoint as it includes a high proportion of resistors and capacitors, which are relatively costly because of the large area they occupy. Both RTL and RCTL circuits are still used in established equipment, but are rarely used for any new development.

Diode transistor logic (DTL)

The next family of integrated logic circuits to become established is the *diode transistor logic* circuit shown in Fig. 6. The logic is performed by input diodes D1, D2 and D3, and the signal is then coupled through series diode D_S to an inverter stage consisting of a transistor and its load resistor. The overall DTL circuit constitutes a NAND gate.

If all inputs are at logic 1 with a positive signal voltage equal to V_{CC}, the three input diodes are reverse-biased and pass no current. Series diode D_S is forward-biased and current flows through R_D and D_S into the base of the transistor and holds it in saturation, with the low collector voltage, $V_{CE(sat)}$, giving a logic 0 at the output.

If one of the inputs drops to ground potential, logic 0, the corresponding input diode conducts and current flows down through R_D and the diode. The potential at **X** drops to the voltage across the input diode, which is now about 0.7 volt. This is not sufficient to drive current through diode D_S plus the base–emitter junction of the transistor in series. Thus no base current flows, the transistor is cut off and the collector potential rises to V_{CE} to give a logic 1 output.

Going back to the condition when all inputs are at positive V_{CE} potential, the input diodes are reverse-biased and current flows through R_D and D_S into the base of the transistor. The potential at **X** is approximately 1.4 volt, 0.7 volt across series diode D_S and 0.7 volt across the base–emitter junction of the transistor. Now let one input voltage be reduced gradually.

For the associated input diode to start to conduct, it is necessary to reduce the input voltage down to 0.7 volt so that there is a forward voltage of 0.7 volt across the diode. Then the diode conducts, the voltage at **X** falls to 0.7 volt

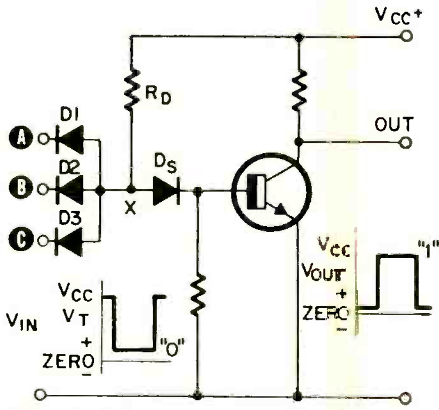


Fig. 6—NAND gate circuit *using input diodes. DTL is faster than RTL circuits.*

and the transistor is cut off. So the threshold voltage of this circuit is 0.7 volt. If two diodes in series are used for D_S, the threshold voltage is increased by an additional 0.7 volt to 1.4 volt (this is usually done in practical DTL circuits).

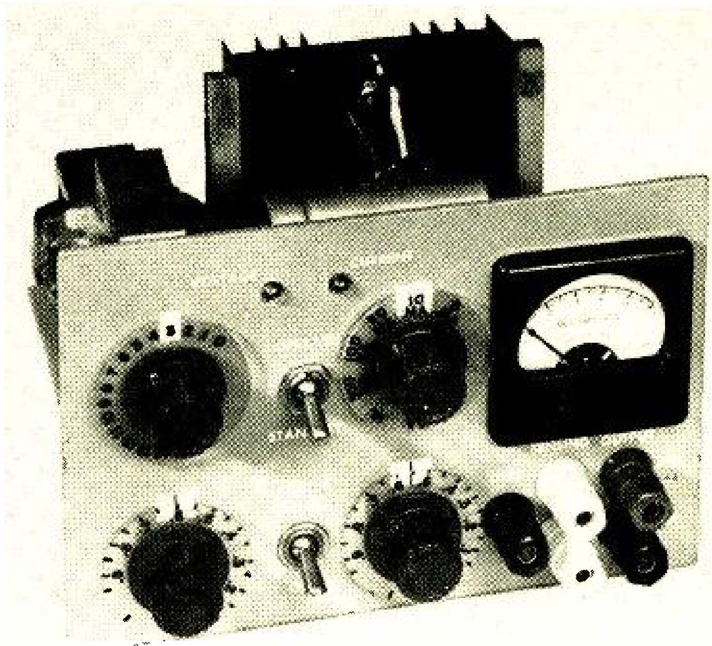
With a logic 1 input, the input resistance of the gate is high—the diodes are reverse-biased, and so the gate does not load the previous circuit. Thus the logic 1 output level from a previous DTL circuit can be the full supply voltage V_{CC}. If this is set at 4 volts, the two operating points at input and output of the gate will be 0.2 volt for logic 0, and 4 volts for logic 1. If two series diodes are used with a threshold voltage of 1.4 volts, the 0 state noise margin will be 1.2 volts, substantially better than that of the RCTL circuit.

The DTL circuit switches faster than the RTL circuit since the signal passes through the low forward resistance of the diodes to the transistor. A typical delay time is 25 nsec. A high fan-out up to the order of 8 is possible because of the high input impedance of the subsequent gates in the logic 1 state. The use of diodes in the DTL gate, rather than resistors and capacitors as in RCTL, makes it more economical in integrated circuit form.

NEXT MONTH

In the October part of this series, we'll look at further examples of IC logic families. A few of the areas to be covered are transistor-transistor logic and MOSFET logic circuits.

IC LAB POWER SUPPLY



Part 2—Details on how to layout, calibrate and test your voltage/current regulating power supply

by LEONARD H. ANDERSON

IN THE FIRST PART OF THIS ARTICLE (last month) the basic operation of this voltage and current-regulating power supply was described. Operation of control-sensing circuits, and calibration procedures concludes the article.

Control and sensing circuitry

A 1-mA reference current flows, so R_E and R_I must have values equal to 1000 ohms per volt. R_S drop is limited to 1-volt to keep error-amplifier voltage swing low and to limit high-current dissipation. This establishes R_I as 1000 ohms maximum. R_S drop should be limited to less than 1 volt for output currents greater than 2 amps.

R_E can be a standard potentiometer, multiturn potentiometer or switch-selected precision resistors. Oak offers a special switch wafer in which four resistors are interconnected for 10 resistance values. I picked a switch with 1000-ohm increments (1-volt steps) in series with a calibrated standard potentiometer for fine control. The STANDBY/OPERATE switch is optional. The STANDBY position shorts R_E for zero output volts.

R_S is a group of accurate resistors selected by a current range switch. Minimum current range selected must be greater than reference current. Power dissipation at high currents must be watched since undue heating will affect accuracy. Accurate low-ohm resistors are difficult to obtain but several 5% carbon-composition resistors can be paralleled. There is good probability that a group of ten 10-ohm, 5% resistors will give 3% accuracy at 1 ohm.

A 1-volt scale voltmeter can be bridged across R_S for continuous current readings, but R_S must be increased in value to compensate for meter resistance. When total voltmeter resistance is known, R_S can be computed by:

$$R_S = \frac{R_M}{I_S R_M - 1.0}$$

where R_M equals total meter resistance in ohms, and I_S is range current in amps. Table II shows several representative values of R_S for two meters.

Long leads and high current ranges introduce voltage error due to drop in lead resistance. Connecting common and voltage-sensing connections directly at the load eliminates this error. How it is done with the aid of two extra terminals is shown in Fig. 5. Each sense and output terminal pair are strapped together when short leads are used. Wire tables can be consulted for specific applications. For example, 10 feet of No. 18 (two 5-foot leads) will cause a 0.063-volt change with a 1-amp current change if remote sensing isn't used.

Contact resistance voltage drop of the current range switch can be as great as 50 mV. This is a 5% error at 1 amp. The extra range-switch pole shown in Fig. 5 eliminates this by placing the drop out of the sensing circuit.

Range switch rating is important. Most contact ratings are given for "holding" conditions when contacts are stationary. Making and breaking currents are 1/3d to 1/5th of holding currents. Conventional 12-position rotary switches, such as the Centralab PA series, are unsuitable for 300 mA or greater.

A recommended switching system with range resistors in series is presented in Fig. 6. A shorting or nonshorting switch contact system can be used. Note that individual resistor values are lower due to series connection. If contacts fail in the open position, the lowest range is automatically in-circuit.

Calibration and testing

A semi-breadboard test layout at this stage isn't necessary but is a lot easier. Any calculation mistakes will show up now and the chassis will not have to be torn up. Assemble the power transistor and heat sink at this stage. Transistor/sink insulation is not necessary if the heat-sink mounting can be insulated. Use a good thermal-conductivity silicone grease for transistor mounting. Range switches can also be prewired.

First, check the regulator board alone. Connect its supply transformer with a variable autotransformer on the line side. Run up line voltage and measure both 15-volt supply lines; they should increase together. Pin 6 of each IC will remain at about −14 volts since their inputs are not complete. Transistor Q5's emitter output to the series transistor will measure about −4½ volts and this transistor will be slightly warm, dissipating about 0.2 watt.

Zener voltage can be read at each sense input with a high-resistance voltmeter. 2N3638 Zeners will be 6.5 ± 0.5 volt. Both lamp terminals will be zero at this time.

Either setup of Fig. 7 can be made but Fig. 7-b is preferred since 7-a has two error sources: multimeter inaccuracy and meter resistance which will become part of trimming resistance.

Adjust trimmers R1 and R6 for exactly 1.0 mA in Fig. 7-a and zero volts in Fig. 7-b. Better sensitivity and accuracy for 7-b are obtained when several mercury cells are used. Multiply the 1.35K resistor by the number of cells. For fixed trimming resistance, temporarily connect a variable in position; match a fixed resistor to the variable resistor value and install.

Indicator lamp circuits are also checked with Fig. 7-b. Connect the lamps. With no sense input, lamps should be off. Connect the Fig. 7-b circuit to current sense input. If the 1.35K resistor is slightly low, the I lamp should light. It may be at half-brilliance at exactly 1.35K. The same test is done with the voltage sense input and E lamp. The lamps can also be used for final R1, R6 setting.

Calibration is now complete and trimmer shafts should be secured with a dab of Glyptal or lacquer.

Interconnect all raw-dc supply components separately with the variable autotransformer on line. Run up line voltage, measuring dc across C_F. Full line should have 1.4 times secondary-winding rms voltage with no ripple. Rectifiers can be checked by connecting a resistive load for full current.

Interconnect all components. Make certain that sense inputs are not reversed. Set voltage to zero and current for maximum. Turn on line. The E lamp should light. regulator board output will be about 0.33 to 0.5 volt, and the series transistor should be cool. A voltmeter on the output terminals should indicate zero.

Retain the voltmeter and advance voltage with R_E. The voltmeter should follow control settings; but if precision resistors are used in control, the voltmeter will probably be less accurate than the supply.

Make up a resistive load for nearly maximum voltage and half of maximum current. Connect it to the output terminals, observing voltmeter reading. Voltmeter indication should remain stationary with no needle jerk. Decrease the current control potentiometer. At about half setting, depending on the value of the dummy load, the E lamp will go out and I lamp come on.

Remove the dummy load and connect a scope to the output terminals. Reduce voltage settings to a few volts and look for any evidence

Table II—Values for Load Current Sampling Resistor, R_S with Typical Current Meter Connections

Current Range	No Meter	100 ohms/Volt meter (1 mA, 46 ohms internal res. in series 953 ohms)	5000 ohms/Volt meter (200 μA, 1K int. res. in series 4020 ohms)	Power Dissipation in Watts
2 Amp	0.500*	0.500*	0.500*	2
1 Amp	1.00*	1.00*	1.00*	1
500 mA	2.00*	2.00*	2.00*	1/2
300 mA	3.33*	3.34*	3.33*	1/3
200 mA	5.00*	5.03*	5.01*	1/5
100 mA	10.0 (10.0)	10.10 (10.0)	10.02 (10.0)	1/10
50 mA	20.0 (20.0)	20.41 (20.5)	20.08 (20.0)	under 1/10
30mA	33.3 (33.2)	34.48 (34.8)	33.56 (34.0 in parallel with 2610)	"
20 mA	50.0 (49.9)	52.63 (53.6 in parallel with 2940)	50.51 (51.1 in parallel with 4320)	"
10 mA	100 (100)	111.1 (110)	102.0 (102)	"
5 mA	200 (200)	250 (249)	208.3 (210)	"
3 mA	333 (332)	500 (499)	357.1 (357)	"
**2 mA	500 (499)	1000 (1.00 K)	555.5 (562 in parallel with 44.2 K)	"

**Values under ten ohms should be made up of paralleled resistors for accuracy and power dissipation; IRC type AS-2 resistors are available at 2 Watts and 1% accuracy in 1, 2, and 3.3 ohms.*

***Two milliampere range not recommended, too close to reference current.*

All resistances in ohms; figures in parentheses indicate nearest values of manufacturers' stock 1% tolerance resistors.

Resistances are for 1.00 volt drop at full range.

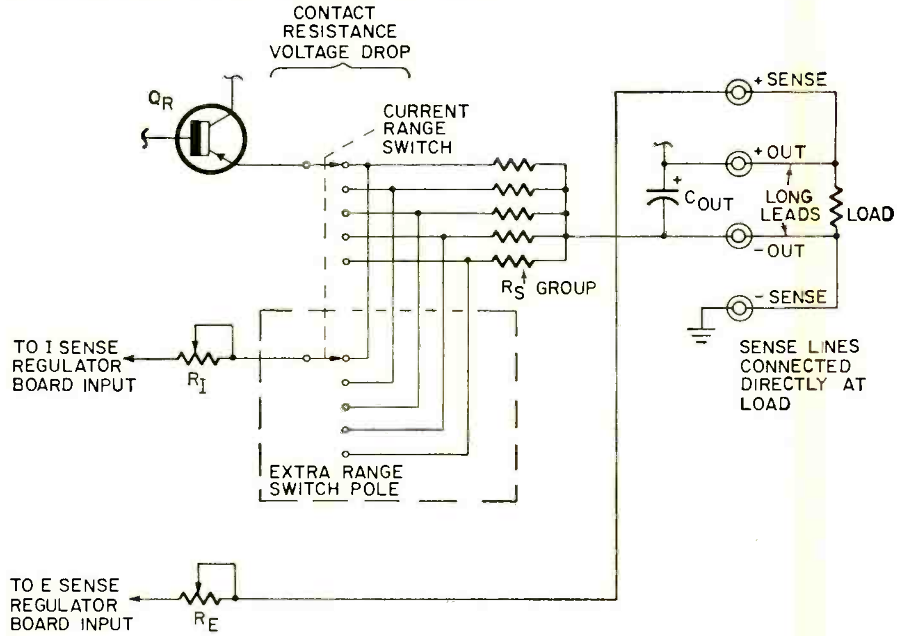


Fig. 5—Add extra range-pole switch to increase the accuracy of the supply by removing the voltage drop due to the range switch from sensing circuit.

of oscillation. Older-design power transistors will have limited frequency response and can introduce phase shift in the loop. Change C2 and C4 values to stop oscillation.

The following two tests should be made in sequence. Set voltage anywhere above zero, current range to maximum but current potentiometer to zero. Short the output terminals; the I lamp should indicate current control. Increase the current potentiometer (a current meter will track pot setting) to 100%. The series transistor will become warm. Your transistor dissipation and heatsink calculations are now being tested. It is a very good idea to measure transistor case temperature physically at this step. If operation is ok, let everything warm a few minutes.

Remove the short and set current range to minimum, voltage to 1 or 2 volts. Insufficient I_{CBO} compensation is indicated by output voltage being slightly higher than setting.

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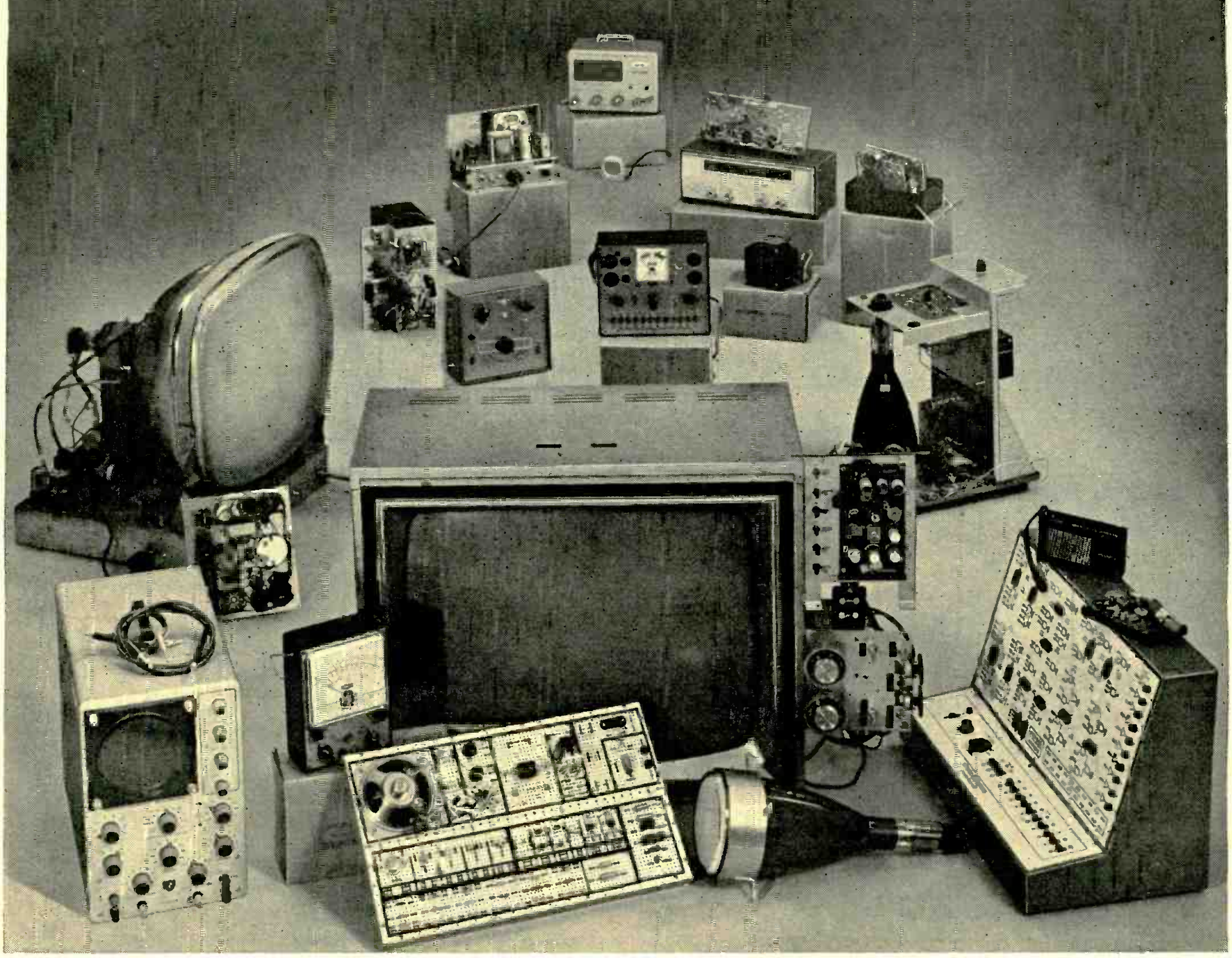

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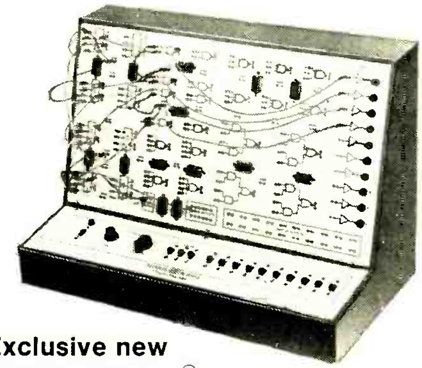

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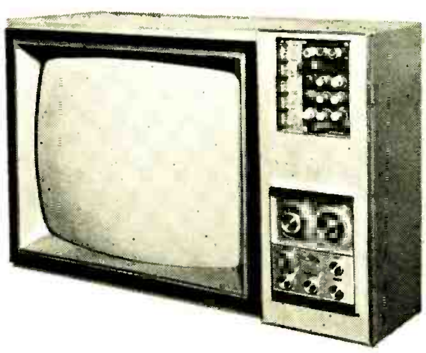

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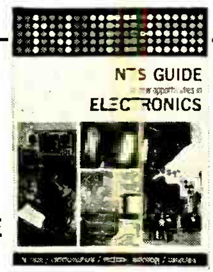

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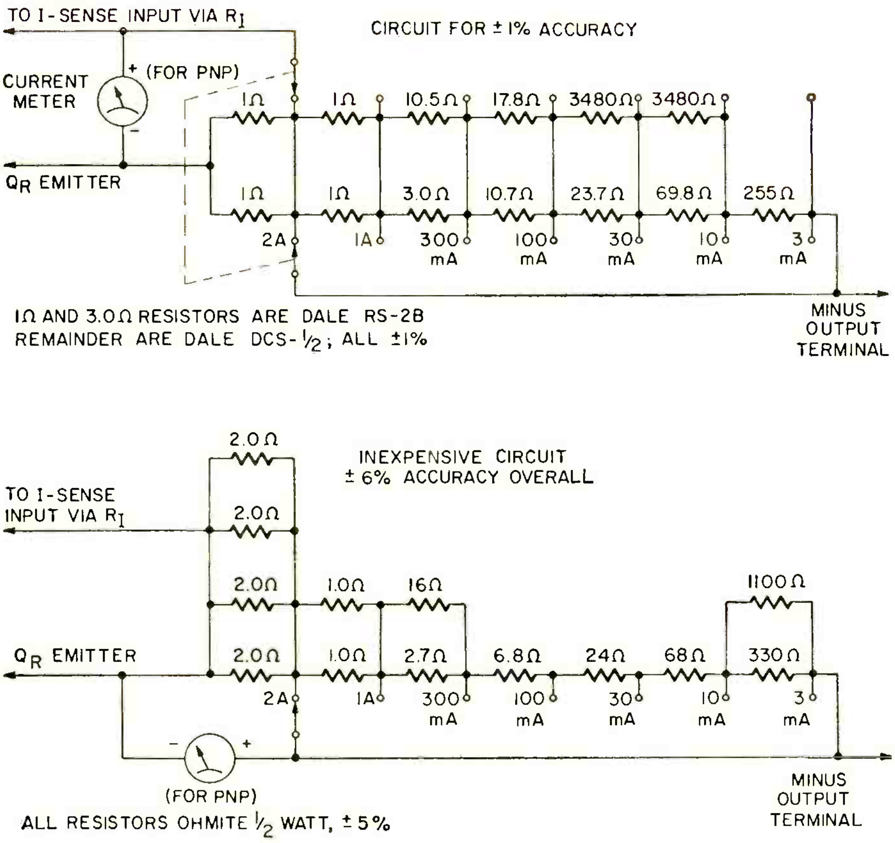
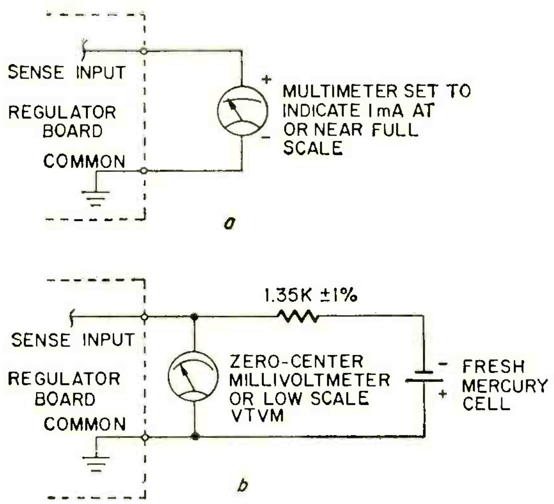


Fig. 6—Range switch setup for 1% accuracy (top circuit) Less critical setup delivers 6% accuracy. Use the one that gives the accuracy level you require.



NOTE: IN BOTH (a) AND (b), POLARITIES ARE SHOWN FOR CURRENT-SENSE REFERENCE ALIGNMENT; REVERSE POLARITIES FOR VOLTAGE-SENSE.

Foil side of the circuit board is shown full size on page 58.

Fig. 7-a—Reference current circuit for the power supply. b—Preferred bridge-null technique provides still greater accuracy where application demands it.

Shunt R20 with another resistor to restore tracking. This test must be performed with series transistor at maximum temperature.

Line-frequency ripple in output will be less than 5 mV peak-to-peak per 10 volts output.

A note on multiturn potentiometers for control: Some types will have up to 3% tolerance on total resistance even though linearity is much better. Total resistance is compensated by setting trimmers with near-maximum voltage and comparison with an accurate voltmeter on output.

Chassis construction

Layout can be anything desired. The transistor heat sink must have an easy airflow path. High-current versions should also have some heat sinking for raw-dc supply rectifiers. Regulator board mounting may be by spacers or right-angle brackets.

I used 5 x 7-inch chassis with the regulator board inside, transformers and electrolytics on the outside. I used Masonite for the front panel. Masonite must have a good primer, such as zinc chromate, to close the porous surface. For added panel support, add an insulated bracket from the meter terminals to the chassis.

"Hot" heat-sinking mounting can be made by oak or maple strips attached to the chassis rear.

One version of this supply was built on a 5 x 9 x 3-inch chassis with normal top surface as the front panel. Transformers, heat sink and electrolytics were mounted on the "bottom plate" (now back plate) outside surface and the regulator board on inside surface.

Access holes for trimmer potentiometers are recommended.

Repeat all operations tests after wiring is finished.

The definite voltage-setting capability frees a voltmeter for other uses. As circuits are built up on a breadboard, current limiting can be advanced for each circuit. Any overcurrent glitches will switch in current limiting and indicate it. Current limiting can take over on an increment smaller than approximately 1% of the full range.

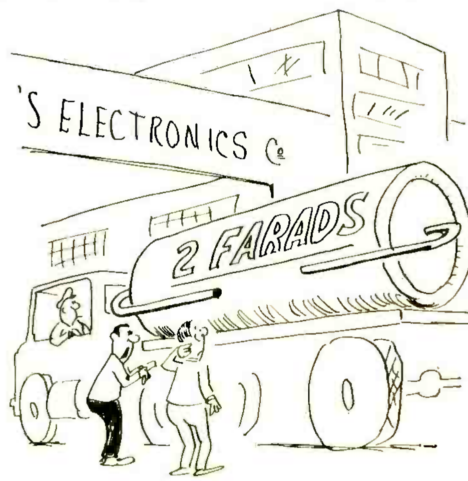
Constant-current regulation with overvoltage limiting is excellent for dc tests of transistors. Two supplies will make any forward or reverse dc transistor test.

One unique use for a low-voltage, high-current version is as a precision electroplating supply.

The supply can also be used as a meter calibrator. The 1% control resistors and careful calibration make it more accurate than any average multimeter or vtvm.

When the supply is used with fast-pulse circuits, supply leads can introduce series inductance with load. A bypass capacitor should be added directly at the load to lessen the problem in this case.

For an investment of $40 or less, you will have an accurate, dependable, easy-to-use, useful instrument for the workshop. **R-E**



"What do you mean? You suppose you made a LITTLE mistake!"

Circle 26 ➔

FIX THOSE SPECIAL SOLID-STATE TV CIRCUITS

by MATTHEW MANDL

CONTRIBUTING EDITOR

TRANSISTORS CAN DO ALMOST EVERYthing tubes can. But their characteristics are so different that special circuit designs must often be used to get desired results.

The triode is still the most popular transistor type, and neutralization is a must in rf amplifier stages to prevent oscillation. Transistors have low-impedance characteristics and are primarily current amplifiers. Thus, extra stages are often used to increase signal levels. Typical examples include driver stages in vertical and horizontal sweep systems and the added stages in video amplifiers.

Set manufacturers often use special circuits peculiar to their own design and not found in other sets. Sometimes, however, a new circuit that improves the performance of a particular stage is adopted by others and becomes standard TV design.

What hampers servicing, however, is the lack of knowledge on how the new circuit functions as well as its purpose. While we can make voltage measurements, observe scope patterns and check components, for final trouble localization, knowing "how it works" helps expedite the job.

White control and noise cancel

The Westinghouse transistor TV chassis V-2483-1 (a black-and-white 19-inch receiver) has a *white-level control* (see Fig. 1). The term *white level* refers to that level of the video signal near the base of the blanking pedestal as shown in Fig. 2. The top of the blanking pulse drives the picture tube into cutoff, thus representing black. Hence, video signals ranging from the bottom to the top of the blanking pedestal appear as brilliant white to very dark scenes.

The white-level control of Fig. 1 regulates the voltage on the base of the first video amplifier (forward bias). This controls the gain of the stage and determines the signal drive applied to the second video amplifier and the video output.

This control is preset at the factory, but these sets are now several years old and will be coming into your shop more frequently. When replacing any video amplifier transistor or

(*continued on page 72*)

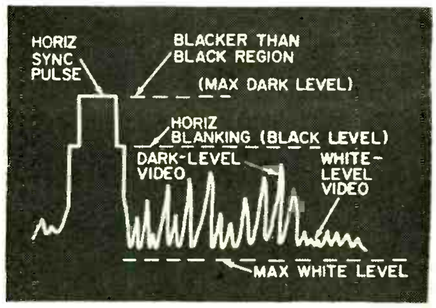


Fig. 2—Compositive video signal *shows white-level video adjusted by the control.*

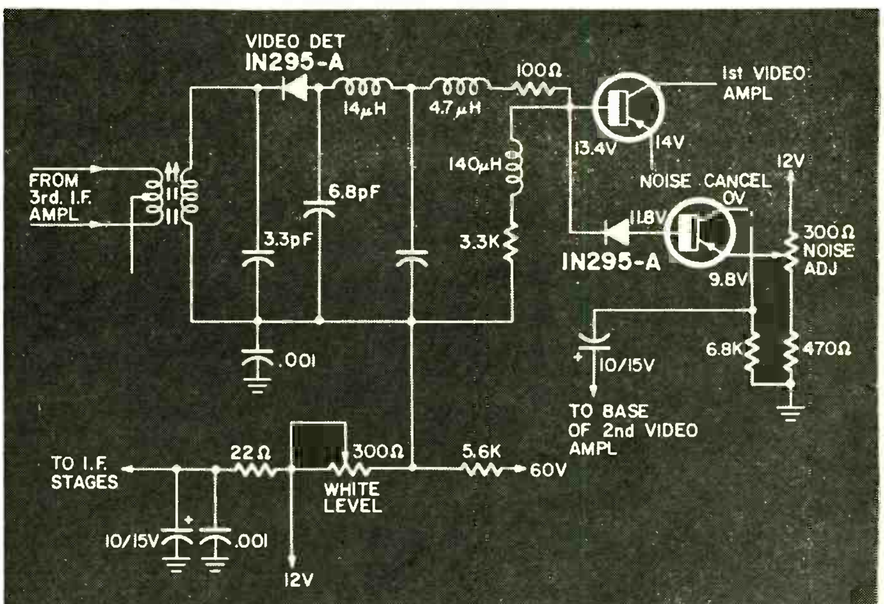


Fig. 1—Circuit for white-level control *and noise-cancel adjust in Westinghouse V-2483-1 transistor chassis. White-level control sets video signal amplitude.*

IF YOU <u>REALLY</u> VALUE YOUR RECORDS

DON'T UNDERRATE THE GRAM!

(. . . a commentary on the critical role of tracking forces in evaluating trackability and trackability claims)

TRACKABILITY:

The "secret" of High Trackability is to enable the stylus tip to follow the hyper-complex record groove up to and beyond the theoretical cutting limits of modern recordings—not only at select and discrete frequencies, but across the entire audible spectrum—and at *light tracking forces that are below both the threshold of audible record wear and excessive stylus tip wear.*

The key parameter is *"AT LIGHT TRACKING FORCES!"*

A general rule covering trackability is: the higher the tracking force, the greater the ability of the stylus to stay in the groove. Unfortunately, at higher forces you are trading trackability for *trouble*. At a glance, the difference between ¾ gram and 1, 1½, or 2 grams may not appear significant. You could not possibly detect the difference by touch. *But your record can! And so can the stylus!*

TRACKING FORCES:

Perhaps it will help your visualization of the forces involved to translate "grams" to actual pounds per square inch of pressure on the record groove. For example, using ¾ gram of force as a reference (with a .2 mil x .7 mil radius elliptical stylus) means that 60,000 lbs. (30 tons) per square inch is the resultant pressure on the groove walls. At one gram, this increases to 66,000 lbs. per square inch, an increase of *three tons* per square inch—and at 1½ grams, the force rises to 75,000 lbs. per square inch, an increase of *7½ tons* per square inch. At two grams, or 83,000 lbs. per square inch, *11½ tons* per square inch have been added over the ¾ gram force. At 2½ grams, or 88,000 lbs. per square inch, a whopping *14 tons* per square inch have been added!

The table below indicates the tracking force in grams and pounds, ranging from ¾ gram to 2½ grams—plus their respective resultant pressures in pounds per square inch.

TRACKING FORCE		GROOVE WALL PRESSURE		
GRAMS	POUNDS	POUNDS PER SQUARE INCH		
		(See Note No. 1)		
¾	.0017	60,000		
1	.0022	66,000	+10%	(over ¾ gram)
1½	.0033	75,000	+25%	(over ¾ gram)
2	.0044	83,000	+38%	(over ¾ gram)
2½	.0055	88,000	+47%	(over ¾ gram)

SPECIAL NOTE:

The Shure V-15 Type II "Super-Track" Cartridge is capable of tracking the majority of records at ¾ gram; however state-of-the-art advances in the recording industry have brought about a growing number of records which require 1 gram tracking force in order to fully capture the expanded dynamic range of the recorded material. (¾ gram tracking requires not only a *cartridge* capable of effectively tracking at ¾ gram, but also a high quality manual *arm* [such as the Shure-SME] or a high quality automatic turntable *arm* capable of tracking at ¾ gram.)

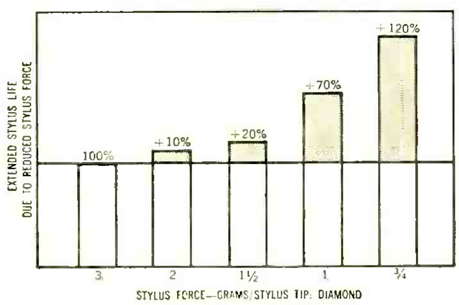
TESTS:

Our tests, and the tests of many independent authorities (see Note No. 2), have indicated two main points:

A. At tracking forces over 2 or 2½ grams, vinylite record wear is dramatically increased. Much of the "high fidelity" is shaved off of the record groove walls at both high and low ends *after a relatively few playings.*

B. At tracking forces over 1½ grams, *stylus wear is increased to a marked degree.* When the stylus is worn, the chisel-like edges not only damage the record grooves—but tracing distortion over 3000 Hz by a worn stylus on a brand new record is so gross that many instrumental sounds become a burlesque of themselves. Also, styli replacements are required much more frequently. *The chart below indicates how stylus tip life increased exponentially between 1½ and ¾ grams*—and this substantial increase in stylus life significantly extends the life of your records.

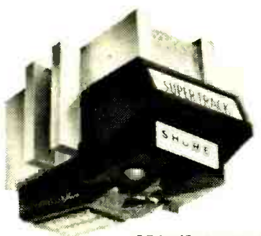
RELATIVE AVERAGE TIP LIFE VS. TRACKING FORCE



No cartridge that we have tested (and we have repeatedly tested random off-the-dealer-shelf samples of all makes and many models of cartridges) can equal the Shure V-15 Type II in fulfilling all of the requirements of a High Trackability cartridge—both *initially* and after *prolonged* testing, especially at *record-and-stylus saving low tracking forces.* In fact, our next-to-best cartridges—the lower cost M91 Series—are comparable to, or superior to, any other cartridge tested in meeting all these trackability requirements, regardless of price.

NOTES:

1. From calculations for an elliptical stylus with .2 mil x .7 mil radius contact points, using the Hertzian equation for indentors.
2. See HiFi/Stereo Review, October 1968; High Fidelity, November 1968; Shure has conducted over 10,000 hours of wear tests.



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Circle 28 on reader service card

Fix Special TV Circuits
(continued from page 70)

other component in this section, recheck the white-level control and reset it, if necessary, to provide a full contrast range. If contrast is still below par, check and reset the agc system.

This receiver also uses a diode–transistor combination as a noise canceller, as is also shown in Fig. 1. To conduct, a pnp transistor must have a forward bias applied between base and emitter, with the base negative with respect to the emitter. For normal operation, however, the noise canceller transistor has about 11.8 volts at the base and 9.8 volts at the emitter, making the base positive with respect to the emitter and cutting off the transistor in this application.

The video signal is inverted at the base of the first video amplifier (Fig. 2 upside down) and, when a noise signal appears, it has a high negative amplitude. The series diode applies such a noise pulse to the base of the noise canceller transistor and thus applies forward bias. Now the transistor conducts and the amplified noise pulse at the collector is applied to the base of the second video amplifier transistor and cuts this stage off for the duration of the noise pulse. During servicing, set the NOISE ADJUST control just below the point where picture bending occurs.

Power supply filters

The power supply sections of transistor TV's often use special circuits to improve regulation, decrease ripple without having to use chokes and excessively large filter capacitors, and to generate several voltage levels as required. Typical is the power supply used in the RCA KCS 153 receiver. The system uses dual rectification (see Fig. 3). A half-wave supply develops 140 volts for the audio and video output amplifiers. The 30 volts for most of the other circuitry is obtained from a full-wave bridge rectifier. The half-wave section is tapped to the output of the bridge, enabling a single circuit breaker to protect both sections. The half-wave secondary winding adds voltage to the tapped section to produce 140 volts.

Full-wave rectification and 1000-μF filters usually produce fairly smooth dc. However, to maintain minimum ripple in both video and sound i.f. stages, as well as in susceptible sweep circuitry, special ripple-filter transistor circuits are used in the low-voltage system.

As shown in Fig. 3, one transistor forms a filter-driver circuit and the other a power driver. Any ripple signal that appears at the output of the 30-volt supply is applied to the emitter circuit of the filter driver. Because this is a grounded-base circuit, the amplified ripple signal in the collector has the same phase as at the emitter. This collector signal is applied to the base of the power filter, which operates in the grounded-emitter mode. Thus, the amplified ripple in the power
(continued on page 97)

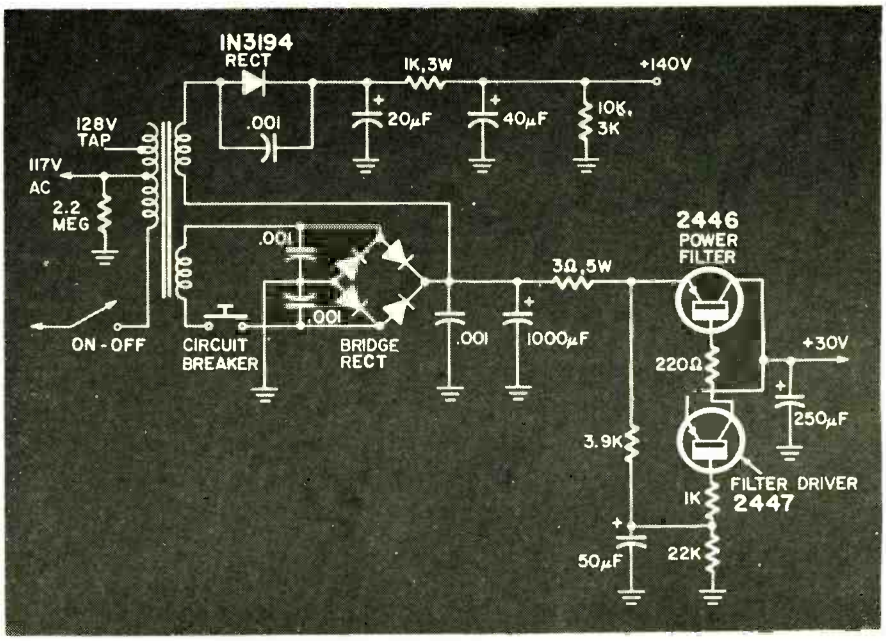

Fig. 3—Dual rectification and special electronic ripple filtering *provide clean dc on this RCA KCS153 chassis without large chokes and filter capacitors.*

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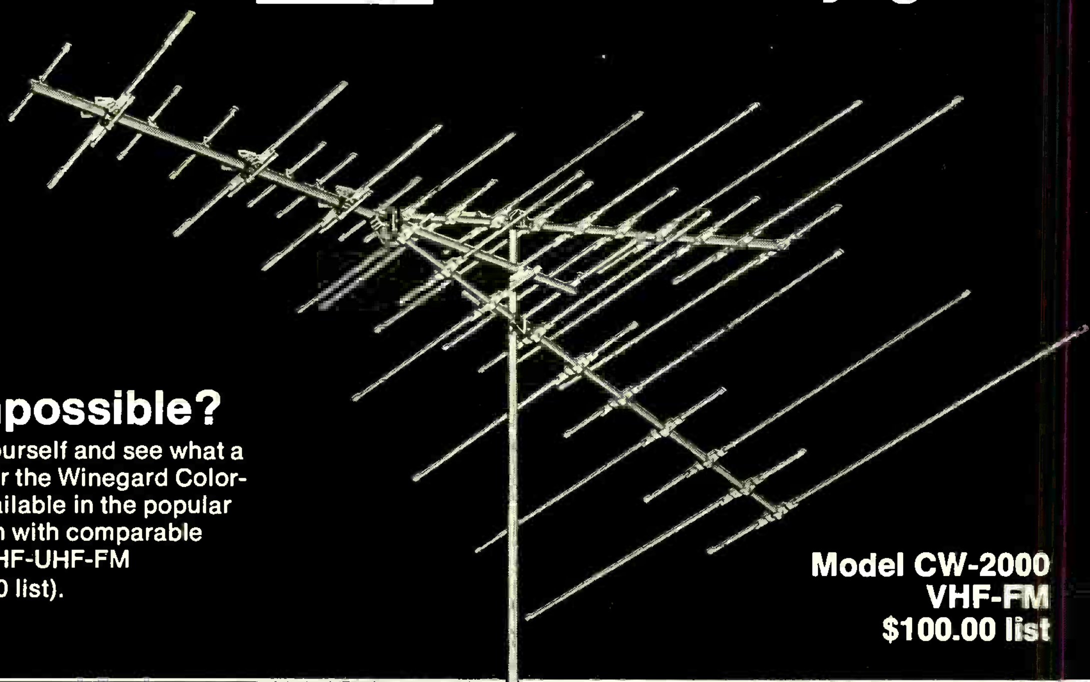

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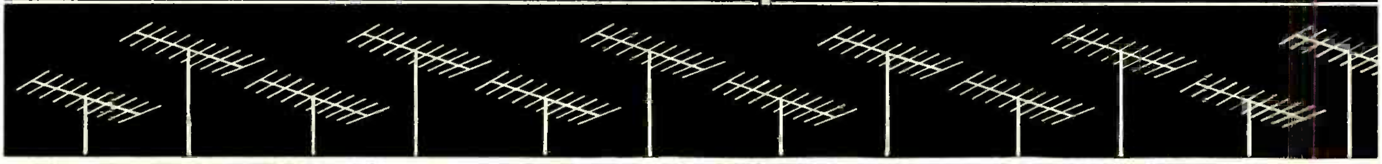


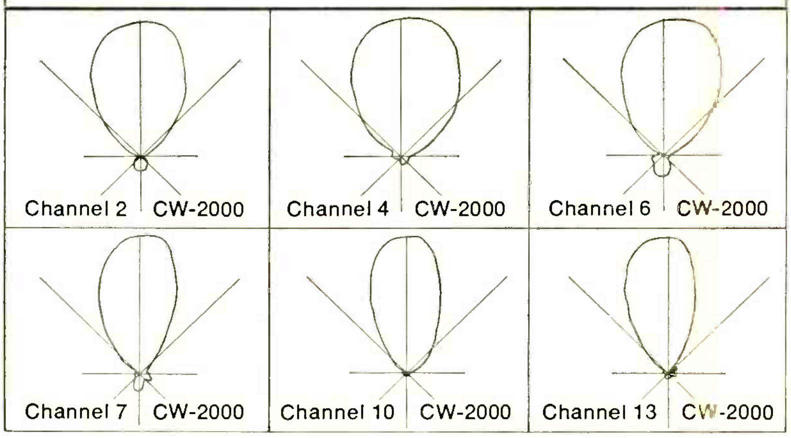
example A:

CHECK DB GAIN

Channel	CW-2000	10-Elem. Yagi
2	7.2	7.8
4	7.2	7.6
6	7.4	8.0
7	12.2	10.8
10	11.4	11.0
13	12.0	11.5

example B:

CHECK DIRECTIVITY



example C:

CHECK FRONT-TO-BACK RATIO

CW-2000	CH. 2	CH. 4	CH. 6	CH. 7	CH. 10	CH. 13
DB	22	26	17	20	35	30

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- **10-Channel IC Color Organ**
  Top performance with any audio system. Uses IC's as active filters and with an agc circuit.

- **200-Watt Stereo IC Amplifier**
  Build a top-performance hi-fi amplifier using a miniature hybrid IC

- **Stereo Headphones**
  Find out the results of listening tests conducted by R-E's editorial staff

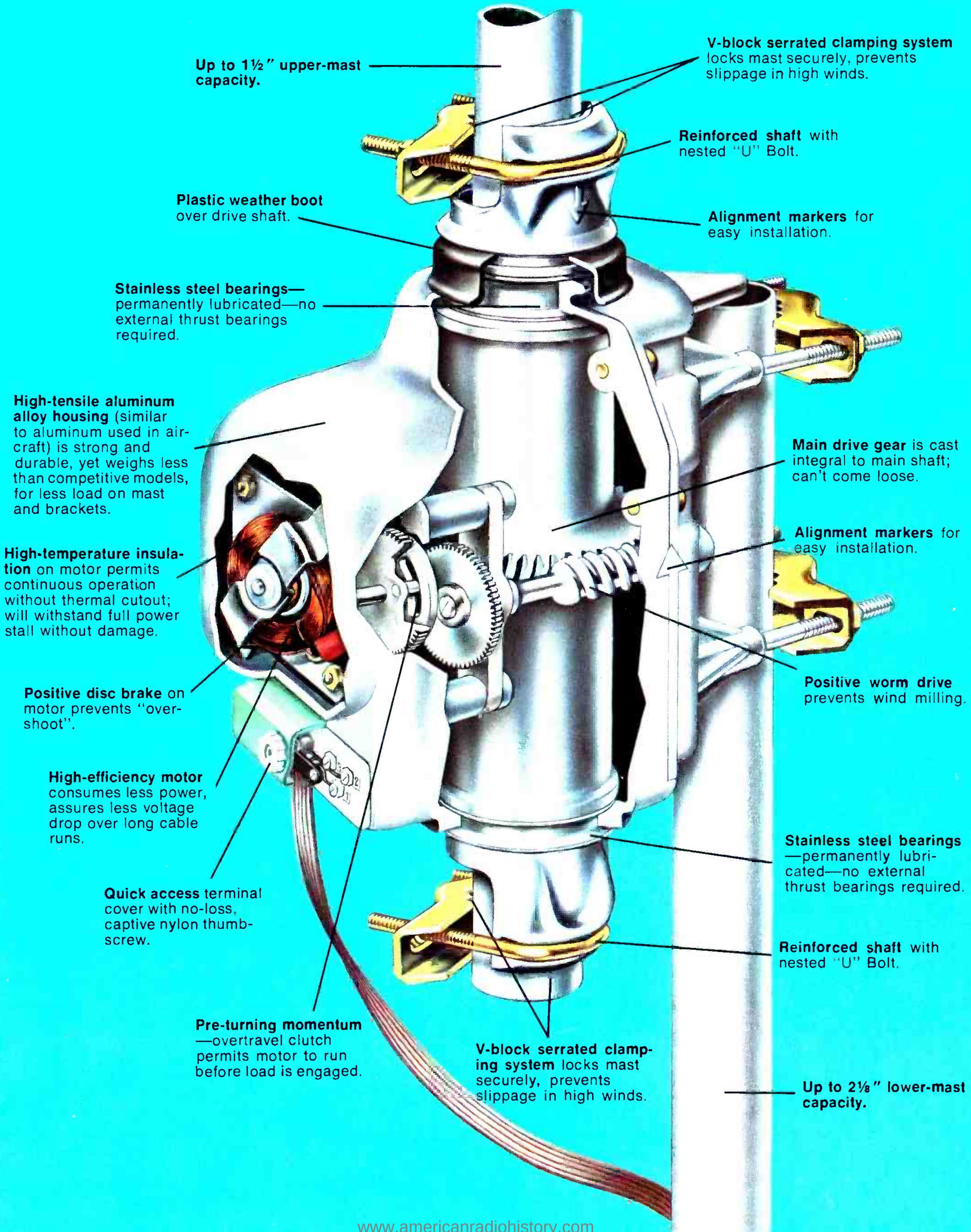
- **How the Dolby System Works**
  Learn how electronic circuits take the hiss out of hi-fi tape recordings

Plus other features in hi-fi and TV

no other rotator can make this statement.

Reliable performance . . .
Brand-name acceptance

RCA rotators offer an exclusive combination of features that give the top-notch performance that people identify with the RCA name. *Engineered and designed by RCA,* these rotators feature a rugged, lightweight drive unit that handles many times the weight of the largest TV antenna easily, effortlessly. RCA rotators—the ones that sell—that don't come back.



The RCA fully Automatic Rotator (model 10W707) has "Space Age" Solid State Circuitry for absolute synchronization plus the *RCA silent operation.* The "707" uses a fully balanced DC bridge circuit to synchronize control unit and antenna with a positioning accuracy of two degrees, unaffected by line voltage variations, cable length, weather conditions or age. No mechanical detents to limit antenna positioning. Full 360° operation—no dead spots. It's "childproof" too—can't be put out of synchronization or damaged by any amount of knob-twisting. Positive directional indicator lights instantly show the *exact* direction of operation, and are positive indication that drive motor is drawing power.

Sheer elegance in appearance Plus the name you can depend on . . . RCA

The new RCA low silhouette beige control cabinets will complement any decor . . . to please the man and woman of any household. And, they perform as beautifully as they look. No competitive antenna rotator does all the things, has all the features, that are built into RCA Rotators!

The RCA sleek positive push-button fingertip control Rotator (model 10W505) has a 360° indicator dial that shows the antenna position at all times . . . to change this position just touch a button. Unique mechanical design achieves precise control with few moving parts. Proven in life tests . . . over 30,000 operations without a failure! A great value in a push-button rotator—RCA quality at a budget price!

RCA

"Space Age" Engineering... Tested Performance

RCA Tests and Tests—RCA subjects rotators to continuous-operation life tests. Far more severe than any normal use, these tests surpass the use a rotator would receive over a period of more than 20 years. In one of these tests (top photo), the RCA Rotator was operated *continuously* with 64 lb concrete weight loading for over 30,000 full 360° rotations without failure. Results of this testing prove the RCA rotators you sell will perform year in and year out at their peak. Tell your customers about RCA testing, reinforcement for RCA brand-name power.

RCA Engineered—RCA engineers took a long, hard look at every factor involved in creating a rotator to turn an antenna. Circuitry, mechanics, materials were among the problems carefully studied. Solutions to each problem drew extensively from RCA's 50-year engineering experience, and were directly related to RCA accomplishments in space and radar systems. The result: the best rotator the RCA name can sell for you.

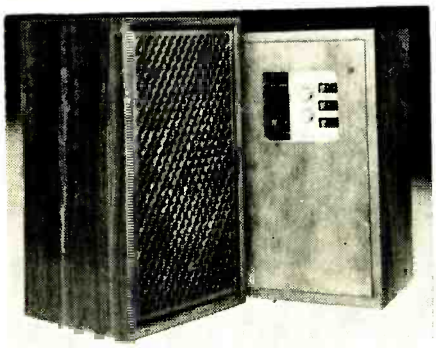
RCA

Parts and Accessories | Rotators | Antennas | Reception Aids & Installation Hardware

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.

3-WAY SPEAKER SYSTEM, *Model SP-1001*, consists of a 10" woofer, 6½" mid-range speaker and 1" dome-shaped tweeter. Features include pushbutton connection terminals and electronic cross-over for simple hookup of bi- or tri-



amplification systems. Max. input, 40 W (IHF). Impedance, 8 ohms. Sound pressure level, 100 dB. Frequency response 35-20,000 Hz. Network, 12 dB/octave parallel type. $139.95.—**Sansui Electronics Corp.**, Woodside, N. Y.

Circle 46 on reader service card

3-WAY RATCHET NUT DRIVER, *Model 70711*, measuring 8½" long and weighing 10 oz., is chrome-plated and has a corrosion-proof internal mechanism with tempered steel springs. Tools adjusts automatically to nuts from ¼"-

7/16". Thumb pressure on three-way shift selector located on the shaft controls forward, reversed or locked position of unit. $5.95.—**Vaco Products Co.**, Chicago, Ill.

Circle 47 on reader service card

VOLTAGE ADJUSTER FOR TV, *Saturn Model 50–172*, changes low ac line voltage to normal or increase 117 V to 140 V line if necessary. Unit is simply plugged in series with the color TV set and the edge-view meter and 6-position switch allow the viewer finger tip control

of line voltage for proper and sharper picture quality. Capacity, 300–500 watts. Size, 5½" x 3" x 2¼". Weight, 3 lbs. $26.95.—**Terado Corp., New Products Div.**, St. Paul, Minn.

Circle 48 on reader service card

RHYTHM INSTRUMENT, *Model X-92*, 7½" x 7⅛" x 2", is a complete electronic rhythm section that plays through guitar or music amplifier. Operates on self-contained battery or optional ac power

supply. Tempo can be adjusted as desired after selection from 5 basic rhythm patterns which are fox trot, after beat, jazz rock, rock beat, fore beat and rock-a-ballad. $90.00.—**Olson Electronics Inc.**, Akron, Ohio

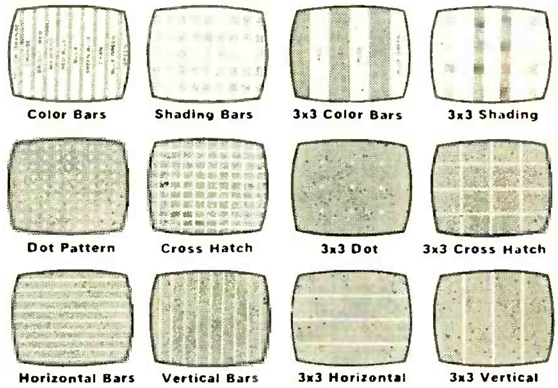
Circle 49 on reader service card

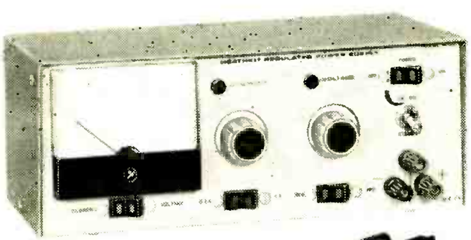
SOUND N' COLOR EQUIPMENTS, all solid state, provide synchronization of sound with color. Three models in audio/color organs; *Models 3445* and *3450* are both 4-channel. *Model 3440*, 3-channel. Translator, *Model 3465*, 3-channel. 1500 watts, turns music system sound frequencies into 3 primary pulsating colors, red, blue and green. *Strobe Lite, Model 3475*, permits use with wide range of music sources at minimum vol-

9 Exciting New Kits

NEW
Kit IG-28 $79^{95}*

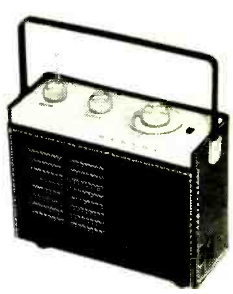
Standard 9 x 9 Display **OR** Exclusive Heath "3 x 3" Display





NEW
Kit IP-28
$47^{50}*

NEW
Kit ID-29
$29^{95}*



NEW
Kit GR-88
Kit GR-98
$49^{95}*
each

NEW
Kit GD-209A
$149^{95}*

NEW Heathkit Color Bar-Dot Generator... Advanced Integrated Circuitry Produces 12 Patterns Plus Clear Raster, Eliminates Divider Chain Instability Forever

The new IG-28 is the signal source for all color and B&W TV servicing. No other instrument at any price will give as much stable, versatile TV servicing capability. Its solid-state circuitry produces dots, cross hatch, vertical and horizontal bars, color bars, and shading bars in the familiar 9x9 display . . . plus exclusive Heath 3x3 display of all these patterns . . . plus a clear raster that lets you adjust purity without upsetting AGC adjustment. Fifteen J-K Flip-Flops and associated gates count down from a crystal controlled oscillator, eliminating divider chain instability and adjustments. And for time-saving convenience the IG-28 has variable front panel tuning for channels 2 through 6. Plus & minus going video signals at the turn of a front panel control . . . for sync, in-circuit video or chroma problems, use the front panel sync output. Two front panel AC outlets for test gear, TV set, etc. Built-in gun shorting circuits and grid jacks too. Add any service-type scope with horizontal input and you have vectorscope display capability as well. Fast, enjoyable circuit board-wiring harness construction. You can't beat the Heathkit IG-28 for versatility or value . . . put it on your bench now. 8 lbs.

NEW Heathkit 1-30 VDC Solid-State Regulated Power Supply

The new modestly priced IP-28 is an excellent power supply for anyone working with transistors. Compact Heathkit instrument styling with large, easy-to-read meter . . . two voltage ranges — 10 V., 30 V. . . . two current ranges — 100 mA, 1 A. External sensing permits regulation of load voltage rather than terminal voltage. Adjustable current limiting prevents supply overloads and excessive load current. Convenient standby switch. Fast, easy assembly with one circuit board and wiring harness. Order yours today! 9 lbs.

NEW Heathkit Solid-State Auto Tune-Up Meter ... Measures Dwell, RPM And DC Voltage

The new Heathkit ID-29 is most versatile . . . really three automotive test instruments in one. Measures Dwell on all 4-cycle, 3, 4, 6, or 8 cylinder engines . . . measures RPM in two ranges, 0-1500 and 0-4500 . . . measures DC voltage from 0 to 15 volts. And no batteries are needed . . . running engine provides both signal and power. Easy to use . . . on both 6 and 12 volt system without changing leads. Lightweight and easy to carry . . . its black polypropylene case has a built-in lead storage compartment and is resistant to virtually everything. Fast, simple assembly . . . only about 5 hours. The perfect accessory for the handyman, emergency road service personnel or shop mechanics . . . order your ID-29 now. 4 lbs.

NEW Heathkit GR-88 & GR-98 Solid-State Portable Monitor Receivers For VHF-FM and Aircraft Bands

GR-88 . . .

Tunes both narrow and wide band signals between 154-174 MHz . . . for police, fire, most any emergency service. Exceptional sensitivity and selectivity, will outperform other portable receivers. Smart compact styling, portable or fixed station capability with accessory AC power supply, variable tuning plus single channel crystal control, collapsible whip antenna, adjustable squelch control, easy circuit board construction. The new GR-88 receiver is an added safety precaution every family should have . . . get yours today! 5 lbs.

GR-98 . . .

Tunes 108 through 136 MHz for monitoring commercial and private aircraft broadcasts, airport control towers, and many other aircraft related signals. Same exceptional features as the GR-88 above. The perfect receiver for aviation enthusiasts. 5 lbs. **GRA-88-1**, Accessory AC Power Supply . . . **$7.95***

NEW Heathkit Deluxe Radio-Controlled Screw-Drive Garage Door Opener Semi-Kit

The next best thing to a personal doorman. The "wireless" factory assembled transmitter operates up to 150 feet away. Just push the button and your garage door opens and the light turns on . . . and stays on until you're safely inside your home. The giant 7 ft. screw mechanism coupled with the ¼ HP motor mean real power and reliability and the adjustable spring-tension clutch automatically reverses the door when it meets any obstruction . . . extra safety for kids, pets, bikes, even car tops. Assembles completely without soldering in just one evening. Easy, fast installation on any 7' overhead track (and jamb & pivot doors with accessory adapter). Order yours now. 66 lbs.

Adapter arm for jamb & pivot doors, Model GDA-209-2, **$7.95***

From The Leader HEATHKIT®

NEW Heathkit Ultra-Deluxe "681" Color TV With AFT . . . Power Channel Selection & Opt. RCA Hi-Lite Matrix Tube

The new Heathkit GR-681 is the world's most advanced Color TV with more built-in features than any other set on the market. Automatic Fine Tuning on all 83 channels . . . power push button VHF channel selection, built-in cable-type remote control . . . or you can add the optional GRA-681-6 Wireless Remote Control any time . . . plus the built-in self-servicing aids that are standard on all Heathkit color TV's. Other features include high & low AC taps to insure that the picture transmitted exactly fits the "681" screen, automatic degaussing, 2-speed transistor UHF tuner, hi-fi sound output, two VHF antenna inputs, top quality American brand color tube with 2-year warranty. With optional new RCA Matrix picture tube that doubles the brightness, **Model GR-681MX only $535.00.**

GRA-295-4, Mediterranean Cabinet shown **$124.95***

Heathkit "295" Color TV

With Optional RCA Matrix Tube . . . with the same high performance features and built-in servicing facilities as GR-681 above . . . less AFT, VHF power tuning and built-in cable-type remote control. You can add the optional GRA-295-6 Wireless Remote Control at any time. New optional RCA Matrix tube doubles the brightness, **Model GR-295MX, $485.00.**

GRA-295-1, Contemporary Walnut Cabinet shown **$64.95***

Both the GR-681 and GR-295 fit into the same Heath factory assembled cabinets; not shown Early American style at $109.95*

NEW Deluxe Heathkit "581" Color TV With AFT

The new Heathkit GR-581 will add a new dimension to your TV viewing. Brings you color pictures so beautiful, so natural, so real . . . puts professional motion picture quality right into your living room. Has the same high performance features and exclusive self-servicing facilities as the GR-681, except with 227 sq. inch viewing area, and without power VHF tuning or built-in cable-type remote control. The optional GRA-227-6 Wireless Remote Control can be added any time you wish. And like all Heathkit Color TV's you have a choice of different installations . . . mount it in a wall, your own custom cabinet, your favorite B&W TV cabinet, or any one of the Heath factory assembled cabinets.

GRA-227-2, Mediterranean Oak Cabinet shown **$109.95***

Heathkit "227" Color TV

Same as the GR-581 above, but without Automatic Fine Tuning . . . same superlative performance, same remarkable color picture quality, same built-in servicing aids. Like all Heathkit Color TV's you can add optional Wireless Remote Control at any time (GRA-227-6). And the new Table Model TV Cabinet and roll around Cart is an economical way to house your "227" . . . just roll it anywhere, its rich appearance will enhance any room decor.

GRS-227-5, New Cart and Cabinet combo shown **$54.95***

Both the GR-581 and GR-227 fit into the same Heath factory assembled cabinets; not shown, Contemporary cabinet $64.95*

NEW Heathkit Deluxe "481" Color TV With AFT

The new Heathkit GR-481 has all the same high performance features and exclusive self-servicing aids as the new GR-581, but with a smaller tube size . . . 180 sq. inches. And like all Heathkit Color TV's it's easy to assemble . . . no experience needed. The famous Heathkit Color TV Manual guides you every step of the way with simple to understand instructions, giant fold-out pictorials . . . even lets you do your own servicing for savings of over $200 throughout the life of your set. If you want a deluxe color TV at a budget price the new Heathkit GR-481 is for you.

GRA-180-1, Contemporary Walnut Cabinet shown **$49.95***

Heathkit "180" Color TV

Feature for feature the Heathkit "180" is your best buy in color TV viewing . . . has all the superlative performance characteristics of the GR-481, but less Automatic Fine Tuning. For extra savings, extra beauty and convenience, add the table model cabinet and mobile cart. Get the value-packed GR-180 today.

GRS-180-5, Table Model Cabinet & Cart combo **$42.50***

Both the GR-481 and GR-180 fit the same Heath factory assembled cabinets; GRA-180-2, Early American Cabinet $94.95*.

Add the Comfort And Convenience Of Full Color Wireless Remote Control To Any Rectangular Tube Heathkit Color TV . . . New Or Old!

Kit GRA-681-6, for Heathkit GR-681 Color TV's **$64.95***
Kit GRA-295-6, for Heathkit GR-295 & GR-25 TV's **$69.95***
Kit GRA-227-6, for Heathkit GR-581; GR-481 & GR-180 Color TV's **$69.95***

Now There Are 6 Heathkit® Color TV's To Choose From

2 Models In 295 Sq. Inch Size

NEW
Kit GR-681
With AFT
$499^{95}*
(less cabinet)

Kit GR-295
$449^{95}*
(less cabinet)

2 Models In 227 Sq. Inch Size

NEW
Kit GR-581
with AFT
$419^{95}*
(less cabinet)

Kit GR-227
NOW ONLY
$379^{95}*
(less cabinet & cart)

2 Models In 180 Sq. Inch Size

NEW
Kit GR-481
with AFT
$359^{95}*
(less cabinet)

Kit GR-180
NOW ONLY
$329^{95}*
(less cabinet & cart)

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Circle 115 on reader service card

BUILD RE'S IC CLOCKS
(continued from page 46)

COMPONENT AND VECTOR BOARD WIRING

COMPONENT From	To	VECTOR BOARD From	To
R9	Q2-B	A11, D17	A9, D11
Q2C	V1-1	A20, D12	A10, D7
Q2E	GND	A8, D12	GND
D1/R12	D2/R12	A5, D29	A5, D29
D1/R12	R12	A5, D29	A5, D29
R12	Q3B	A5, D25	A5, D25
Q3E	GRD	A8, D23	GND
Q3C	R11	A4, D21	A4, D20
R11	VCC	A8, D20	VCC
115VAC	T1-P1	115VAC	A2, D52
115VAC	T1-P2	115VAC	A4, D57
T1-P1	D5/D6	A2, D52	A38, D43
T1-P2	D9	A4, D57	A45, D55
D9	R16	A50, D55	A49, D58
R16	C1	A52, D58	A55, D58
C1/R16	R6	A55, D58	A45, D1
R6	R5	A45, D1	A39, D1
R5	R4	A39, D1	A28, D1
R4	R3	A28, D1	A22, D1
R3	R2	A22, D1	A11, D1
R2	R1	A11, D1	A5, D1
C1	T1-P1	A55, D39	A2, D52
C1	R16	A55, D57	A52, D57
R16	D9	A49, D57	A50, D55
C12	T1S1/ D3D5	A31, D41	A32, D41
D4	D3	A26, D42	A26, D44
D3/D4	GND	A26, D44	GND
D5/D6	R13	A38, D42	A38, D46
C12	T1S2	A32, D43	A31, D43
R13	C2/R14	A32, D46	A33, D46
C2	GND	A51, D50	GND
R14	C3/Q5B	A28, 046	A27, D39
Q5B	D7/R14/C3	A31, D48	A28, D46
D7	GRD	A25, D44	GRD
R14/CZ	Q5C	A32, D46	A32, D45
Q5E	VCC	A40, D57	VCC
C4	GND	A6, D32	GRD
C5	GND	A19, D32	GRD
C6	GND	A23, D32	GRD
C7	GND	A36, D32	GRD
C8	GND	A40, D32	GRD
C9	GND	A53, D32	GRD
C10	GND	A40, D46	GRD
C11	GND	A53, D46	GRD
T1P1	D5, D6	A38, D43	A38, D42
Q4B	D8/R17	A37, D39	A35, D40
Q4E	GRD	A36, D39	GRD
D8	GRD	A37, D36	GRD
R17	D3/D5	A29, D39	A32, D41
D5	D6	A38, D42	A38, D44
D7	R14/C3	A30, D48	A28, D46
T1S1	D3/D5	T1	A31, D41
T1S2	D4/D6	T1	A31, D43
C3	GRD	A11, D39	GRD
R15	VCC	A39, D45	VCC

*Capacitors used to increase noise immunity.

JUMPER CONNECTIONS

1. A33, D41 to A32, D42 to A34, D42
2. A26, D42 to A26, D44 to A25, D44
3. A32, D43 to A32, D44 to A34, D44
4. A32, D45 to A32, D46 to A33, D46 to A32, D50
5. A35, D40 to A34, D39 to A37, D39
6. A37, D40 to A30, D40 to A42, D40
7. A38, D42 to A38, D43 to A38, D46
8. A54, D37 to A51, D50

R-E

EQUIPMENT REPORT

Spar Model 100 AC Power Supply

For manufacturer's literature, circle No. 116 on Reader Service Card.

THIS HANDY LITTLE POWER SUPPLY was a surprise. It isn't very awe-imposing in appearance, but performance is excellent. It will deliver voltages between zero and 16 Vac, completely variable, at current levels up to 1 ampere. Voltage regulation insures that line voltage variations of as much as 10% will not cause more than a 25 mV variation at the output.

Increasing power drain has little effect on voltage too. Varying the load from zero to full load will not cause more than a 20 mV output variation.

Current limiting is built into the supply too. It is intended to protect the users equipment. Even if you short the output of this power supply it will not deliver more than 1.1 amps.

The supply is protected against thermal damage to its own circuitry. Should temperature exceed specified limits the supply will shut down to avoid burnout of semiconductor devices in its circuitry.

The unit is housed in a 5 x 4¾ x 3¾-inch case of gold anodized aluminum.—*Warren Roy*

Eico 385 Color Bar Generator

For manufacturer's literature, circle 122 on reader service card.

A MUST FOR THE SERVICE TECH'S TUBE caddy or tool box is a portable dot-bar generator for color and b-w TV servicing. The smaller the generator the better. A new solid-state color-bar generator, Eico's model 385 Colormate, fills the bill nicely.

The 385 is only 8½ inches wide and deep, 3 inches high, and weighs 4½ pounds. The metal case will stand up to the bouncing encountered on service calls, and the unit is battery powered (6 C-cells).

The Colormate uses three crystal-controlled oscillators and divider chains to provide 7 horizontal lines, 8 vertical lines, a 7 x 8 crosshatch, 56 dots and 8 separate color bars. Rf output of the unit is on TV channel 3 (61.25 MHz). Two front-panel controls, VERT HOLD and HORIZ HOLD, control the sync frequency in the vertical and horizontal divider circuits.

Stability of each the five patterns was excellent, locking in immediately after selection with the 6-position switch. In case anything goes wrong with the unit, instructions are provided for adjusting the counters, color oscillator and rf channel. This can be done with a general-purpose service scope using the waveforms shown in the manual.

Concealed in the battery compartment and permanently wired into the 385 is a conventional color CRT socket and cable with color-killer transistors. Three front-panel switches are used to cut off the CRT guns.

Whether you assemble the 385 as a kit or buy the wired Colormate, the generator will be a compact and useful addition to your test gear.—*John R. Free*

MANUFACTURER'S SPECIFICATIONS

Rf output: 10,000 µV into 300 ohms. **Horizontal lines:** 7. **Vertical lines:** 8. **Crosshatch:** 7 horizontal by 8 vertical lines. **Dots:** 56 (two scanning lines thick). **Color bars:** 8 distinct standard bars. **Master pattern oscillator:** 187.2 kHz, crystal-controlled. **Chroma oscillator:** 3.65 MHz, crystal-controlled. **Rf oscillator:** 61.25 MHz (channel 3), crystal-controlled. **Crystal accuracy:** 0.005%. $79.95, kit. $109.95, wired.

R-E ON FILM

Two sources of filmed back issues of RADIO-ELECTRONICS are now available. Please write the companies for further information. Microfilm editions are available from University Microfilms, A Xerox Company, Ann Arbor, Mich. 48106. Beginning with the January, 1969, issue, Microfiche editions are available from NCR Microcard Editions, Industrial Products Division, 901 26th St., N.W., Washington, D.C. 20037.

Fix Special Solid State TV Circuits
(continued from page 97)

Linearity defects caused by a faulty thermistor are shown in Fig. 5. There was some vertical jitter here too. If the thermistor and vertical output circuitry check out ok, look at the pattern at the base of the vertical output transistor. An inverted sawtooth should appear (Fig. 6). This waveform should have at least 3 volts amplitude, peak to peak. Less than that will affect drive and height. Waveform distortion will affect linearity and, in either case, the vertical oscillator and vertical driver circuits will have to be checked.

In many transistor TV's the contrast control is the emitter circuit of the video output amplifier. The brightness control is on the collector side. On occasion, however, both contrast and brightness controls are in the collector side (see Fig. 7, a G-E TC chassis).

Video signals applied to the cathode have a positive polarity as was shown earlier in Fig. 2. High positive-amplitude signals (and blanking) raise the CRT cathode voltage and make the grid more negative. Blanking signals cut off the tube.

The brightness control adjusts the dc positive potential on the cathode. This regulates the bias because any change in cathode voltage makes an inverse change on the grid with respect to the cathode. The contrast control, however, simply regulates the amplitude of the signal voltage picked up from the collector of the output video amplifier and transferred to the cathode. If the 0.1-μF coupling capacitor is leaky or shorted, brightness and contract are both affected.

A weak output transistor, however, affects only contrast. Excessive brightness can be caused by an open in the uppermost section of the brightness control or a defect in the power supply system delivering the dc applied to the top of the control. An open 220,000-ohm series resistor from the brightness control to the cathode cuts off the tube and darkens the screen. **R-E**

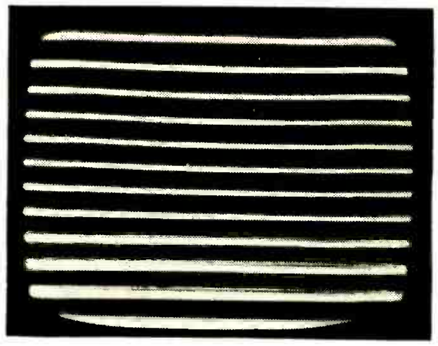


Fig. 5—Faulty thermistor in vertical output caused this linearity defect.

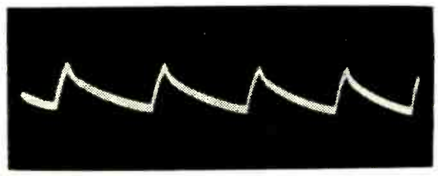


Fig. 6—Scope pattern that should appear at base of vertical output transistor on the Fig. 4-b circuit. Waveform amplitude should be at least 3 Vp-p.

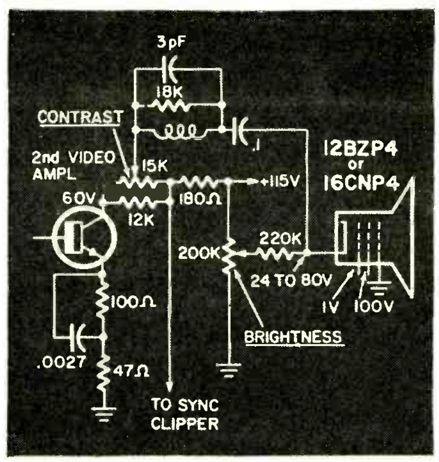


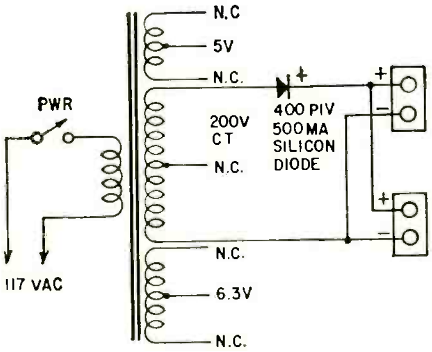
Fig. 7—Both brightness and contrast controls are in collector circuit of video output transistor in G-E TC chassis.

TRY THIS ONE

AC SUPPLY FOR PROFESSIONAL PHOTOFLASH UNITS

A number of professional photoflash units, including my pair of Heiland Strobonar 60-S's, owe their light weight and portability to the use of high-voltage batteries as power sources.

During periods of fully portable operation—photographing news stories, for example—the reduction in weight is most welcome. However, high-voltage batteries are expensive ($8 each for the 60-S; $16 for some other models) and have limited life. For work in the studio or in locations where line voltage is available a less expensive source of power for the flash units is nice to have on hand.



My ac power supply is surprisingly simple. It consists of a transformer, on-off switch, line cord, silicon rectifier and two sets of plugs and sockets. The transformer used was a military-surplus item, but transformer catalogs list suitable equivalents. No filter is included, because the photoflash unit itself contains both a current-limiting resistor and a large storage capacitor. The rectified high voltage is supplied to the two polarized sockets, where mating plugs carry it to the photoflash units.

Connecting the power unit to the photoflash units was done by disassembling a pair of rundown batteries and removing the phenolic plates on which the terminals were mounted. The power cord was wired to the terminals, observing correct polarity (the storage capacitor is electrolytic and expensive), and the terminal plate then pushed back into contact in the photoflash unit.

The 60-S units operate from 240-volt batteries. The transformer I used is rated at 200 volts rms, and measured dc voltage at the power unit output terminals with photoflash units connected is 255 volts. Take care not to go more than 10% over battery voltage, or the storage capacitors may blow up. For units requiring 510-volt batteries, use a 350-volt rms transformer.

The silicon diode is a standard 400-volt type. Several have been substituted and all have performed without failure, though the voltages are a bit high for this V rating. For 510-volt use, use two diodes in series, with 1-meg balancing resistors in parallel with each.

With both photoflash units connected, this power unit recharges in 10 seconds after an exposure is made. This is approximately the same time delay encountered with fresh batteries. With only one photoflash connected, recycle time is less than 2 sec.

For safety's sake, the connections to the photoflash units should be insulated, as they carry 250 volts. I planned to use epoxy car-body putty to mold plugs, but I've been using the setup so much there hasn't been time! In fact, this unit supplied the power to take its own portrait. It has been more than worth the small investment in time and materials.—*Jim Kyle* **R-E**

TECHNOTES

MULTIPLEX ALIGNMENT HINT

In the absence of a crystal-controlled 19-kHz oscillator or marker, an audio generator may be used to align the 19- and 38-kHz coils or transformers if it is calibrated using either method outlined below:

- Connect an antenna to the set and tune in a station known to be transmitting stereo. Set the audio generator to 19 kHz and feed the signal into the multiplex (19-kHz) amplifier through a 10,000-ohm isolating resistor. Slowly adjust the generator frequency until you hear a zero beat from the speaker.
- Connect the output of the audio signal generator to the detector output of a receiver tuned to a FM multiplex broadcast. (Use a 10,000-ohm isolating resistor.) Adjust the generator frequency for a zero beat between the generator output and the station's pilot carrier.

The generator is now tuned to exactly 19 kHz and can be used for multiplex alignment.—*Emerson Service Note*

AM TRACKING ALIGNMENT TOOL

A simple and inexpensive tool for checking alignment tracking of AM broadcast receivers can be made from a 6-inch length of ½- or ⅝-inch diameter ferrite rod (a discarded ferrite antenna) and a 2-inch diameter loop of heavy copper wire (about No. 6) with the ends soldered together. The loop is attached to one end of the rod with an adhesive or plastic electrical tape to form a "tuning wand."

Hold the wand close to the set's antenna while tuning the receiver to 600, 1000 and 1400 kHz and listening to the noise level. An increase in noise level indicates that tracking is off and should be corrected by realigning the rf or antenna circuit.

With the coil end of the wand placed against the set's antenna (or antenna coil), an increase in noise level indicates that circuit inductance is too *high*. If the noise level increases when the rod end of the wand is against the antenna, circuit inductance is too low.

The set should be aligned using signals from an rf signal generator with 400-Hz amplitude modulation. Set the signal generator to the highest frequency on the receiver's dial. Tune the set so the tuning gang is completely open and adjust the oscillator trimmer for maximum output from the speaker. Tune the set and generator to 1400 kHz and peak the signal with the antenna and rf (if any) trimmer capacitors. Tune set and generator to 600 kHz. Adjust the oscillator slug for maximum output while rocking the tuning gang 20–40 kHz each side of center frequency. Adjust the antenna and rf transformer coil inductances for maximum output.

If the set's tuning capacitor has split plates, tune the generator and set to 1000 kHz. Gently bend the first meshed split sector toward or away from the adjacent stator plate for maximum output.—*RCA Service Tips*

NO COLOR—ADMIRAL TV

Weak or no color on the G11, G13, H10, H12 and K15 series chassis may be due to failure of capacitor C521 (0.1 μF, 50 volts). This permits a negative voltage to be produced at the plate of the color killer which will bias off the second bandpass amplifier. Measuring this capacitor with an ohmmeter may not reveal the fault, so the best test is direct substitution. Replace it with a 0.1-μF capacitor of higher working voltage such as 200 volts (this value is now used in production).—*Admiral Service News Letter* **R-E**

NEW BOOKS

HANDBOOK OF ELECTRONIC TABLES & FORMULAS, 3rd ed., by Howard W. Sams staff. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis, Ind. 46206. 5¾ x 8¾ in., 224 pages, hard cover, $5.50.*

This expanded edition is an excellent source of electronic formulas, laws, symbols, standards, charts and tables. Includes an eight-page color foldout chart indicating current FCC allocations for the entire broadcast spectrum.

ELECTRONIC CONNECTION TECHNIQUES AND EQUIPMENT 1968-69. Edited by G. W. A. Dummer and J. Mackenzie Robertson. Pergamon Press Ltd., 44-01 21st Street, Long Island City, New York, 11101. 552 pp, 8½" x 11". Hardbound, $32.

A truly comprehensive review of all current connection methods. Included are automated systems, microelectronic interconnections, soldering, welding, bonding, wrapping, crimping and more.

TRANSISTOR TV SERVICING GUIDE, by Robert G. Middleton. Howard W. Sams & Co. Inc., 4300 W. 62 St., Indianapolis, Ind., 46206. 8½" x 11", 128 pp. Softcover, $3.95.

Revised edition is updated to cover more circuitry and additional circuit tests. Quick checks have been included, wherever they can serve a useful purpose. Text is functionally divided into the various receiver subsections and subdivided according to symptoms. **R-E**

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In the special audio–hi-fi October issue you'll find construction details for an all-IC 200-watt (continuous) stereo amplifier. Two new hybrid IC's do the job. You mount them on a heat-sink type chassis, add a few components and a power supply. The specs on this project are tops.

Floating bar in picture

I'm servicing a Transvision professional 23" TV set and can't get a schematic. It has a horizontal bar that floats up and down the screen. This doesn't show up on a blank raster, only when there is a picture. Filters seem to be all right. Scope shows a small hump going back and forth on the plate signal of the sync separator.—R. H., Selden, N. Y.

It appears that Transvision Co. is no longer with us. Sams *Photofacts* has four schematics listed, and I think the one in 192-10 will be very close to the Professional 23 chassis.

This problem is probably due to a lack of filtering. A spike of current being drawn by the vertical output stage gets into the dc power supply where it causes a voltage spike or added ripple. This, since it's locked with the picture's vertical scan frequency, it floats up or own the screen.

Line frequency will be a fraction of a cycle out of phase with the TV station's vertical frequency, so the bar moves.

Cure: more filtering. Even if the electrolytics check good, add more capacitance until you get rid of the bar. I've had to use 100–150 μF of extra capacitance to kill it in other sets. **R-E**

Mysterious blue blob

I've got a color TV with an odd problem. Every so often (about 15 minutes) I get an irregular blue blob in the lower right corner of the screen. This comes about halfway up, then disappears. Degaussing and checking purity hasn't helped at all. What do I do now?—A. P., Chula Vista, Calif.

I know what I do. I get out the crystal ball. This is probably the only item of test equipment that will help on something like this!

Seriously, this could be due to something similar to Barkhausen oscillation. (The right-hand position of the screen interference suggests an origin in the horizontal output tube section.) It could be radiating a burst signal. (Not a colorburst signal, of course, but some kind of random signal occurring in bursts at a frequency that would generate blue if it got into the i.f. circuits or tuner.)

Try a new horizontal output tube first. Next, try pulling the antenna off quickly the next time this thing shows up. If the blue blob disappears, it's something getting into the tuner input by radiation. Try moving the deflection-yoke wires as far as possible from the antenna lead to the tuner, checking tube shields, etc.

Next: loosen the deflection yoke. When the blue blob appears, quickly turn the yoke sidewise, watching the picture in a mirror. If the blue blob stands still while the picture turns on its side, this is something in the picture tube itself! (Possibly some kind of oddball magnetization in the shadow mask.) If the blob turns with the picture, it could be arc-over in the yoke itself.

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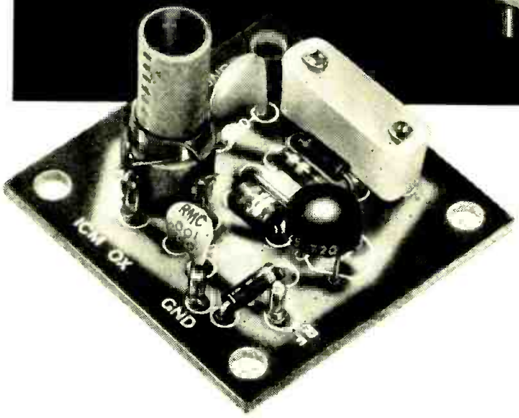

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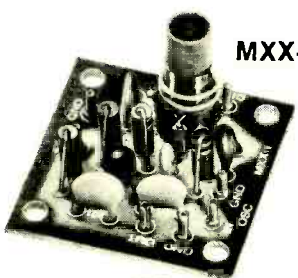

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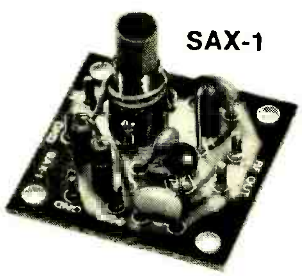

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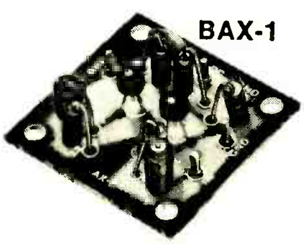

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