60¢ ■ DEC. 1973

Radio-Electronics

FOR MEN WITH IDEAS IN ELECTRONICS

ALL ABOUT CMOS
Micropower IC's

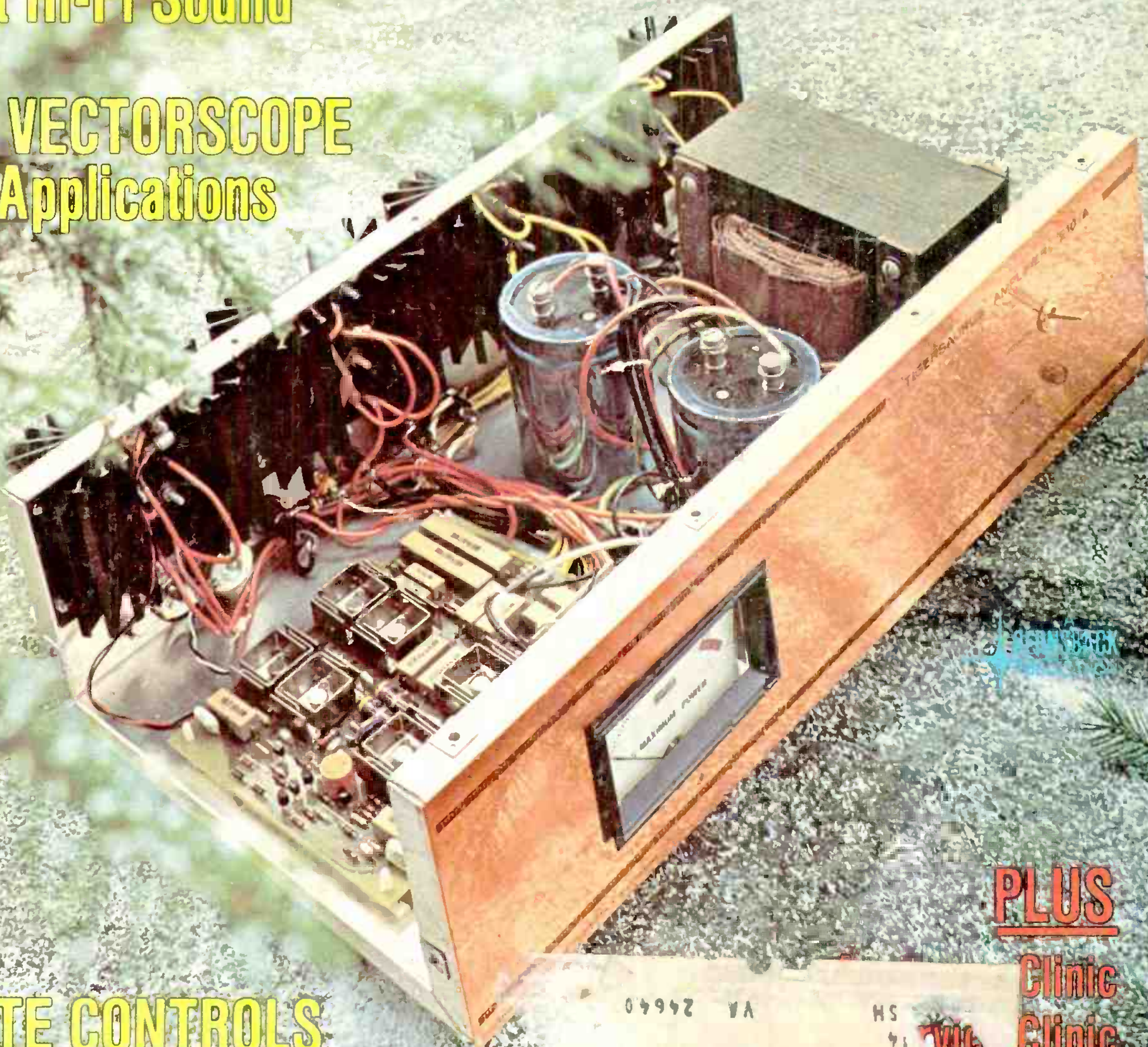
REGULATED IC POWER SUPPLIES
How To Design Your Own

NEW COLOR TV CIRCUITS
'74 Sets Are Different

BUILD TIGERSAURUS
250-Watt Hi-Fi Amplifier

TWO NEW SPEAKER SYSTEMS
For Great Hi-Fi Sound

USING THE VECTORSCOPE
10 New Applications



TV REMOTE CONTROLS
Something New For '74

PLUS

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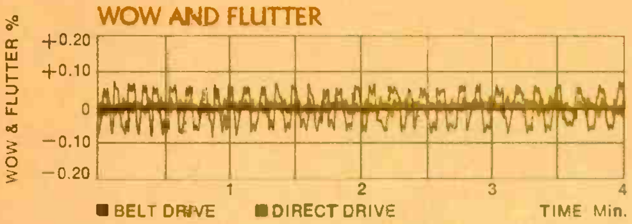
Replacement Guide

The better the turntable the fewer the moving parts. Ours have only one.

The one is the Technics direct drive DC motor. A DC motor to escape wow, flutter and hum. A DC motor that is brushless and spins at 33⅓ or 45 rpm so it doesn't have the vibration and noise problems of its faster competitors.



And it has an analog feedback speed control so it never suffers from frequency or voltage fluctuations.

The drive system is just as important as the motor. And direct drive doesn't depend on an idler wheel or belt. They had to go because they show their age and lose their shape. Instead we put the platter right on the motor shaft.

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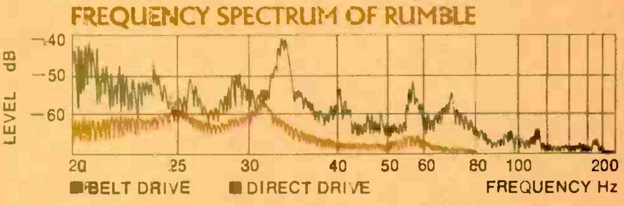

We make three direct drive turntables. The SL-1100A, shown below, comes with a professional-type tone arm, viscous-damped cueing, illuminated stroboscope, variable pitch controls and a dust cover.

The SL-1200 includes most of the same features at a more modest price. And the SP-10 is for those who insist on choosing their own tone arm.

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(A TRUE STORY)

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"In fact, my ICS training helped me get the first job I ever applied for. I won out over two guys with college degrees. Even though I had no experience.

"Naturally, I was nervous at first. So I took my lesson diagrams with me on the job. And I could lick any problem.

"Pretty soon, they asked me to head up the air-conditioning department. I also picked up business of my own on the side. That's helping to pay for my new house."

Soon, a new home built on a wooded lake site will give John and Cheryl Muirhead lots of room for their growing family. (Photo: Frank Cowan)

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Radio-Electronics

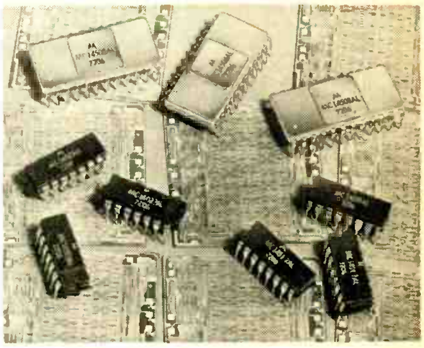
FOR MEN WITH IDEAS IN ELECTRONICS

More than 65 years of electronics publishing

DECEMBER 1973

SEASON'S GREETINGS

The editors and staff of Radio-Electronics extend best wishes for the holiday season.



CMOS, A NEW BREED of micropower IC's. Learn how they work and see what you can do with them. . . . see page 33

Cover photograph by Walter Herstatt
Cover design by Louis E. Rubsamen

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looking ahead

Sophisticated Europe

West Berlin—To an American observer, Berlin's recent International TV-Radio Exposition was a real eye-opener. It drew more than 600,000 attendees, some 30% of them traveling from West Germany across East German territory via plane, train and car, to see new models of home electronic equipment and watch continuous TV and radio originations in about a dozen studios on the huge exhibition grounds.

Color TV was probably the biggest attraction—simply because there's a huge color boom in Europe now. In terms of sales, West Europe is at the same point where U.S. color was in 1966. In terms of product sophistication, it could be far ahead—because the public appears to be willing to spend from $850 to more than $1,250 for a large-screen color set.

TV developments

In Germany, at least, color and monochrome TV have now reached the point where virtually everything is solid-state, most sets having modular construction. Manufacturers are quickly moving away from the 90° deflection picture tube to the slimmer 110° models. And, of course, almost all sets use electronic varactor tuning—a simpler proposition in Europe than in the U.S., because there are fewer stations and, therefore, less possibility of adjacent-channel interference.

The tuning knob went out years ago, and now pushbuttons seem to be on the way out, too, yielding to the button which merely has to be touched. Touchbuttons are showing up on audio equipment, too. Nixie tubes are seen on many sets as channel indicators. One 26-inch color set by Loewe Opta has a built-in digital clock with Nixie readout, which also functions as an on-off timer, while the Nixies double as channel indicators.

Remote control, a much simpler proposition with electronic tuning—since no motors are required—is available in all makes, sometimes as an add-on option, using a special module. Some remotes have as many as 20 buttons—12 separate channel buttons plus two buttons each for brightness, contrast, volume and on-off. NordMende is offering a remote control unit with eight channel buttons and including a two-hour on-off timer in the wireless hand-held unit.

Two manufacturers experimented with wireless remote listening. NordMende showed a developmental headset system operated from the set by infrared transmission, while Philips demonstrated a similar unit using an ultrasonic carrier. Blaupunkt is offering a color set which provides on-screen channel indication—a yellow number on a black background shows at the upper right-hand corner of the picture for one to two seconds after the channel is tuned by remote-control selector (a somewhat similar device is offered by Hitachi and Sharpe in the U.S. and Japan).

'Head stereo'

If there was any single major sensation at the show it was a new adaptation of an old principle in audio which provided astounding directionality and realism from two-channel tape. Using standard stereo headphones, listeners could hear sounds which actually appeared to be coming not only from left or right, but front or rear, up or down, and even to gauge the distance of the speaker from the microphone. One segment of the tape represented a cocktail party with several conversations occurring simultaneously in different parts of a room—and the sensation was so realistic that the listener could actually choose which conversation to eavesdrop, switching his attention from one to another at will.

The system was used Sept. 3 in an FM-stereo broadcast by RIAS Radio, Berlin, and a tape of portions of the science-fiction drama was played for visitors to the exposition.

The developers—Drs. Ralf Kuerer, Georg Plenge and Henning Wilkens of Berlin's Heinrich Hertz Institute—call their system "Kunstkopf," or "Dummy Head." Originally developed for the measurement of concert-hall acoustics, the dummy head is an exact-scale model of a human head, made of a hard-rubber material with an acoustical impedance similar to that of a human head. Inside a faithful replica of each ear canal is a solid-state miniature condenser microphone, with all conditions arranged to exactly simulate the sound pressure of human hearing.

For acoustical measurement purposes, the dummy head is already in production by the professional audio equipment manufacturer Georg Neumann in Germany and sells at about $1,500—but it has never previously been exploited for recordings aimed at the consumer. As the system currently stands, recordings from the head microphone can be made on any two-channel medium—tape or disc—and reproduced on standard equipment with conventional stereo headphones.

Because the technique reproduces room acoustics as well as directionality and distance so accurately, its developers are now attempting to free it from the restrictions of headphones, and at press time, were planning to demonstrate a loudspeaker setup. The system will use four speakers, placed in a conventional four-channel arrangement, but with a special rear-channel amplifier and modified frequency response in the speakers. They claim that at some points in the listening area, the results will be as good as with headphones—but that in the entire room the sound will be better than four-channel "because the timbre is correct."

Videodiscs' debut

Telefunken used the Berlin show as the launching platform for commercial sales of its home videodisc system, which it identifies by the tradename "TED." Described previously in **Radio-Electronics,** the TED system uses a thin, flexible 7-inch disc which spins at 1,500 rpm on a cushion of air, with a sled-like "pressure stylus" serving as the transducer. The discs play 10 minutes in color, and a catalog of about 500 hours of selections—varying from animated cartoons to lecture courses for physicians—was placed on the market. In Germany, the TED player will retail for about $450 and discs for $4 to $10 each, depending on their particular program content.

A version of the TED player designed for the American NTSC color system (the disc revolves at 1,800 rpm but still plays for 10 minutes) was also demonstrated at the show, as was a developmental disc changer with a 5-second changing cycle.

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

new & timely

Charge-coupled devices miniaturize new TV camera

A TV camera that measures only 3½ x 1½ x 2¼ inches and weighs only 6 ounces (without lens) has been demonstrated by the Space & Defense Systems division of Fairchild Camera & Instrument Corp.

FAIRCHILD MV-100 TV CAMERA measures 3½ x 1½ x 2¼ inches (without lens) and weighs 6 ounces. It operates over a wide range of light levels and its power consumption is low.

Using charge-coupled devices (Radio-Electronics, June 1971, page 6) the new MV-100 camera has an array of 10,000 photosensors assembled on a standard 24-pin dual in-line package. Each line of sensors is affected by light like a similar line of elements in a vidicon tube, but unlike those in the tube, they do not require scanning by an electron beam. The charge on each element, induced by the light falling on that element, is conveyed along the line from one element to the next by a step-by-step process controlled by a clocking system, and delivered at the end of the line as a standard television signal.

The resolution of the MV-100 is 16 lines per millimeter, the horizontal scanning frequency is 15,750 lines and the vertical, 120 frames per second. Video output is 1 volt peak-to-peak, and bandwidth [illegible] MHz. The camera can be used on ordinary ac or with a battery pack for portable use.

Burglar alarm systems not all joy to police

The rapidly growing home and industrial intrusion alarm system business has been picked up happily by numbers of electronic service organizations, who find it profitable to sell and install them. The police departments who monitor those alarms are not always so happy. The trouble is—false alarms! Every time a signal appears on the station board, a car must be rushed to the scene. But in many cases, there is no burglar, no good reason for the signal.

Most of the alarms are caused by careless users, the police say. "They forget the system is 'on' and open a door or window," says one officer. Poor installations are another cause of trouble, and the owner of a new alarm system occasionally sets it off intentionally, just to see how long it will take the police to arrive.

A recent report of the New York City police department points up the seriousness of the situation. In one two-week period, 8,602 alarms were received, only 141 of which were found to be valid. The department estimated that 3,461 man-hours were wasted on these false alarms, at the expense of the New York taxpayer and the safety of the population deprived of that much police service.

New York City is by no means an exception. The town of Tenafly, New Jersey, has only about 200 alarm systems on its control board. Yet it found the false alarm situation so unbearable that it instituted a penalty system. Subscribers are now allowed three false alarms a year. A fine of $15 is imposed for the fourth, $25 for the fifth, and the sixth means that the system will probably be disconnected from the police board.

The method has worked well—the number of false alarms has dropped from 50 to 60 a month to four or five. Other towns have followed suit, and some slap on a $50 fine immediately after the first three "free calls."

NEW GLASS-FIBER MAKING SYSTEM, devised by Ray Jaeger and Walter Logan at Bell Labs, uses a carbon dioxide laser to melt a glass rod so that it can be drawn into a fiber a mile long. The laser is a highly controllable and—most important—a clean source of heat, whereas conventional heaters put minute impurities into the glass.

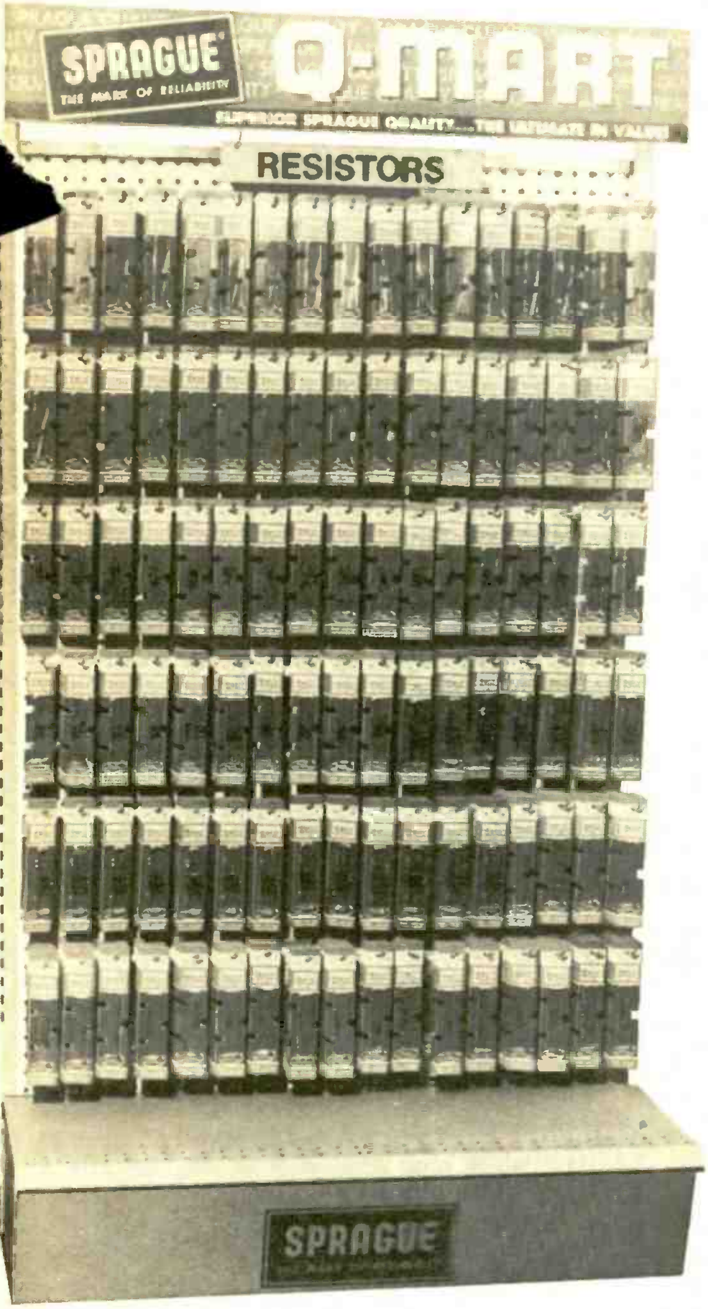
Molten lithium may solve controlled fusion problem

A study of the use of high-power lasers to produce controlled thermonuclear fusion, now under way at the University of Rochester, may solve the problem of containing the plasma. At its temperature of 100 million degrees, it cannot be held in a vessel of any known material. The approach being taken by the University, with support from General Electric Co., Esso Research and Engineering, and Northern Utilities, is to absorb the energy generated by fusion reaction in small quantities of material in a liquid medium, which will be circulated to release the power in the form of heat.

In one proposed approach, a spherical vessel is filled with molten lithium. Pellets of frozen deuterium (heavy hydro-

(continued on page 12)

THE NEW SELF-SERVICE REPLACEMENT RESISTOR Q-MART FOR SERVICE TECHNICIANS



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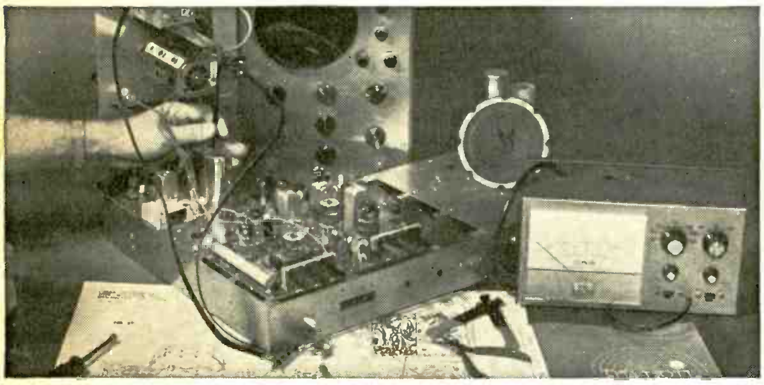

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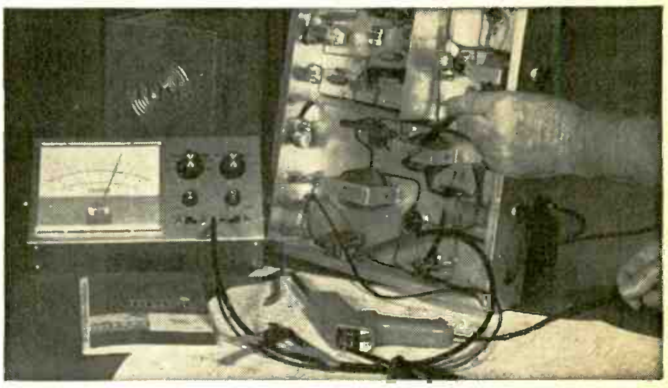
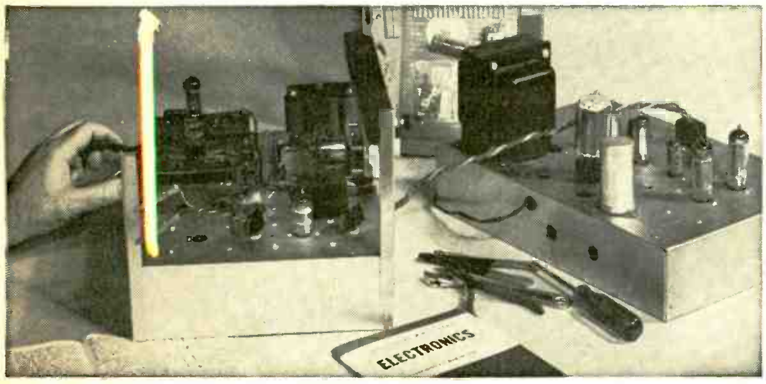


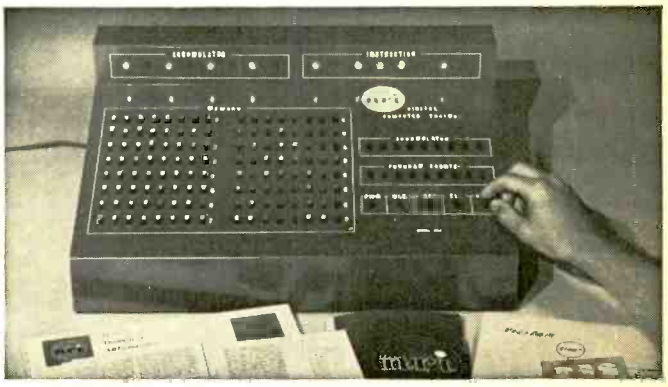
There's glamour, success awaiting Technicians in COMMUNICATIONS

NRI gives you the experience you need to qualify for jobs in TV broadcasting stations, or operating and servicing mobile, marine, aviation communications equipment. You build and use a solid-state voltohmmeter; perform experiments on transmission lines and antenna systems, even build your own 25-watt, phone-cw amateur transmitter band. In all NRI Communications courses, *you must pass your FCC exams—or you get your money back.*



Fill technical jobs without a degree in INDUSTRIAL ELECTRONICS

NRI's Electronics Technology course gives you completely specialized training kits engineered for business, industrial and military Electronics fields. On completing this training, competent technical ability can be instantly demonstrated by you. As you learn, you actually build and use your own training center in solid-state motor control and analog computer servo-mechanisms. Telemetering circuits, solid-state multi-vibrators, even the latest integrated circuits are included in your home training program.



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OVER 50 YEARS OF LEADERSHIP IN ELECTRONICS TRAINING

(continued from page 6)

gen) and other components are dropped—one by one—into the swirling lithium, where they are hit by tremendously intense pulses of laser light. Heated to 100 million degrees by the beam, the pellets undergo fusion reactions.

The fantastic quantities of heat produced by the fusion are absorbed by the molten lithium, which is continually circulated between the chamber and a heat exchanger, where it can be used to produce steam to run a turbine-generator to produce electricity, or for other purposes.

FCC asserts control over use of utility poles for CATV

The FCC decision that it has jurisdiction over the fees charged and the terms imposed on CATV systems by telephone and electric companies for the use of their poles for distribution cables is "a major victory for the fast-growing CATV industry," according to a spokesman for the National Cable Television Association.

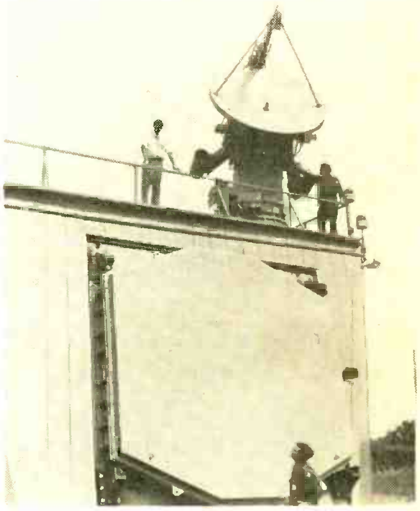
Since the companies have a monopoly on the poles, cable companies have been restrained by the threat of uncontrolled increases in renting rates at the whim of the companies who own the poles. While the present FCC ruling does not attempt to set rates—instead requests that the utilities and the industry work out "mutually satisfactory agreements," presumably for FCC ratification, the decision does protect the CATV systems from arbitrary and unreasonable rates by asserting the right of the FCC to act as a judge.

New Navy defense radar looks all ways at once

Heart of the Navy's new AEGIS weapons system is an electronically steered antenna that can scan in all directions almost simultaneously, making it possible to search space for new threats while tracking oncoming missiles. The antenna, AN/SPY-1, has been demonstrated on a land-based testing site by RCA and will be shipped late this year to the Navy's test ship, USS Norton Sound, for at-sea trials.

AEGIS can cover an expanse of ocean sufficient to protect an entire carrier task force, and can handle threats at long and short distances with a capacity greater than that of any present systems. It can successfully engage massed raids that include combinations of high and low-flying aircraft and fast low or high-flying missiles. AEGIS can also attack surface or airborne platforms from which the missiles are launched. It includes as its most important feature the AN/SPY-1 antenna, commanding control computers, weapons launchers and other supporting components.

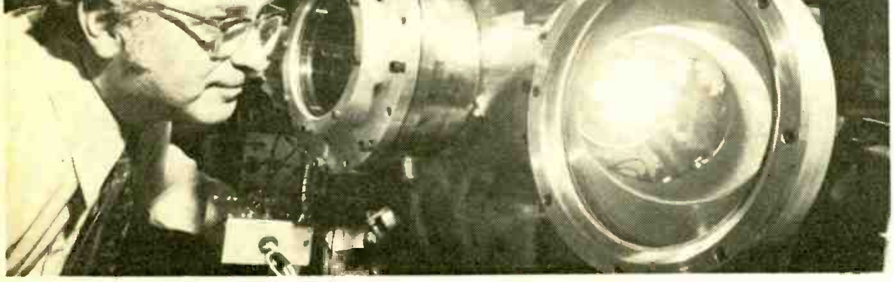
The AN/SPY-1 radar system antenna is composed of four 12 x 12-foot units, each made up of some 4,100 radiating elements and each covering a quarter of the hemisphere of surface and space surrounding it. Each of the radiating elements contains a phase shifter. By energizing these phase shifters, the radiated energy can be progressively delayed across the array face under computer control, directing the beam in any desired direction instantly.



ONE OF THE FOUR FLAT RADIATING SURFACES OF THE AN/SPY-1 ANTENNA, set up at RCA's test site in Moorestown, NJ. The small parabolic antenna above is part of the AEGIS weapon system, also developed by RCA's Missile and Surface Radar Div. at Moorestown.

The AN/SPY-1 is also used to direct return missiles from the AEGIS launcher, and because of its instant-steering capabilities, can do so while performing its other functions of searching space and tracking oncoming missiles or aircraft.

A particularly interesting feature of AEGIS is the Operational Readiness Test System (ORTS), which carries on a continuous test of all parts of the equipment. It is said to be the first automated test system designed and built with, and as an integral part of, an electronic tactical weapons system.



Dr. LEONARD M. GOLDMAN, physicist on loan from GE's Research and Development Center, Schenectady, NY, observes action in target chamber in which pellets of deuterium or lithium deuteride are vaporized by bursts of laser light.

Electronic payment system may end "check pollution"

The US government is engaged in a test that may initially result in about 20,000 Air Force personnel being paid without the use of checks. The Federal Reserve Board reports that the tests are being made to investigate the possibility of cutting down the cost of making payments and "to prevent check volume

(continued on page 14)

new & timely

(continued from page 12)

from becoming so large as to clog and disrupt the nation's payment system."

In the test, the Air Force is putting on a single magnetic tape the amount of pay and other payment and withholding information that would normally be used in making out computerized pay checks. The taped information is then sent to a District Federal Reserve bank, sorted and sent to the commercial banks in which the employees have their accounts.

Knowledge of the "bugs" that infest all newly set up systems prevents the next logical step—depositing the amounts to the credit of the individual employees. Instead, the Air Force personnel are being paid in the regular manner, with the polluting paper checks, and simulated electronic deposits made. The whole system is then being turned over to the developers for study, debugging and possible modification. If the test proves the system efficient, reliable and economical, the government may eventually pay all its personnel electronically.

Some action is urgent, the Federal Reserve estimates: 26 billion checks are now being written annually and at the present rate of increase, the number will be 54 billion in 1985. The Board hopes that the new system under test may spread from the Air Force to all government agencies, and may eventually cover all banking, with even individual families making electronic deposits and payments instead of handling checks or currency.

Audio engineers meet

Growing professionalization—as might be expected in an engineering group—marked the forty-sixth convention of the Audio Engineering Society, held in New York in September. While a few of the noted names in consumer products demonstrated loudspeakers, even they placed main emphasis on their studio monitor speakers, sound reinforcement systems and other equipment intended for studio recording and broadcast use.

Four-channel was omnipresent, with some indication that the advocates of discrete 4-channel sound are gaining on the matrixing approaches. The term "CD-4" (compatible discrete 4-channel) was seen and heard frequently. **R-E**

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Circle 4 on reader service card

letters

TV TYPEWRITER CORRECTIONS

Here are a few corrections to the TV Typewriter supplement:

1. Diode D6 is backwards on the power supply overlay, and the negative supply diodes are shown backwards on the schematic.

2. In Figure 3 schematic, NCLR pin 25 should also go to keyboard input B and the diodes D10-14. The connection between diodes D10-14 and "C" should be deleted. The PC board is correct.

3. Callouts are missing on the keyboard edge connector. "A" is nearest the RF twinlead; "L" is nearest J1.

4. Delete R11 and R12 from the mainframe Figure 3 schematic. Add R5, R6 to the mainframe parts list, 1K, ¼ watt carbon.

5. There are several printing problems on the supplement overlays. The overlays on the kit PC boards are correct and complete.

6. On the improved ASCII encoder schematic, IC2 should be 7402. TP tie points go to pins 4 and 5 of IC4.

7. Table V. For normal use, the switch should be left in the FULL position.

8. Timing E, cursor TPH should be 10 milliseconds, not microseconds.

9. An additional 0.05 μF disc capacitor with minimum lead lengths might be needed across the TOP of cursor IC1 (7408) from pin 7 to 14. Counter IC substitutions in the cursor might require slight shifts in pulse widths and positions. You can tell by a careful study of test point F on the cursor board. In the SUBTRACT position, one extra dot should appear before the 512 timing pulses every keypressed. In the ADD position, one short line should eliminate two of the normal 512 timing pulses.

10. An inverter formed from pins 11 and 12 of IC8, cursor board must be placed between IC6 pin 1 and "A" on the cursor board. This is shown correctly on the foil pattern (Figure 16) but should be added to the schematic of Figure 8.

11. The dot to the left of C14 on Figure 8 cursor should be a no connection. Once again, the foil is correct.

12. Connector stack pins 15 and 16 are correct as shown on the foil patterns. Ø1 and Ø2 notation only are apparently backwards in Figure 7 and Table III.

13. On the main timing chain schematic, Figure 6, the LEFT end of C5 should go to R3. The RIGHT end of C6 should go to R2. The foil pattern is correct.

14. In Figure 3, mainframe schematic, CURSOR OFF-ON should be S7, not S5.

In general, so far, we have found no errors on the foil patterns. Unless things change with more corrections, always assume the foil pattern and the printed overlay (with the exception of power supply diode D6 overlay) are correct.

As we point out in the supplement, errors are almost inevitable on a project this complicated. My thanks to the read-

(continued on page 22)

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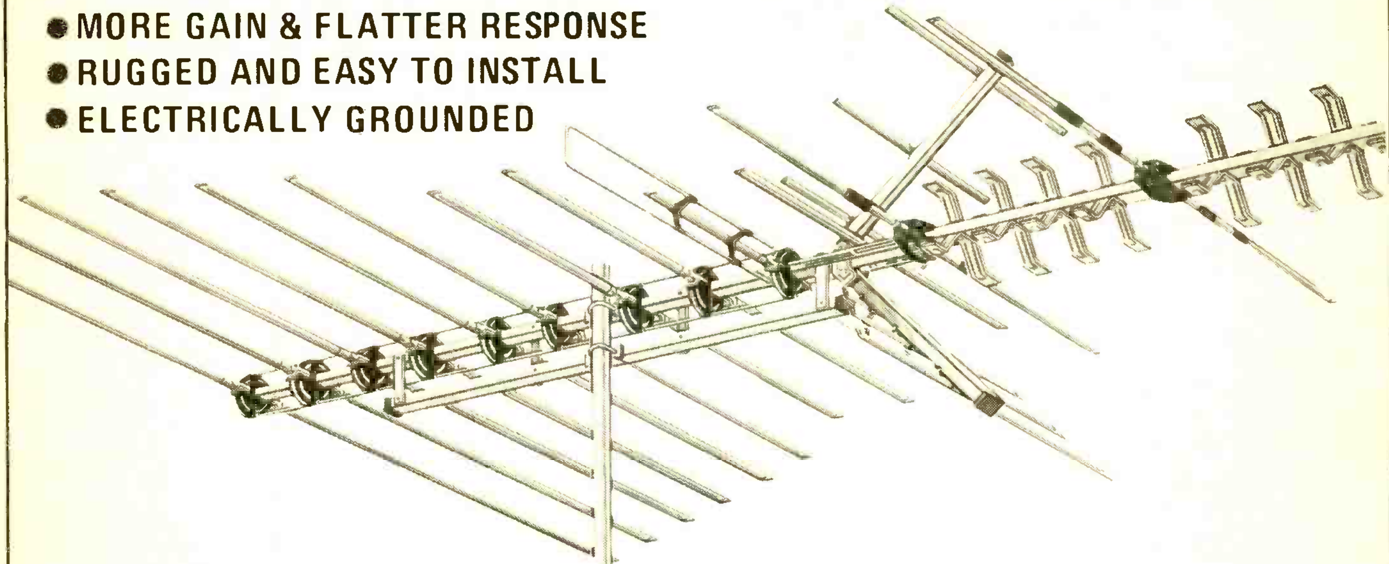

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Circle 80 on reader service card

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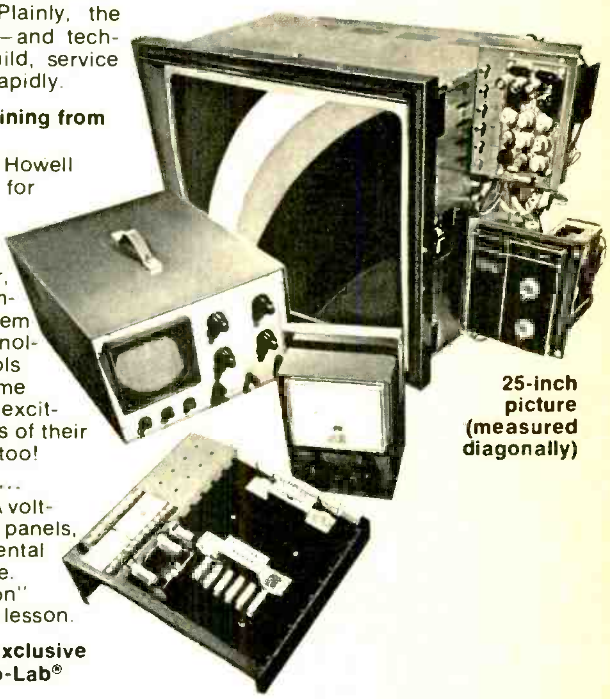

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(continued from page 16)

ers who have sent in corrections. Please keep sending them in so we can keep others up to date.—*Don Lancaster*

WE GOOFED

If we set out to measure readers' reaction to an electronic quiz or test their knowledge of semiconductor basics, we could hardly have expected a greater response than the deluge of letters we received on the quiz in the September issue. Somehow—we can't begin to explain how—there were errors in the answers to questions 2 and 5 printed on page 90. In the first 16 letters received, 13 called attention to both errors. In addition three readers considered question number 2 as being too vague. One wanted to know whether the transistor was cutoff, saturated or working in the linear region. Another pointed out that the emitter is negative *only* if the transistor is being operated in a *reverse-bias* mode, a connection that is rarely made. The third felt the question incomplete because there was no point of reference. He added that if the emitter was returned to ground through a resistor, it would then be negative with respect to ground.

I think that by now, we all agree that the answer to question 2 should be PLUS and that it is the silicon, *not* germanium transistor that starts conducting with a forward bias of 0.6 volt.

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I have a Radiola 33, complete with outboard speaker, and a number of old-time radio tubes, condition unknown, of the UX–, 14, 17, etc., era.

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I know that there are a number of collectors of old radios, and I would rather give mine and the tubes to one of them rather than throw them away. I don't want the trouble of packing and shipping, therefore the "come and take them away".

J.K. VOLAND
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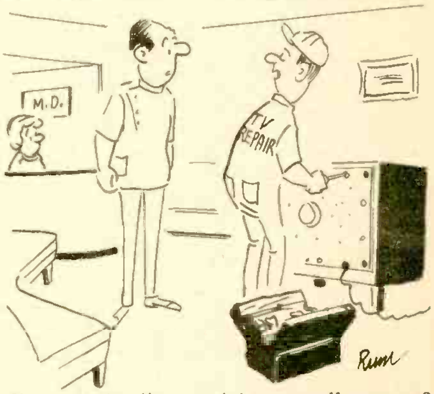
LETTER TO JACK DARR

I was reading your item in R-E August '73 and on page 69 you were wondering aloud why the Philco 39-45 had that weird 1st i.f. transformer with the third winding connected to the suppressor of the 78. I think this circuit was one of the wondrous variable selectivity ideas that were used in those days. The stronger the signal, the wider the pass band and hence the greater fidelity (like the capture ratio effect only different.) When the signal strength drops, the avc drops and the variable-mu 78 changes its characteristics so the broad (untuned) secondary (third winding) does not predominate the output of the stage.

Which brings up an interesting point, why don't you include questions from readers restoring old radios every month. There are more interesting old circuits found in old radios than in most new sets.

If not many people ask for this data, fake it.

STEVE P. DOW
Gibsons BC



I'm only the diagnostician—a colleague of mine will perform the actual operation.

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This battery-powered beauty is less than one inch thick yet performs all mathematical functions with results up to eight digits. A constant (K) switch permits fast repetitive work when multiplying or dividing. ⅛" LED display reads-through bright and clear with no distorting magnifier. Uses readily available 9-volt battery or optional AC converter for desk-top operation. It's a rewarding stocking stuffer for businessman, housewife or student. Mailing weight, 2 lbs. GRA-43-1, AC converter, 1 lb., 3.95*.

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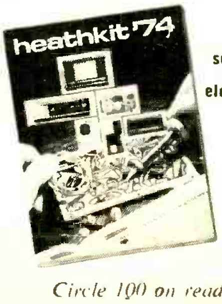

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Circle 100 on reader service card

appliance clinic

SPEED CONTROLS AND BLACK BOXES

by JACK DARR
SERVICE EDITOR

QUITE A FEW OF THE NEWER APPLIANCES use solid-state speed controls, in one form or another. There is the variable-speed electric drill, probably the first unit to use one, and such applications as light dimmers. All of these use SCR's in one form or another. In such units as blenders and mixers, you may find a row of pushbutton switches to control the speed of the rotor. SCR controls are used in some of these, too. Some use a group of diodes. These are set up in conjunction with tapped motor windings.

The diode controls work with the same motor taps, as before. For example, a motor might have four taps on the winding, which would give four different speeds. To get a greater range of speed-control, they could switch in a diode to each of the tapped windings. Now they have eight different speeds, for the price of only the diodes and four more switch contacts. The principle of this is simple. On the first four taps, the motor has full-wave ac applied to the windings. On the last four, "half-wave ac" (sic) is fed to the same windings, and the motor runs slower. (Note: in an actual circuit, the diodes would probably be "interleaved" between the direct taps, but for greater clarity, we've drawn it like Fig. 1.

You can identify this type of circuit by checking the number of wires going to the motor. In this one, you'd see five wires; four taps and a common. The selector switch would be connected as shown. This is drawn something like a rotary switch, but any type of switch can be used, and will. The multiple-pushbutton type is very common, especially in blenders.

Black boxes

Practically all of these controls are built as what we call Black Boxes. Translated, this means that all parts are encapsulated in plastic, usually one of the epoxies, with some wires coming out of it. In these things, it is literally true; they *are* usually black. Black-boxed things are not repairable. You can't take them apart. If anything inside fails, you replace the whole thing. Disconnect the wires and put in an exact duplicate, period.

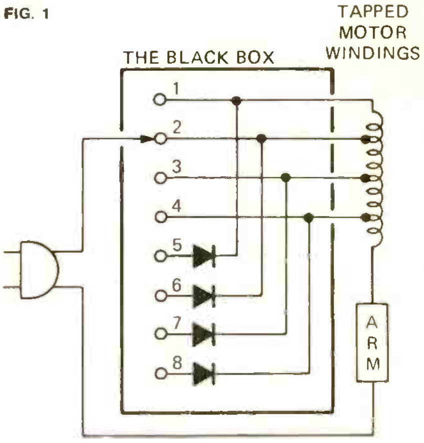
(They're a lot like a raw egg. Not too hard to get into, but pretty difficult to put back together.)

The essential thing here, of course is to be sure that the black-box is at fault, and not something else. In practically all of the simpler speed controlled appliances, this isn't too difficult. For example, if a drill won't run at all, just jumper-out the speed-control device with a clip-lead. If the motor will now run at full speed, there you are. The black box is open. However, if the motor runs full speed at all times, the black box is shorted. Same result in either case.

Put in a new black box

On the multiple-speed things, like blenders, it isn't hard to check for troubles, by simply pushing buttons and noting what happens, or doesn't happen. For example, in the circuit of Fig. 1, with eight pushbuttons; if the

FIG. 1



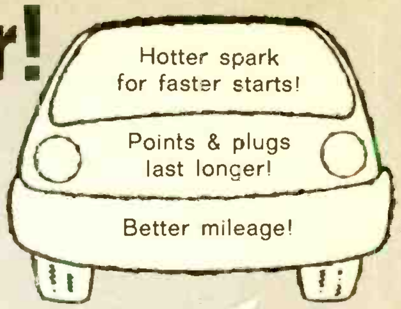
motor runs on the first four, but stops when No. 6 is pushed; the diode in this position is open. The motor itself has been checked out by the fact that it will run normally on the first four positions.

If the first five positions are working normally, but No. 6 makes the motor run faster instead of slower, then this diode is shorted. As you can see from the diagram of Fig. 2, it is connected to No. 2. Check; if both No. 2 and No. 6 give the same speed, this is it.

Here are some handy hints, if you do have to change a black-box. *Before*

(continued on page 84)

Build yourself a better car! Build an Archerkit™ from Radio Shack



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"After an hour or so of driving . . . we noted that the engine was acting the way it did two years and 20,000 miles ago . . . a definite improvement in performance. Acceleration, specifically, was much improved." **Popular Electronics,** *May, '73*

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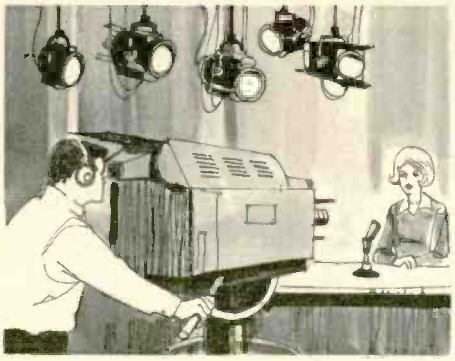

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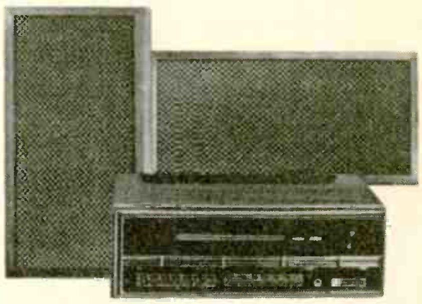

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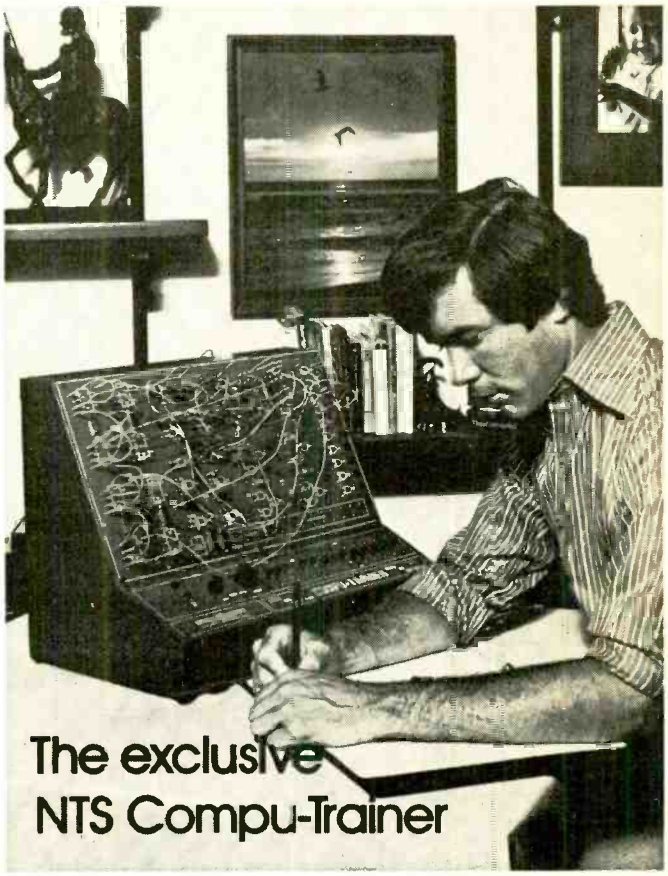

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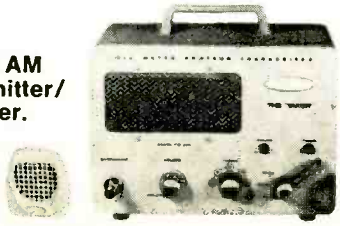

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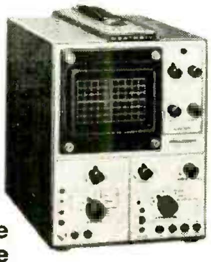

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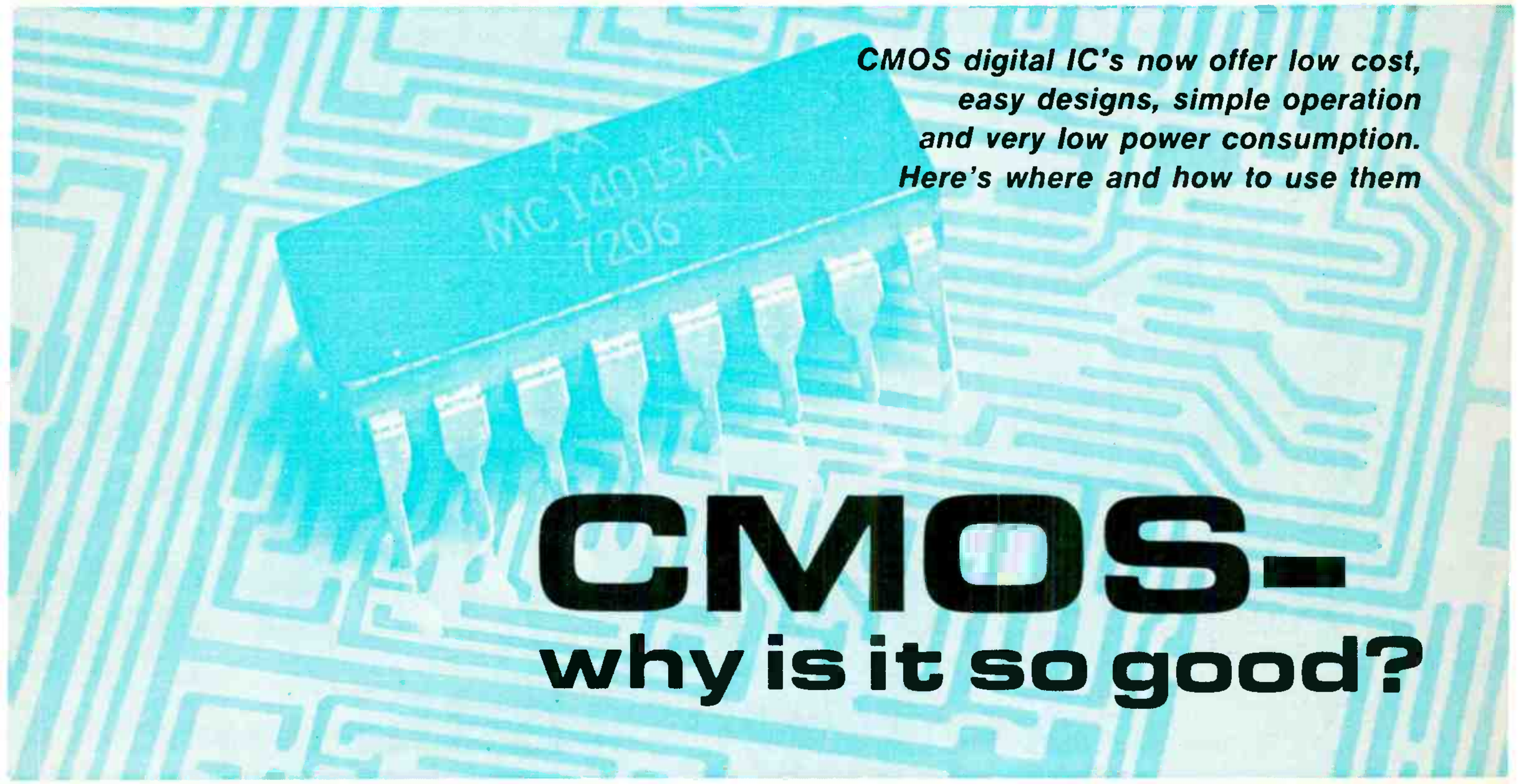
CMOS— why is it so good?

CMOS digital IC's now offer low cost, easy designs, simple operation and very low power consumption. Here's where and how to use them



by DON LANCASTER

CMOS OR COMPLIMENTARY METAL OXIDE Silicon integrated circuits have been around for a number of years. Pioneered by RCA, their high price has kept them from popular use. During that time, their micro power consumption, easy circuit design, and outstanding noise performance has been verified time and time again in many military, industrial, and critical aerospace applications.

Some things about CMOS seem almost magic. All the inputs are open circuits. As long as the IC doesn't *change* state, it draws essentially *zero* supply power. It's only when you are changing information inside the package that any power is drawn at all, and then the power is drawn only while the change is taking place. CMOS is fantastically forgiving of sloppy power supply design—it works over a 3 to 15-volt range. It slices its logic right down the middle, so it is also forgiving of noise problems. Better yet, it doesn't generate any noise of its own. Its output states look like *resistors,* either a 400-ohm resistor to + or a 400-ohm resistor to ground. Finally, as an experimenter bonus, CMOS is very easy to convert to linear circuitry, particularly crystal oscillators and electrically variable switches and attenuators.

Today, the price of CMOS has dropped to around a dollar per gate package, and around $4 for the fancier versions. Surplus is available for even less, as a quick check of the ads in the back pages of **Radio-Electronics** will verify. Yes, TTL is cheaper, but CMOS is economical enough right now for practically everything you might like to do with it. Better yet, further price reductions are almost a certainty, so now is the time to learn about CMOS and start using it.

Once you get into the designs, you'll find that so much is easier with CMOS—things like circuit and power supply design, noise performance, and your design time, that many times, *today,* CMOS is the cheapest logic you can use on a system basis.

Many CMOS manufacturers are listed in Table 1. Right now, RCA with their 4000 series COSMOS and Motorola with their 14000 and 14500 series MCMOS are leading the pack in having lots of devices widely available. The smaller companies also have many unique IC's offered. Solid State Scientific has many fancy large scale circuits, including a complete micropower clock in one package. Inselek offers ultra fast CMOS, and Harris offers a number of unique devices. National has both the traditional 4000 series devices as well as a line of CMOS with pins identical to the popular TTL 7400 series devices.

There's every indication that the 4000 series of devices will be the industry standard. (Motorola's 14000 series is identical—just subtract 10,000 from the part number). These are propably the best devices to start working with, particularly since they are likely to be available from a wide range of suppliers.

Two myths

Before we go into complete details of what CMOS is and how to use it, let's throw out two myths about CMOS.

Myth 1 says that CMOS is inherently slow. Not true. There is no fundamental reason why MOS circuits should be any slower than bipolar ones. What happens is that many products now offered happen to have higher impedances, trading off supply power for speed of operation. Even so, you can easily run to 5 MHz with the majority of CMOS circuits (except for some specials). One type of CMOS, called SOS for Silicon-on-Sapphire and offered by *Inselek* runs as fast as ordinary TTL, and in fact is the *fastest* logic available *anywhere* on a speed-power basis. Since the majority of circuitry in use runs slower than a few megahertz, particularly experimenter circuits, the trick is to use CMOS where you can and save the high-speed stuff for other families if you have to use them.

Myth 2 says that CMOS is static sensitive and very hard to handle. Again, not true. Virtually all newer CMOS circuits are internally protected six ways from Sunday with resistors and Zener diodes to eliminate any possibility of static damage. A little bit of common sense handling advice still remains—we'll see about it in a minute—, but this is a strictly "just-in-case" type of precaution, and its highly unlikely that you will ever damage a CMOS integrated circuit, unless you are extremely careless.

As with any logic family, there are certain rules of the road that you have to follow in order to get reliable operation. Familiar examples are the tight power supplies and the many 0.01 μF high frequency bypassing capacitors needed to get TTL to work, and the waveform cleanliness and fast falling edges needed with RTL. With CMOS, there are only two precautions you have to worry about. All inputs must always go somewhere and cannot be left floating. Secondly, if you connect a low-impedance piece of test gear to a non-working (power off) CMOS circuit, you could conceivably hurt one of the input diodes. Common sense takes both problems in stride.

Some basics

Before we find out all about CMOS, maybe we'd better review some basics of what digital logic is in the first place. A digital integrated circuit performs simple yes-no or "one-zero" decisions. It provides a "yes" or "no" output or outputs in response to a group of "yes" or "no" commands on its various inputs. Groups of these "yes-no" commands can represent calculator numbers, computer words, or alphanumeric messages. Depending on the internal complexity of a digital IC, we can get anything from a simple combinational decision to a complete calculator in a single package.

The exact value of the input voltage doesn't matter, so long as a "1" is within a guaranteed range of allowable "1" values and a "0" is within a specified range of permissible "0" values.

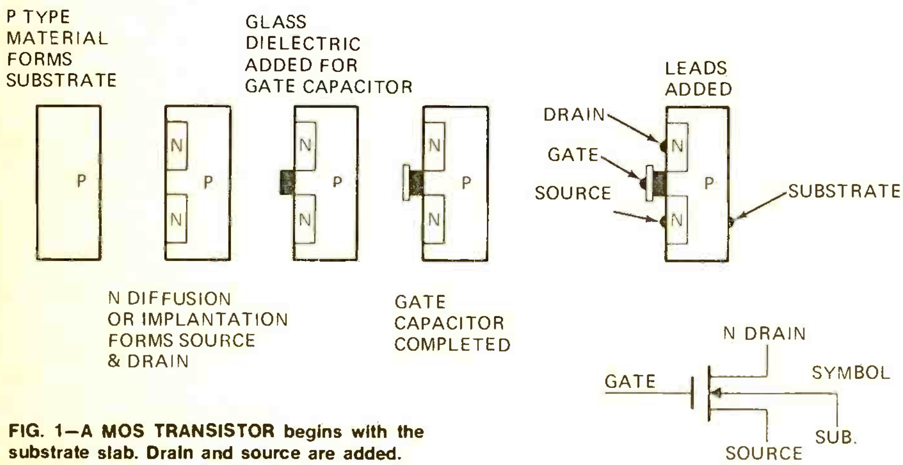


FIG. 1—A MOS TRANSISTOR begins with the substrate slab. Drain and source are added.

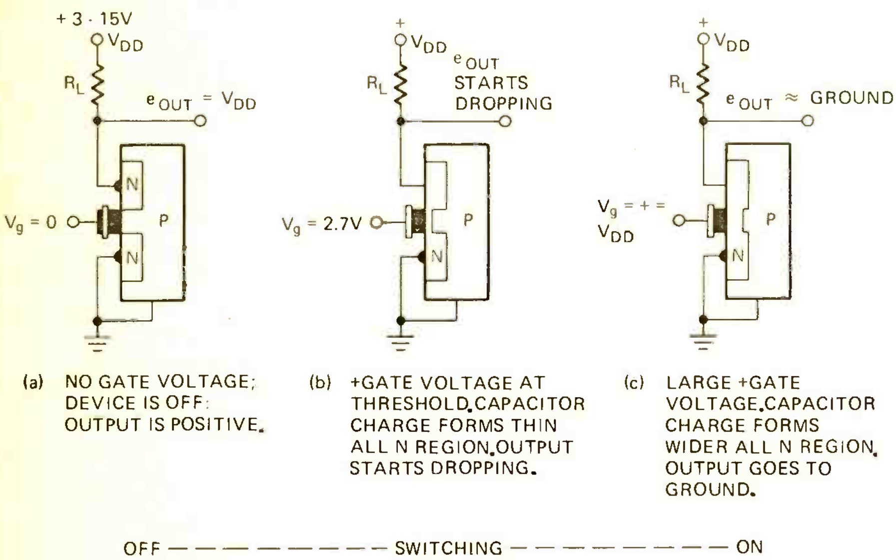


FIG. 2—THREE STAGES OF OPERATION of an n-channel device. Note that the output polarity is opposite that of the input and the device operates as an inverter.

We can usually connect one digital IC to another by direct connection. A given package has a certain drive capability called the *fanout*. Similarly, a given input has a certain load it presents called the *fanin*. These are usually normalized to one *unit* load to simplify things. With CMOS, one package's output can usually drive at least *fifty* other inputs; thus the fanout of CMOS is usually 50.

Our digital IC's also need supply power, often a single positive supply and a ground return. CMOS will work with any supply voltage from 3 to 15 volts. With some logic families, there are limits to the range and the value of the internal impedance of the supplies, particularly at high frequencies. This is particularly true in TTL where the normal circuit operation inherently returns a lot of noise to the supply. This noise must be eliminated before it can hurt the logic performance of another IC down the line.

We'll find out in a bit that CMOS wins on most of these system problems. You can run over a 3 to 15-volt range with a poorly bypassed supply and get away with it. You could, theoretically even use a 15-volt supply with 12 volts of ripple! The ranges of a guaranteed "1" and a guaranteed "0" are even nicer—about half the supply voltage for each. Thus, on a 5-volt supply, a "0" can be anything from around 2.3 volts down to ground, and a "1" can be anything from 2.7 volts up to the positive supply. The logic slices right down the middle. As you add loads to an output, the logic levels don't change like they do with other families—they simply slow down a bit, so the noise performance turns out to be pretty much independent of the loading.

Inside the package

From what we've promised you above, CMOS obviously has to be quite different inside the package than are the common logic families. Let's find out why.

We can start by building an ordinary MOSFET, as shown in Fig. 1. We'll find out shortly that the one we'll start with is an *enhancement mode, N channel* one.

To start, we take a handy bar of p-type silicon, and place two N junction regions in it through diffusion or ion implantation. We call the original bar of p-type material the *Substrate*. The upper N region is the *Drain*, and the lower region is the *Source*.

Next, we put a thin layer (an *extremely* thin layer) of glass or another *nonconductor* dielectric over the substrate between the source and the drain. Then, we add a metal or silicon contact on top of the glass, forming a capacitor. We call this new contact the *Gate*. The Gate has the ability to turn the conducting path between source and drain off and on. Note that there is no DC path from the gate to anything else in the circuit. All the leads are attached by mechanical or non-rectifying, or *ohmic* contacts. And this just about completes the device.

Turning to Fig. 2, we can hook this MOSFET up in a circuit with a load resistor going to a positive source, perhaps something between 3 and 15 volts. If we ground the gate input, there will be no charge on the gate capacitor, and the drain to substrate circuit will look like a *reverse* biased pn junction, and no drain to source current will flow. So with a grounded gate, the device is *off*.

Suppose we start to make the gate slightly positive. The capacitor will charge up, piling up holes (a lack of electrons) on the input end and piling up electrons on the substrate end. The greater the voltage, the more charge we build up.

The black magic comes in next. Since the substrate was initially p-type material, it is normally lacking some electrons, or normally has an excess of holes. As the gate capacitor starts to charge, the extra charging electrons start to accumulate immediately *under* the gate capacitor. Each electron wipes out a hole on the average, so the material immediately under the gate appears to have *less* holes than it did before we biased it. The area under the gate, which we'll eventually call a *channel* becomes *less* of a P type material than it was, and stays that way so long as the charge remains on the gate capacitor.

If we add yet more positive voltage to the gate, we pick up even more electrons under the gate capacitor, and eventually all the holes are offset by the available electrons. The material immediately under the gate capacitor now looks *intrinsic* or free of either electrons or holes in any excess. The voltage on the gate needed to exactly do this is called the *threshold* voltage and is around 2.7 volts for the 4000 series CMOS.

What if we add more positive gate voltage? Now the excess electrons start piling up since there are no more local holes to combine with. *Immediately under the gate capacitor, the substrate temporarily turns to n-type material, as it has an excess of electrons.* Now, we have all N material going from source to drain. It looks like a plain old junction-free resistor, and conducts current. The more positive the gate voltage, the thicker the N *channel* becomes, and the more current we can draw, limited only by the load resistor bottoming when its voltage drop equals the supply voltage.

Our MOS transistor is normally off, and stays off for negative or zero gate voltage. When the gate voltage reaches a threshold of 3 volts, the source to drain starts conducting and the current increases with increasing positive gate voltage. Since the devise is normally OFF, its called an *enhancement* mode unit as increasing the gate voltage enhances or increases the drain to source current. Its also called a N channel device, because the conducting channel is apparently N material when it exists.

Some features of our transistor should now be obvious. First, the input is always an open circuit, so it never draws any current except when you are charging or discharging the very small gate to substrate capacitor. The input impedance is essentially infinite. Also, when we are conducting, there are no saturated junctions or anything of this sort—all the source to drain looks like is a resistor of around 400 ohms when it is ON, and an almost open circuit when it is off.

Note further that our simple switch works backwards. Make the input positive, and the output goes to ground, and vice versa. This is called a logic *inverter.* We'll shortly see how fancier logic blocks may be built up by suitable series and parallel combinations of inverters. Obviously, if two devices are in series, *both* must be turned on to allow current to flow; if two devices are in parallel, *either* can be turned on to do the same thing.

The gate capacitor turns out to be extremely thin, and its open circuit welcomes the buildup of static electricity. The field strength from static can easily puncture the capacitor and permanently damage it. This is why there was so much static problem with early MOS devices. Practically all devices today have external Zener diodes and resistors to keep static from ever getting close to the gate capacitor.

Complimenting the MOSFET

So far, we've built nothing but a plain old N-channel enhancement mode MOS transistor driving a resistive load. When the transistor is off, the load current is zero, and the output voltage is positive. When the transistor is on, the load current is determined by the supply voltage and the resistor value, and the output drops to ground. Our circuit draws supply power only in one state.

We could use another transistor or a current source for the load resistor, and this is done in ordinary non-complimentary MOS integrated circuits such as are used in character generators, shift registers, and read only memories. CMOS does things differently

Instead of using a load resistor, we build an *exactly opposite* or *complimentary* p-channel enhancement mode transistor and use it as a load. As Fig. 3 shows us, a P-channel enhancement mode device can be connected to the positive supply with a load resistor going to ground. Ground the gate, and the transistor turns on, and the output swings positive. Make the gate positive, and the transistor turns off, and the output drops to ground. So a positive gate voltage will turn on an N-channel device, but turns off a P-channel device. A grounded gate input turns ON a p-channel device and turns OFF an n-channel device.

To build a true CMOS inverter, we simply combine a N-channel and a P-channel device in series as shown in Fig. 4. The two gates are then driven in parallel. To actually do this, takes a bit more construction inside the IC than older logic types needed. The two devices are isolated from each other by several possible means, such as diffusing a "P tub" onto a N substrate and then building the other transistor inside it, or by building everything on non-conducting sapphire or spinel.

When we tie the two together this way, we always have only *ONE* transistor turned on. The steady state output is always either a resistor to ground or a resistor to plus. In neither state is there any internal plus to ground path, and the IC magically seems to ten, we can literally run our CMOS off a damp blotter battery. As we increase the operating frequency however; we charge and discharge the capacitor more often and the *average* supply power goes up. When we get to 5 megahertz or so, the total supply power gets up to roughly what the other logic families need. At low frequencies, CMOS takes very little supply power and offers fantastic power supply savings. As you increase frequency, the power needs proportionately increase to the point where there is little power savings above 5 MHz. This shows why the CMOS watch circuits draw so little battery current as the majority of the circuitry changes at a very slow rate. In fact, practially all of the

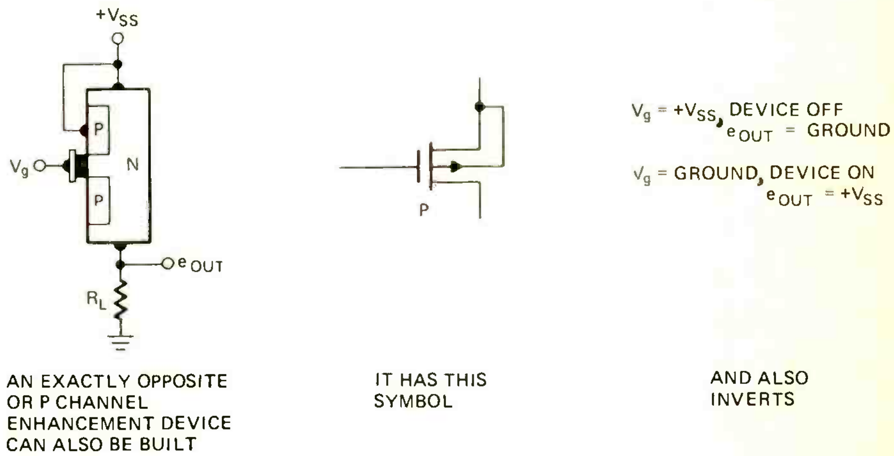


FIG. 3—THE P-CHANNEL ENHANCEMENT MODE DEVICE complements the n-channel FET in Fig. 2. Its construction begins with an n-type slab or substrate.

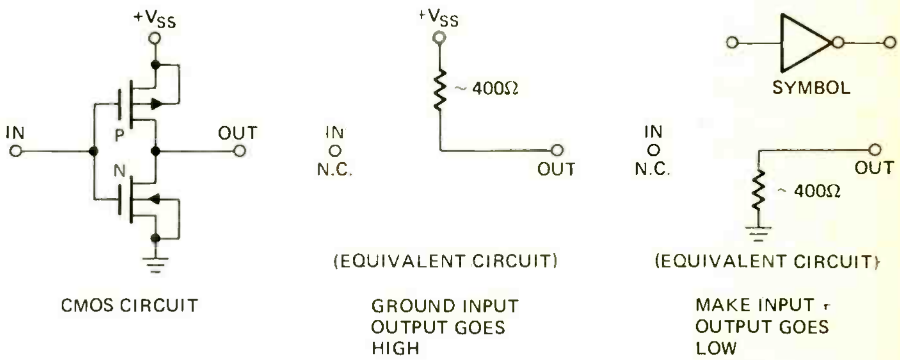


FIG. 4—THE CMOS DEVICE is made by combining two n-channel and p-channel FET's. The circuit configuration shown is that of an inverter.

never need any supply power!

Generally, the output of one CMOS stage drives the input of the next, which is an open circuit, so the load also draws no current. Apparently, we have a logic family that *never* needs any power at all. Can this be?

Obviously not, for we would have some sort of perpetual motion circuit that violates a bunch of laws of information theory and thermodynamics. It *has* to take some power to transfer information. In CMOS, this power gets used in charging and discharging the input capacitance of the next stage. During the charging time, current flows from the positive supply into the gate capacitor of the following stage. During the discharge time, the current from the gate capacitor of the stage following is discharged to ground.

The gate capacitor is a very small one If we don't charge or discharge it very of-

CMOS power is used in the first four divider stages following the crystal on a typical watch; the rest is utterly negligible.

Our basic CMOS inverter (Fig. 4) then consists of a N-channel transistor on the bottom and a P-channel one on top. Both gates are connected together. Ground the input, and the N-channel job turns off and the P-channel one turns on, and the inverter's output goes positive. Make the input gates positive, and this time, the N-channel device turns on and the P-channel device turns off, and the output goes to ground. The output of our inverter always looks like a 400-ohm resistor, either to + or to ground; the input is always an open circuit.

With a fairly high supply voltage and our simple inverter, the decision between a "1" and a "0" is usually made halfway up, a point at which both transistors are moderately conducting. As the supply voltage is lowered, the "1"-"0" decision gets a bit sloppier and wider, but still a bunch of noise immunity is offered.

Since both transistors are never simultaneously conducting very heavily, there is no current surge that gets thrown back onto the supply power line as there is with TTL and some DTL circuits. This greatly eases the power supply and decoupling design problems.

Interface and fanout

As we add more CMOS inputs to an output, only the load capacitance changes, since the gates are all open circuits. The voltage levels do not change. You can drive at least 50 gates or more with one output lead, and the noise immunity and signal levels stay the same pretty much independent of the number of new devices you hang onto an output.

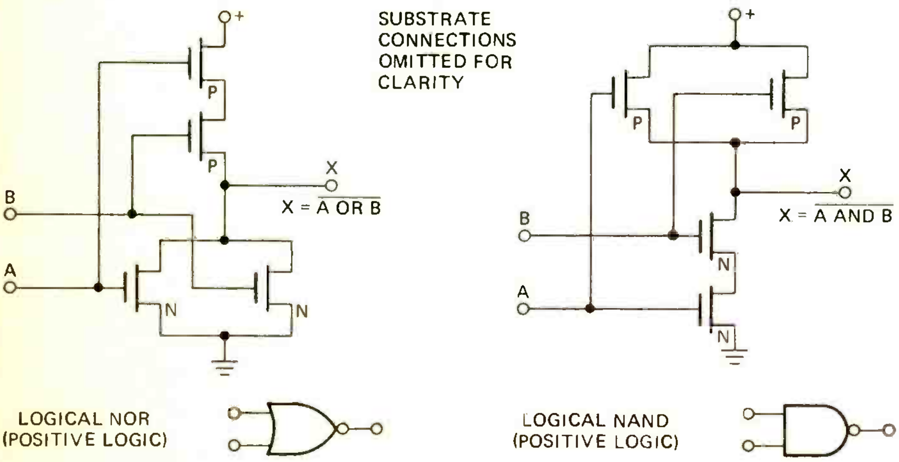


FIG. 5—MORE COMPLEX CMOS LOGIC is easily built up by combining p- and n- channel devices. Shows are connections used to form logic NOR and NAND circuits.

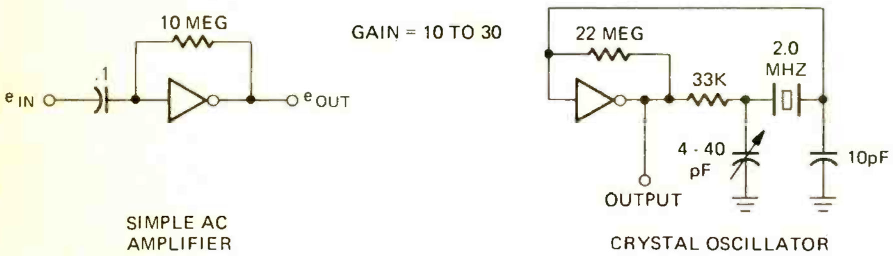
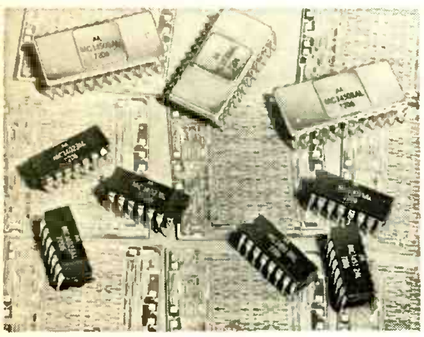


FIG. 6—LINEAR APPLICATIONS OF CMOS need only the addition of a feedback resistor. Here are two examples—a simple ac amplifier and a crystal oscillator.



VARIETY OF MCMOS IC's made by Motorola. Many varieties are currently available.

The story changes a bit when you actually try to draw some load current to interface the outside world or some other logic family. While the ON resistance is around 400 ohms, there is a current limiting that takes place under heavy load or short circuit conditions, and the available source or sink current is typically a bit less than one milliampere. This is more than enough to interface regular MOS, RTL, most discrete circuitry, and *low power* TTL, but it is not quite enough to *reliably* interface regular TTL. To drive TTL, you have to use a CMOS buffer such as the MC14049 or MC14050, or another circuit that provides at least 1.6-mA output current. With a normal device, you can treat the output as a 1-mA current source or sink and proceed accordingly. Some sort of current amplification is recommended for driving LED's or lamps, while liquid crystal and some flourescent displays are directly compatible.

You can apparently short circuit CMOS continuously without harm, at least at room temperature. This is handy for electronic music keying and building bounceless pushbuttons. Other interface techniques are easy to work up.

Coming from the outside world to CMOS is a slightly different story. The open circuit inputs make things relatively easy. All you have to do is never go below ground or above the positive supply with an input. A voltage near ground will be read as a "0" and near the positive supply will be read as a "1". With a +3.6 or +5 volt supply, you can directly interface DTL or RTL. With TTL, the output guaranteed "1" is usually only half the supply voltage, so a simple pullup resistor of 2.2 to 10K should be added. *NEVER let the input go above positive or below ground* particularly from a low impedance, as we'll shortly see that this can hurt CMOS—in fact its about the only way you can really damage it.

Building some logic

There's really not too much you can do with just inverters, although they do have a few handy applications. Fig. 5 shows how we can combine series and parallel arrays of MOS transistors to perform logic. In the NOR circuit of 2A, making the inputs both positive pull the output to ground. So does making either input positiive. Only when both inputs are grounded, does the output swing positive. This is known as a positive logic NOR circuit. To build the familiar OR circuit, you simply add an inverter to the output—making either input positive gets us a positive output.

The series combinations present as real problem, for since they all have to be on anyway to conduct current to an output load, the sequence in which they turn on doesn't matter, and an on device has no voltage drop across it, or at least very little. One minor effect is that the threshold voltages will shift slightly for the differing transistor positions. This is a minor effect and is detailed on most data sheets.

The NAND circuit is an upside down NOR one. Both inputs must be positive to force the output to ground. Add an inverter and we have an AND circuit in which both inputs have to be positive to get a positive output.

More complex logic is easily built up with proper series and parallel combinations. Two NAND gates back-to-back form a set-rest flip-flop. These may be cascaded with a CMOS circuit called a *transmission* gate to form a *master-slave* flip flop which in turn can be used for binary division, decimal counting, and all the more familiar MSI logic applications.

Table II is a more or less random selection of the hundred or so CMOS integrated circuits available today. These will give you an idea of what is on the market and may represent a good choice for initial experiments. Two devices that are particularly interesting that have no equivalents in the older logic families are the MC14016 and MC14046. The former is a quad switch. It can be used for digital or analog signal transmission, and it doesn't matter what you call the input or the output, since the ON equivalent circuit is a resistor and the OFF equivalent circuit is nothing. Tie four of these together, and you can just as easily select one of four input signals and route it to a single output, or use one input signal to go to zero, one, two, three or four places at once. Thus, with this CMOS package, there is no difference between a data selector and a data distributor.

The MC14046 is a phase lock loop circuit; unlike the older PLL's this one will work and track and lock over a 1000:1 frequency range, making it a top contender for electronic music, digital tachometers, frequency multipliers, and things like that. Like many of the older PLL's, it has a maximum frequency of 500 kHz.

Some precautions

As with any logic family, there are several things to watch out for to keep out of trouble. These are surprisingly easy and simple with CMOS.

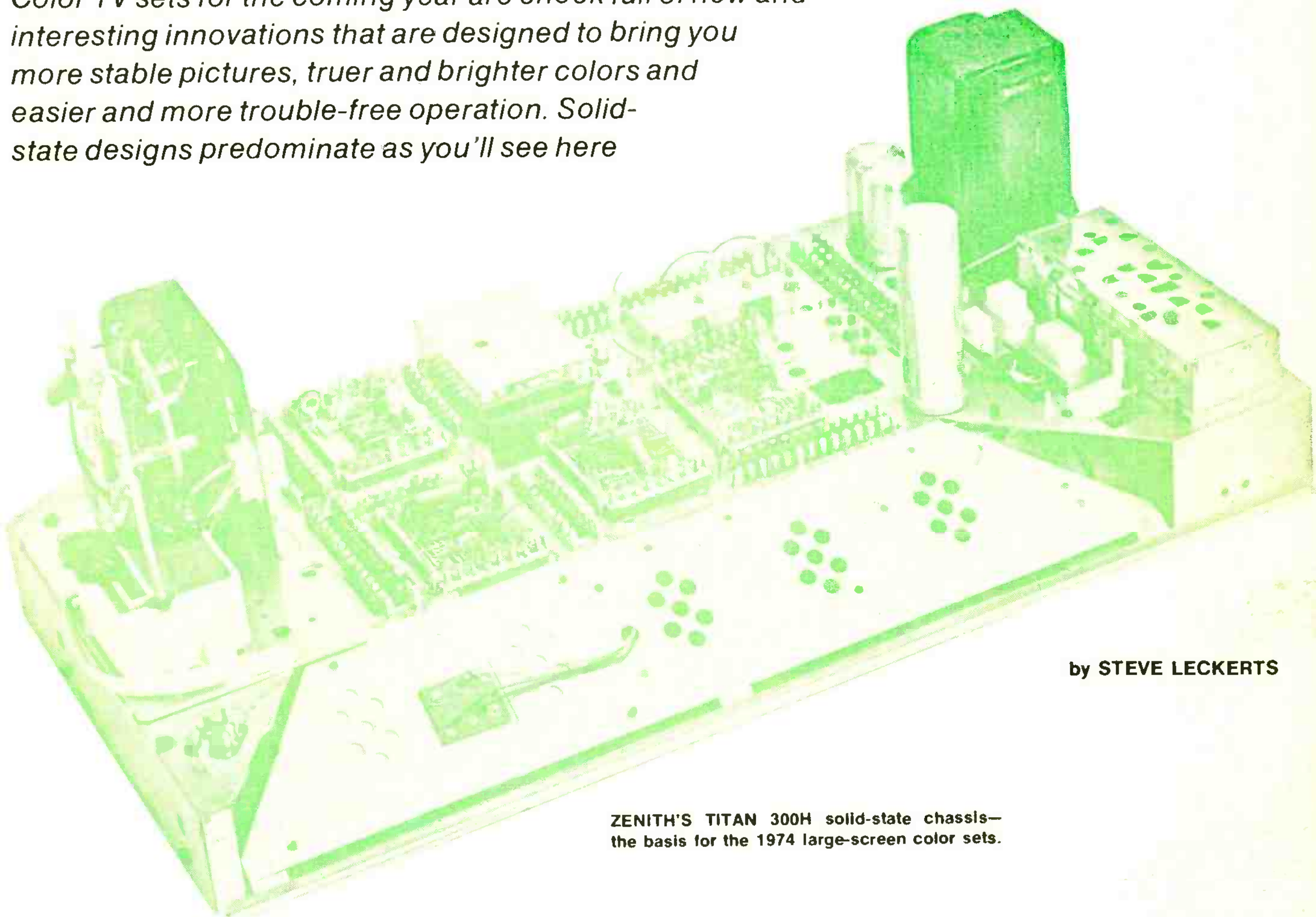
Rule 1 is that *all* inputs must go somewhere. This can be either to a logically similar input or connected to positive or ground as needed to get the right function. The reason is simple—a floating input is an open circuit that can pick up hum and

(continued on page 88)

NEW '74 Color TV Circuits

Color TV sets for the coming year are chock full of new and interesting innovations that are designed to bring you more stable pictures, truer and brighter colors and easier and more trouble-free operation. Solid-state designs predominate as you'll see here

by STEVE LECKERTS



ZENITH'S TITAN 300H solid-state chassis—the basis for the 1974 large-screen color sets.

DESPITE THE ALREADY HIGH DEGREE OF refinement in TV circuits the '74 sets continue the tradition by making innovative contributions to receiver art. For the first time in our hemisphere a practical countdown vertical system has been introduced that truly eliminates the vertical hold control and doesn't just tuck it away in a corner. This newest IC accomplishment is an indicator that other surprises are probably in the works.

Magnetic voltage regulation appears in a major manufacturer's color line as their solution to supply regulation and energy gap brownouts. Just about everyone has recognized the cost effectiveness of the horizontal transformer power supply and ambient light sensing continues to push toward the completely automatic set. These are the highlights.

Zenith

Magnetic voltage regulation is now being used in all Zenith solid-state color sets. 'Power Sentry' reduces power requirements since power consumption can be set close to optimum without the usual overcurrent drain needed to insure proper operation under reduced line voltage.

Fig. 1 shows the transformer hookup. In particular notice the un-

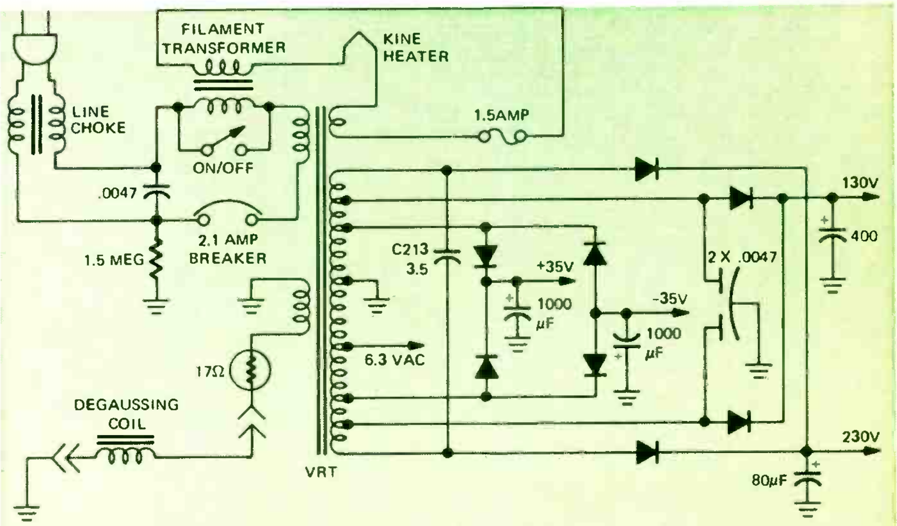


FIG. 1—VOLTAGE-REGULATING POWER TRANSFORMER is a unique feature found in 1974 Zenith color sets. Operating voltages are not affected by line or circuit load changes.

conventionally located C213 across the secondary winding. This capacitor resonates with the inductance of the winding to produce relatively high circulating currents. The peaks of the sine wave ac line voltage saturate the core tending to keep the fundamental 60-Hz component constant. The VRT or voltage regulating transformer extends picture tube and other component life. Cathode life of the picture tube decreases dramatically at increased temperature. The automatic heater voltage regulation protects the heater and cathode from the inevitable voltage surges. The transformer also minimizes the need for electronic supply regulation within the chassis. It will be interesting to see if this unique idea in the industry propagates to other manufacturers.

Zenith has also increased high voltage to 30kV on their 300H horizontally mounted and 300V vertically mounted chassis.

That's the end of the circuits for the new model year. Let's hope next year's offering is as interesting.

RCA

In addition to flesh-tone correction and limited range color saturation and tint controls this year's Accumatic includes reduced range brightness and contrast controls with midrange presets. Fig. 2 shows the modified control system. The Accumatic switch is shown in the on position. At the top of the diagram the contrast control circuitry is connected to the emitter of the 1st video transistor to regulate the amplifier gain. The video input to the kine drivers is limited to about 1.4 to 1.8 volts compared to 1.2 to 2.4 volts in the off position. When Accumatic is on, the 2500-ohm resistance of the control is replaced by a 2400-ohm resistor. The ac impedance bypassing the 1800-, 2400-ohm parallel combination is the contrast level control in series with the paralleled contrast pot and 1200-ohm resistor.

Brightness is modified to a preset range with Accumatic on by wiring in the wiper of the brightness level control and inserting 5.6K R4012 in series with the brightness control wiper.

RCA has introduced a vertical striped Acculine picture tube in a similar vein to others. This item can be described by an eliminated circuit rather than an added or revised one. The conventional dynamic convergence correction circuitry has been eliminated without any sacrifice in convergence performance. Phosphor line segments make up the screen instead of dots to improve sharpness and brightness over conventional triad tubes. The simple yoke assembly is preadjusted and cemented to the tube.

This leads to the CTC 62 chassis which uses the Acculine tube. The SCR deflection system uses ITR's or intrinsic rectifiers combining the SCR's with their respective trace and commutating diodes in a single package.

B+ voltages needed for all circuits but the horizontal deflection itself are derived from the horizontal

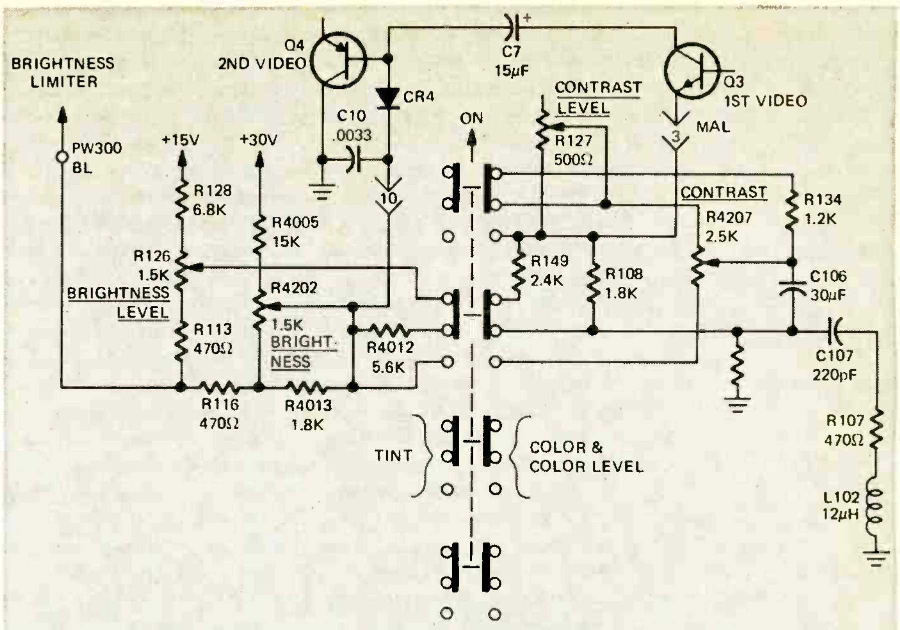


FIG. 2—RCA'S ACCUMATIC CIRCUIT provides flesh-tone correction as before, and in addition, reduces the effective range of the set's brightness and contrast controls.

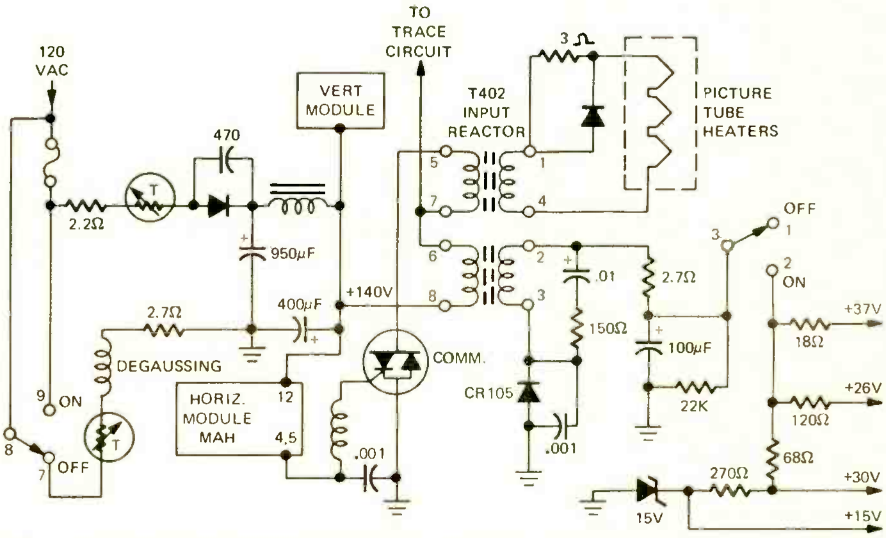


FIG. 3—PICTURE-TUBE HEATERS and low B+ supply are derived from the horizontal deflection circuit. Horizontal oscillator is always on so pix tube is hot for instant operation.

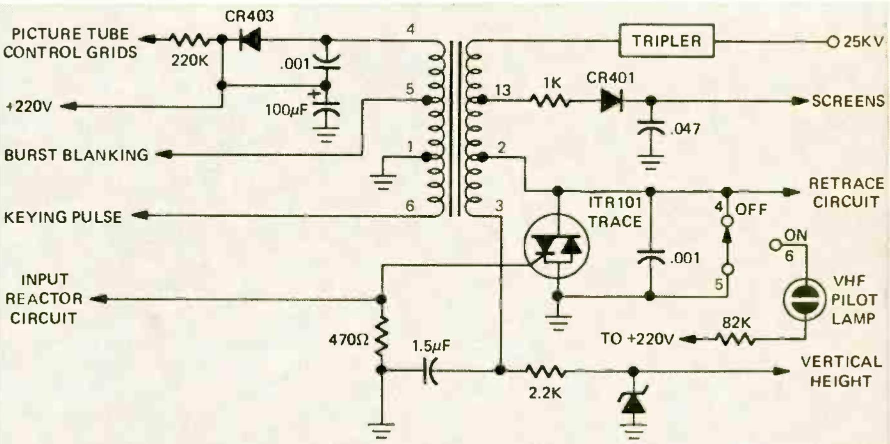


FIG. 4—HIGH VOLTAGE AND HIGH B+ are also developed by the deflection system in the RCA CTC-62 chassis. The tripler rectifies the flyback pulse to develop 25 kV.

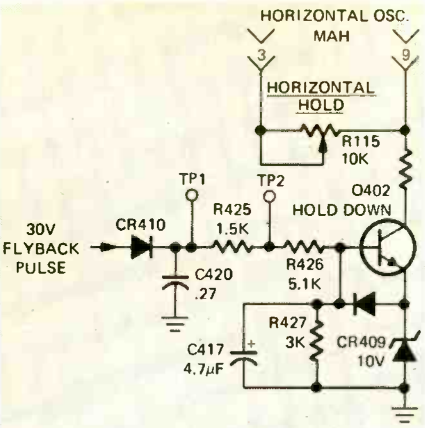


FIG. 5—HIGH-VOLTAGE HOLD-DOWN operates by pulling the horizontal frequency down when Q402's base bias voltage rises.

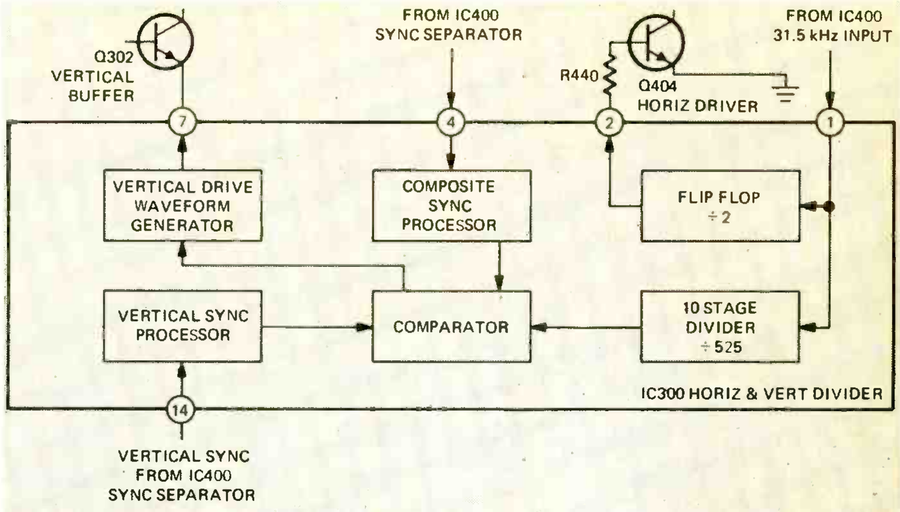


FIG. 6—SYLVANIA'S COUNT-DOWN VERTICAL SWEEP is generated by dividing the 31.5-kHz horizontal frequency by 525. Phase-locked loop provides sync to incoming signal.

high voltage transformer and input reactor. As shown in Fig. 3, even when switched off, the horizontal oscillator in this receiver is always running so that the input reactor T402 can supply heater voltage for Instant On. The input reactor also generates a 40-volt dc supply using CR105 to feed a voltage divider and Zener supply. Fig. 4 is the schematic of the high voltage and kine drive 200-volt supply portion of the deflection system. When the set is off ITR101 is disabled by a direct anode connection to ground shutting down the HV supply and deflection.

Turning the set on removes the short allowing normal trace operation. The HV tripler supplies the 25-kV kine anode voltage and the tap-13 pulse is rectified by CR401 to bias the picture tube screens. Diode CR403 is connected to an auxiliary winding to supply 220 volts to the kine-driver modules and pilot lamps.

The CTC 68 chassis has more high voltage for better picture tube performance; in this case a whopping 31 kV increased from the previous 26.5 kV. To conform to HEW requirements the hold-down circuit of Fig. 5 is used to pull the horizontal frequency low when a tight high voltage limit is exceeded. A 30-volt flyback pulse is rectified by CR410 and filtered by C420 to bias hold down transistor Q402. Excessive high voltage such as might be caused by a defective high-voltage regulator will cause the base voltage of Q402 to exceed the 10-volt Zener connected to the emitter. The exact trigger point is determined by the precision voltage divider R425, R426, R427. The collector current in the transistor pulls down the oscillator frequency by virtue of its connection to R115 the horizontal hold control. Shorting TP1 to TP2 tests the system by biasing the transistor into conduction. Readjustment of the hold control and oscillator coil are futile and will not restore a watchable picture.

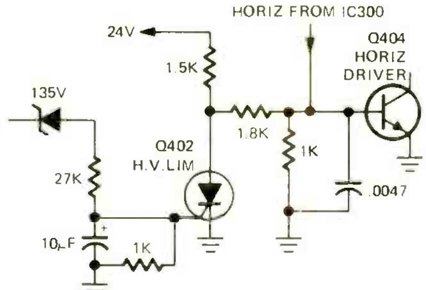


FIG. 7—A RISE IN HIGH VOLTAGE trips the SCR gate to effectively short-circuit the input to the horizontal driver.

Sylvania

The GT Matic receiver should win the outstanding feature of the year award for countdown vertical. If you get a chance, try changing channels on this model at a dealer. You will see the vertical hesitate an instant and then snap in without the familiar picture roll. While this may take some getting used to, the important point is that two TI integrated circuits have replaced the vertical oscillator along with its frequency or otherwise called hold control, with a conglomeration of digital frequency dividers and synchronizing circuits.

This known technique is based on principles used in camera sync generators. Because of standard interlaced TV displays the horizontal oscillator must be twice the scan rate or 31.5 kHz. Dividing by 525 gives the familiar approximate 60 cycle vertical scan.

Since a schematic of the system is unavailable and could alone be the subject of an article the description centers around the block diagram of Fig. 6. The system assumes that a 31.5-kHz horizontal oscillator signal has been synchronized to the incoming horizontal sync. This function is provided by the phase-locked loop on a sister chip IC400. In fact under horizontal phase lock even without a vertical synchronizing impulse, the system will maintain exactly the correct vertical frequency. However the phase will be incorrect with the vertical blanking bar visible. An additional requirement perceived by Sylvania is that the system must handle non-interlaced signals from non-standard generators.

The sync entering pin 4 of IC300 is processed by looking for equalizing pulses to determine whether or not it is interlaced. If it is the countdown mode is selected and the 31.5-kHz input at pin 1 is divided by 525 by a 10-stage feedback binary divider. The signal is routed to the vertical waveform generator to feed the vertical output circuits connected to terminal 7.

Non-interlaced signals are handled by direct impulsing of the vertical drive waveform generator from the sync generator.

Not forgetting that 15,734 Hz is still needed for horizontal, a divide-by-two flip-flop halves the pin 1 frequency and feeds it to pin 2.

High-voltage adjustment on this EO3 chassis is by regulation of the 120-volt source that powers the horizontal deflection system. Certain defects in the regulator will cause the high voltage to rise above allowable HEW set safety standards. To protect against such a mishap, exceeding the 135-volt breakdown of Zener SC435 plus the turn-on voltage of SCR Q402 (Fig. 7) disables the horizontal input to Q404 the horizontal driver. This completely shuts down the high voltage. SCR Q402 remains latched until the protection system is reset by turning off the receiver reducing the SCR current below its holding value. If the fault still exists after turn on the HV will shut down again after a brief instant for charging the capacitors.

General Electric

GE calls their horizontal powered voltage supply system "Scan Rectifica-

(continued on page 92)

REMOTE CONTROL

Remote controls do wonderful
But the way they act
Here's a new look

by KARL SAVON

ALL WIRELESS TV REMOTE CONTROL SYSTEMS USE AN ULTRASONIC transducer to send inaudible air compression waves across the room to a microphone pickup mounted in the TV's front panel escutcheon. These tones in the 40-kHz frequency range are amplified and limited in a fairly similar manner by the receivers and eventually feed a series of frequency selective networks, usually tuned LC tanks, to differentiate and separate the commands.

At this juncture things change suddenly and everyone does his own thing, involving a medium to high degree of complexity in decoding the input signals to get as much mileage as possible out of them.

Some systems are purely mechanical with a motor directly turning the tuner shaft. Some are semi-electronic using a motor driven switch to select the proper tuning potentiometer which then electrically tunes in the desired station by controlling the capacitance of varactor diodes. There are remote control systems that are combinations of the above two.

One experimental system has been demonstrated that is completely electronic using digital techniques to replace the motor and all other mechanical switching.

Described below are a selection of typical systems that will give you good exposure to what is being done in the '74 sets and what the future holds.

The RCA system for remote control

A two-frequency three-function remote control system is being used in the CTC 53 and CTC 71 chassis. There is a one way channel selection motor control frequency and a second on-off-volume control frequency.

Fig. 1 is the schematic of the ultrasonic transmitter. The on-off-volume control frequency is triggered by connecting up the battery power supply, producing a 44.75 kHz output. The channel function uses a shunt 41.5 pF capacitor to lower the transmitted frequency to 41.75 kHz.

The schematic of the remote control system is in Fig. 2 A mechanically tuned vhf tuner and varactor tuned uhf tuner are used. Channel selection is initiated by a preamplified 41.75-kHz signal ringing up the Q1103 input tank. Q1103 closes relay K101's contacts, running the motor. When the motor has rotated so that the station stopper contacts have closed, the motor continues to turn, even if the relay has opened, until the station stopper contacts open at the next channel position. Whenever the motor is turning, the bypass switch contacts are closed. To skip vhf stations, the channels to be skipped are fine tuned counterclockwise, until the sound is muted. When operating remotely the program switches closed in this manner continue running the motor by a ground transferred through the bypass switch. When tuning manually, the bypass switch is open since the motor does not rotate, and any station whether adjusted for bypass or not can be selected.

Since the station stopper switch is connected through a 20 to 1 gear reduction, the tuner shaft can assume any of twenty positions; 12 vhf and 8 uhf. The 12 teeth on G1 and the 13 teeth on G2 are arranged so that any one of the 12 vhf stations are selected by the vhf tuner shaft on G2 by a specific gear tooth on G1. The non-toothed perimeter section of G1 is used to select the particular uhf varactor pot by S2404 while G2 remains fixed in the uhf position.

When in the uhf position B+ is routed to the uhf tuner by S4204. The appropriate varactor potentiometer is selected and series connected through aft amplifier Q1201 (not shown) to the uhf tuner. Bypassing any of the eight uhf positions is done through the bypass switch as for vhf. However, the bypass function is executed electronically by Q1202 the uhf skip detector. To bypass a channel position the pot wiper is adjusted to its maximum clockwise position past the Channel 83 designation. With this wiper adjustment, maximum voltage is applied to Q1202 and in turn Q1203. As before, manual selection of any station is still possible, because of the manual non-operation of the bypass switch.

The on-off-volume system uses two flip-flops as a state memory system. Two flip-flops have a total of 2^2 or 4 combinations of on and off states. There is an off position and three on positions with high, medium and low volume.

Initially Q1107 and Q1109 are off with Q1111 the on/off transistor non-conductive. Reception of a signal by Q1104 operates Schmitt trigger Q1105-1106 to feed an input pulse into the Q1107-1108 flip-flop. The flip-flop enters its TV on/high volume state with Q1107 now on and Q1109 still off. The high supply voltage at the collector of Q1108 now turns on Q1111 through diode CR1112. K1101 is pulled in and Q104 the power on-off triac conducts to supply ac to the receiver. As the flip-flops cycle through the two remaining medium and low volume states either one or both of CR1112 or CR1113 remain on to maintain ac power. When the fifth or original initial position is again reached both diodes are back biased and ac power is interrupted.

Volume changes are controlled by the state decoding of diodes CR1111 and CR1110 to shunt series combination of R4020 the volume control R4201 with the necessary resistance value. The lower the shunted resistance, the higher the volume. In the high volume state 8.2K R1130 is shunted across the control, in the medium volume state 13K R1131 is switched in by CR1111 and in to the low volume state there is no paralleled resistance. CR1117 is a refinement which allows even higher volume at the top end of the volume control in the high volume state. Under these settings 3.9K R4020 is shorted by CR1117 and the saturation resistance of

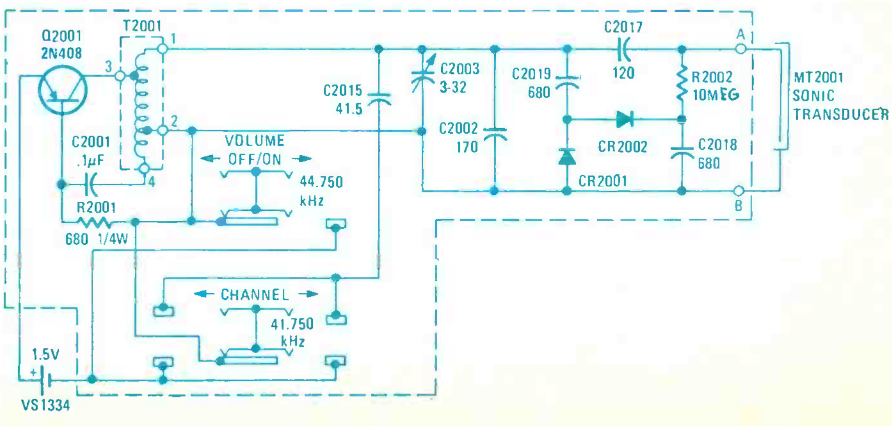


FIG. 1—SCHEMATIC OF RCA's ultrasonic transmitter. Volume is controlled with a 44.75 kHz signal, while channel selection uses a 41.75 kHz signal. Remember, these are ultrasonic signals—not rf. All capacitor values in pF, resistor values in ohms unless otherwise specified.

for color TV

deeds for the set owner.
is often unstated.
at modern remotes

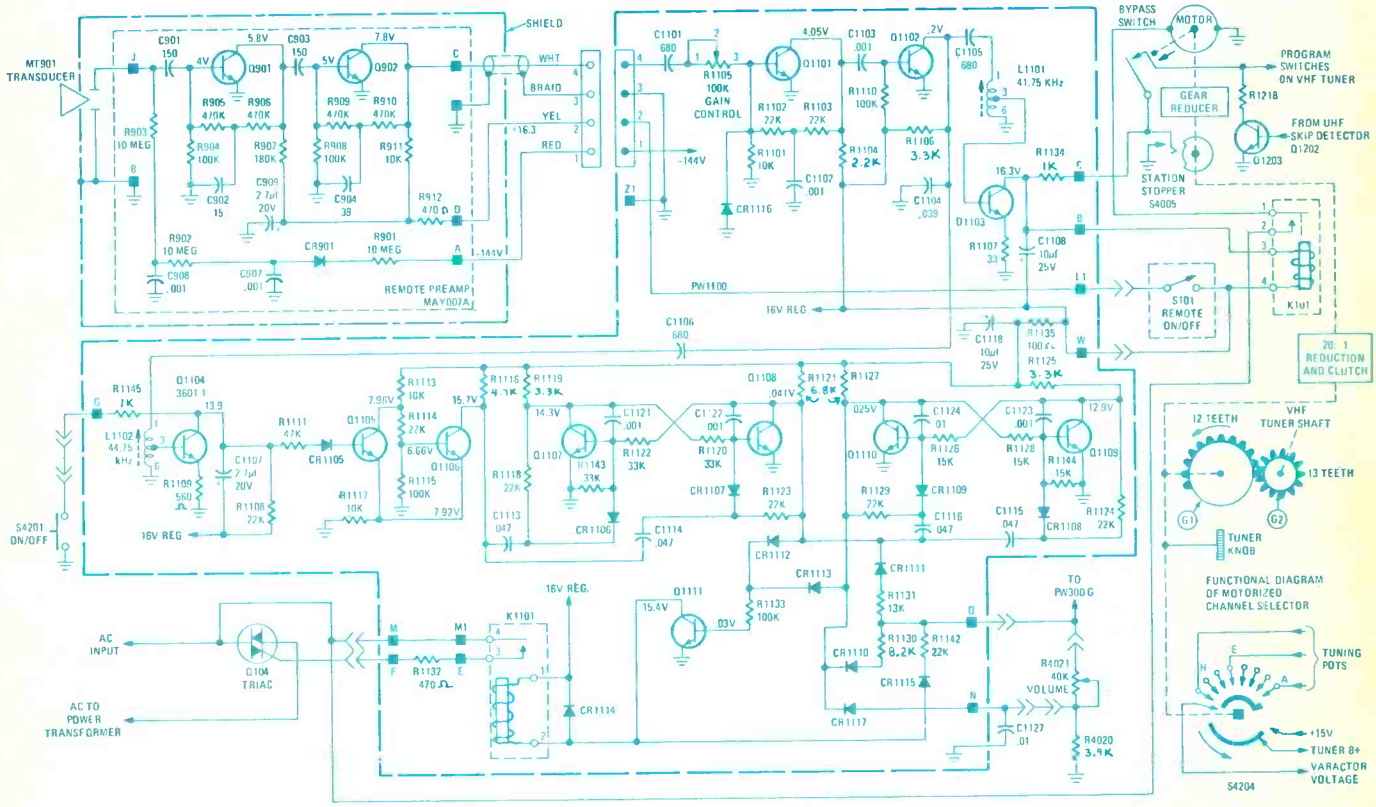


FIG. 2—REMOTE CONTROL SYSTEM ACTIVATED BY THE TRANSMITTER of Fig. 1. Both a mechanically tuned vhf and varactor tuned uhf tuner are operated.

TABLE I
ON-OFF-VOLUME 4-STATE MEMORY FLIP-FLOPS

Power/Volume		Q1107	Q1108	Q1110	Q1109	CR1110	CR1111	CR1112	CR1113	Q104	Resistance in parallel with volume control
Off	–	0	1	1	0	1	1	0	0	0	–
On	High	1	0	1	0	1	0	1	0	1	+ 8.2 K
On	Medium	0	1	0	1	0	1	0	1	1	13.0 K
On	High	1	0	0	1	0	0	1	1	1	∞

0 = off, 1 = on

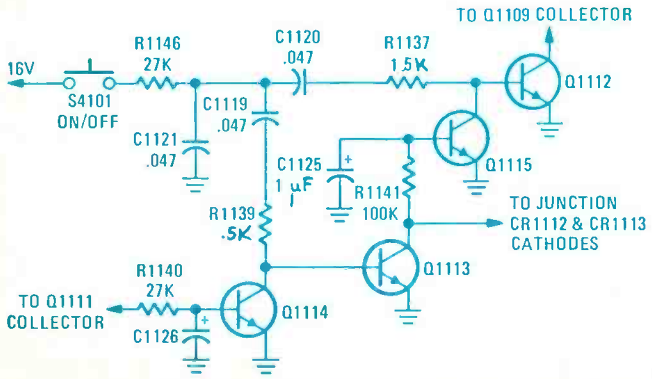


FIG. 3—THIS ADDITIONAL CIRCUITRY is used by RCA for their remote for the CTC 68 chassis.

Q1110 to reduce the volume control resistance. This 4 state memory system is summarized in Table I.

Local operation of the system is identical except the negative state switching pulse to drive the two flip-flops is generated by the on/off switch S4201.

The CTC 68 chassis uses a similar remote control system with the additional circuitry of Fig. 3 so that the receiver can be locally turned off without stepping through all the volume steps as in remote. When the set is turned on by the first flip-flop pulse on/off transistor Q1111 conducts turning off Q1114. The high voltage on the collector of either Q1108 or Q1110 through diode CR1112 or CR1113 and R1133 turns on Q1115. Operation of the on-off switch will now route a positive pulse through Q1113 to pull down the collectors of Q1108 and Q1110 and turn off the set. When the receiver is turned on locally, the pulse is routed through Q1112 to step directly into the medium volume state. The original S4201 is redesignated S4007 for local volume stepping.

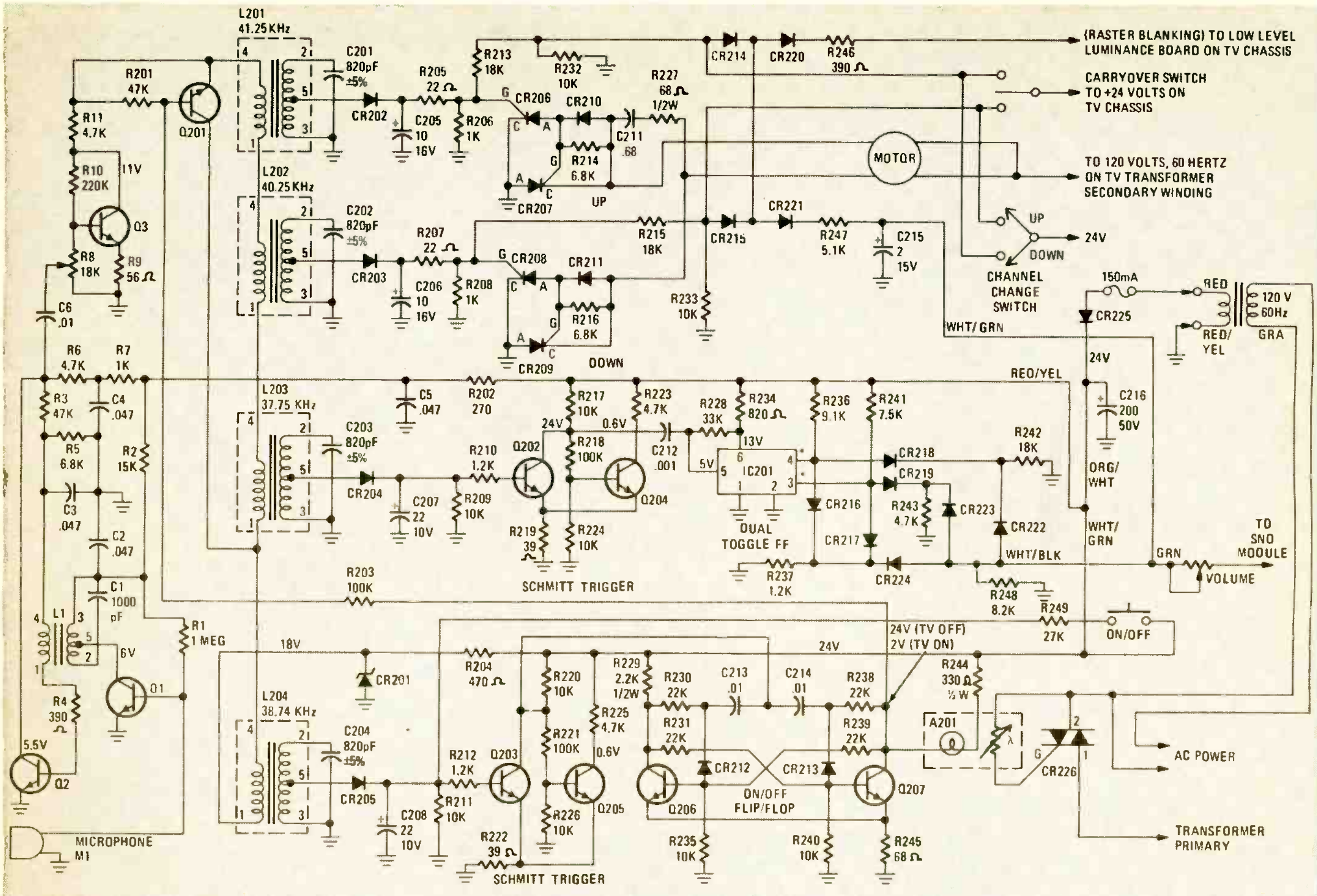


FIG. 4—FOUR-FUNCTION ZENITH SYSTEM is shown here. No battery power is used by the transmitter vibrator rod system.

Zenith has two systems

Three and four function remote systems are used by Zenith. They are quite similar with the four function system separating the on-off and volume functions. Fig. 4 is the four function remote schematic. Now used is an improved transmitter vibrator rod system not requiring battery power. The system can work in conjunction with a varactor tuning control center permitting any mix of uhf and vhf stations. Thyristor devices are used throughout for reliability; the only mechanical contact used is the carryover switch used to simultaneously control motor carryover, raster blanking and sound muting when between channels.

Channel up and down switching is done by the two pairs of SCR's CR206, CR207 and CR208, CR209. SCRs are used rather than triacs for motor control because of their higher turn-on sensitivity.

The four volume levels are selected by the dual flip-flop IC201 and its series of decoding diodes and resistors. In this respect the action is very similar to RCA's.

An on-off flip-flop is activated by a pulse from the collector of Q203 connected to the junction of C213 and C214. When the flip-flop is triggered on, Q207 conducts and the lamp of the photo/optical isolator A201 is lit, lowering the resistance of the light sensitive resistor, triggering on the triac and the AC power to the receiver. For manual on-off, the momentary contact switch feeds Schmitt trigger Q203, Q205 to switch the flip-flop.

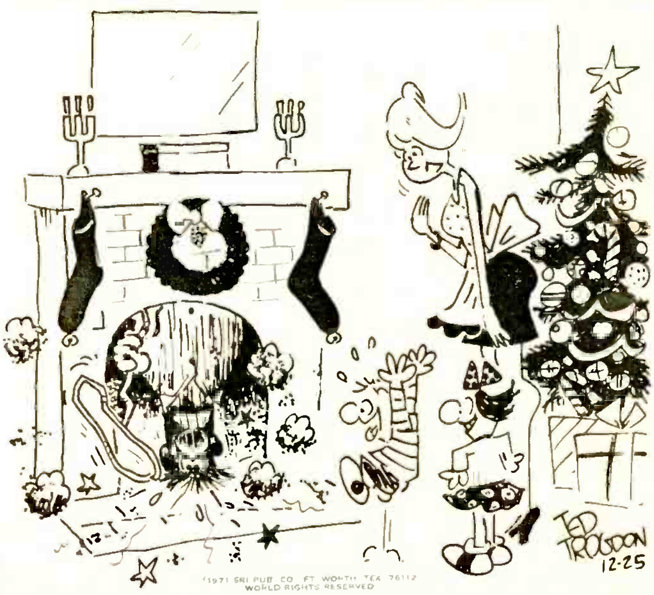
To insure that when the receiver is first plugged in or after a momentary power failure, the receiver remains off, the beta of Q206 is two to five times higher than the beta of Q207. Along with Q206's higher collector resistor, its resultant higher gain guarantees this transistor always turns on first.

Q201 is biased to allow response only to the on command when the set is off. With the set off, L201, L202 and L203 are shorted by the saturation resistance of Q201.

All but one of the systems described use memory flip-flops to store the system's past history. While the other systems use digital storage for simple functions, Panasonic's experimental system remembers its channel position as well by digital means. No doubt other manufacturers are working on similar systems using the multitude of inexpensive digital ICs on the market or with custom designs.

That's about all we have room for here, but we do have data on other remote control systems. These include Sylvania, Sharp and Panasonic. We hope to be able to present them soon. Sure to whet the appetite is the soon to emerge completely digital remote control systems that the industry has been talking about for the past several years.

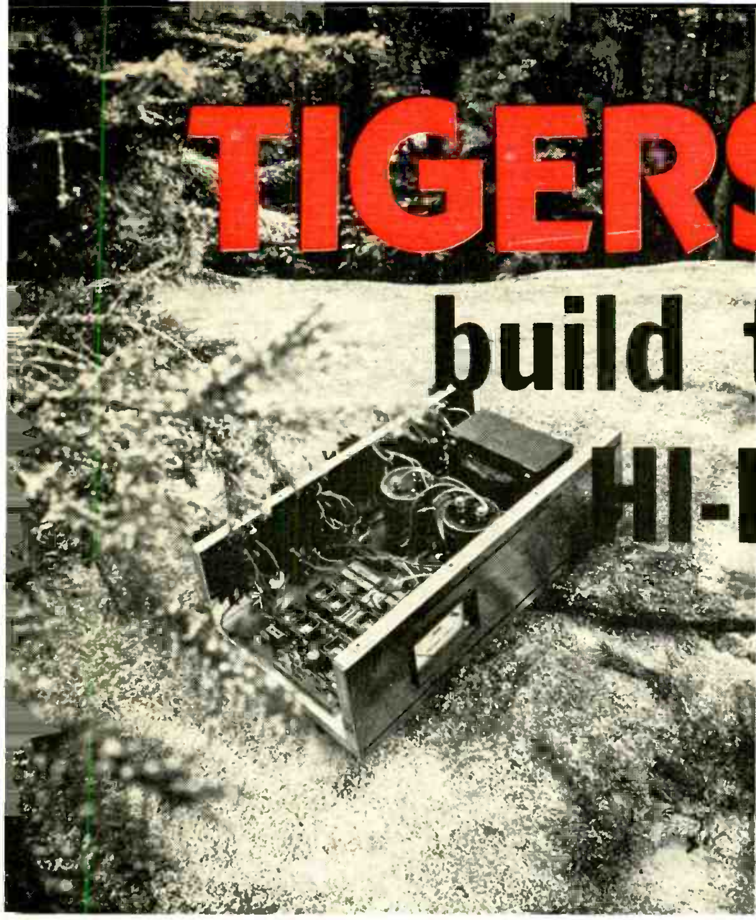
Look forward to seeing remote control announcements along the completely digital line in the next few years. **R-E**



"Hold it, children! That's not Jolly Old Saint Nick, it's Daddy falling down the chimney with the TV antenna."

TIGERSAURUS

build this 250-watt HI-FI amplifier



If you really need lots of power to get ear-splitting volume from an inefficient speaker system or sound for the local stadium, Tigersaurus may be for you.

by DANIEL MEYER

IF YOU OWN ONE OF THE NEW VERY low efficiency speaker systems, that requires enough power to run a small car; or if you must provide sound in a really large area then Tigersaurus "250" should interest you. True to it's name this amplifier produces beastly amounts of power. Power output is rated at a conservative 200 watts into an 8.0 ohm load and 250 watts into a 4.0 ohm load. Typical output at clipping is over 300 watts. A check of the specifications will confirm that Tigersaurus is also equal to, or better in performance than other amplifiers in this power class. The circuit features the same push-pull cross-coupled complementary system used in the Tiger .01 (**Radio-Electronics,** March-April, 1973). Volt-amp limiting type protection in the very robust output stage, with generous heat sinking per channel insures safe operation at any level. Chassis layout is clean and open, so construction is not tricky in any way. If you have always wanted to build a really BIG amplifier, Tigersaurus is for you.

The input circuit in this amplifier is nearly the same as that used in "Tiger .01". Figure 1 shows the basic input system used in these amplifiers. A complementary differential amplifier makes the amplifier push-pull from the input all the way through to the output. The emitters of the differential amplifier pairs are supplied current from a high-impedance current source. This, plus the Zener stabilized supply voltage used for the first two stages insures a very high degree of isolation from any hum, or noise on the supply lines.

Since the critical stages are regulated and isolated so well any type fancy regulation in the power supply is a waste. The supply can consist of a simple rectifier and capacitance filter. A 25-amp bridge is used for the rectifier to insure minimum loss at this point, while large 10,000-μF filters hold ripple down as much as possible at full power operation.

The second stage amplifiers Q4 and Q8 (Fig. 2) provide a current drive voltage to the output stages. Since the output stage operates at a gain of approximately four, emitter resistors for Q4 and Q8 can be made large enough to insure excellent stability in this stage. If the output configuration required a driving voltage equal to the sum of the supply voltages, as is often the case in quasi-complementary output circuits, the driving system would have to be operated at a higher voltage than the output stage, or a less desirable driver system of some type would have to be used. *Only* when the output stage is designed with some gain can you use a lower voltage on the drivers.

The lower driving voltage also is helpful in reducing problems with collector capacity that occur when very large voltage swings are required from the driver. Bias for the output stage is provided by the emitter-to-collector voltage drop of Q9. This voltage is set by trimmer R22. Diode D4 is physically mounted on the heat sink and changes in its voltage drop with heat sink temperature correct the bias voltage as the output stages change operating temperature. Q10 and Q11 are drivers for the output power transistors. In an output stage of this type having more than unity gain, you must use complementary output and driver stages.

There is no way to build this type output section with one polarity of power transistor. This somewhat limits your choice of output transistors to either single diffused, or epitaxial base power transistors. High-voltage triple-diffused power transistors are simply not made with pnp polarity. If you insist on using this type transistor then you are also committed automatically to a quasi-complementary system, high drive voltage, etc. even though you might not choose to do things this way.

Since single-diffused transistors are too slow to be considered for a wide-band amplifier, the only real choice is between the various epitaxial types. You can either use a high-voltage type, or stack lower voltage types to get the necessary voltage rating to handle the desired power. A quick look at the available transistors shows that you will have the same number of devices using either type, provided you want at least a 140-volt 30-amp output rating. Since the lower voltage, higher current types cost much less and since they also have a superior F_t, it should not take anyone more than a

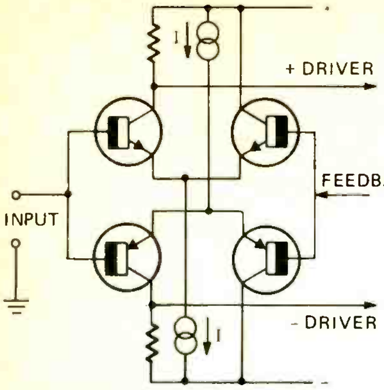


FIG. 1—BASIC INPUT CIRCUIT in a complementary differential amplifier with the emitters fed from constant-current sources.

few microseconds to make a choice.

The output stage then consists of a driven transistor and a slave stage whose only function is to sop up half of the voltage drop across the output stage and prevent exceeding the V_{ce} rating of any of the transistors. The two slave stages are Q16 and Q18 on the positive side and Q21 and Q23 on the negative side of the supply. They are driven by Q12 and Q13 respectively. Q12 and Q13 are biased at approximately half supply voltage by the resistors in their base circuit that connect from the output point to the two supply voltages.

Thus when the output has a signal voltage present the slave stages have one half of the supply voltage plus the signal swing present dropped across them. When the amplifier is driven to full output the slave stage and the driven stage divide up the total peak voltage of approximately 130 volts so that only 65 volts appears across either transistor. This gives a generous safety margin with the 90-volt output transistors that are used in this circuit.

The output transistors are paralleled with a total of eight being used in the output stage. This provides the amplifier with an output system having a 180-volt, 60-amp rating. Although this is far more than needed to give us 200 watts into an 8.0-ohm resistor, it is necessary if the transistors are to be reasonably safe from failure when driving a reactive load. It also makes it possible for the amplifier to provide clean power into a quite reactive load that would otherwise trip the protection circuits and cause distortion.

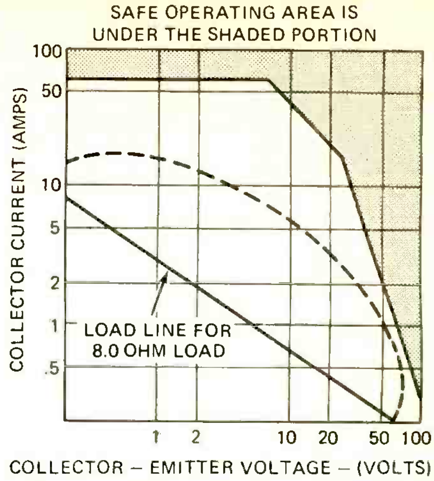
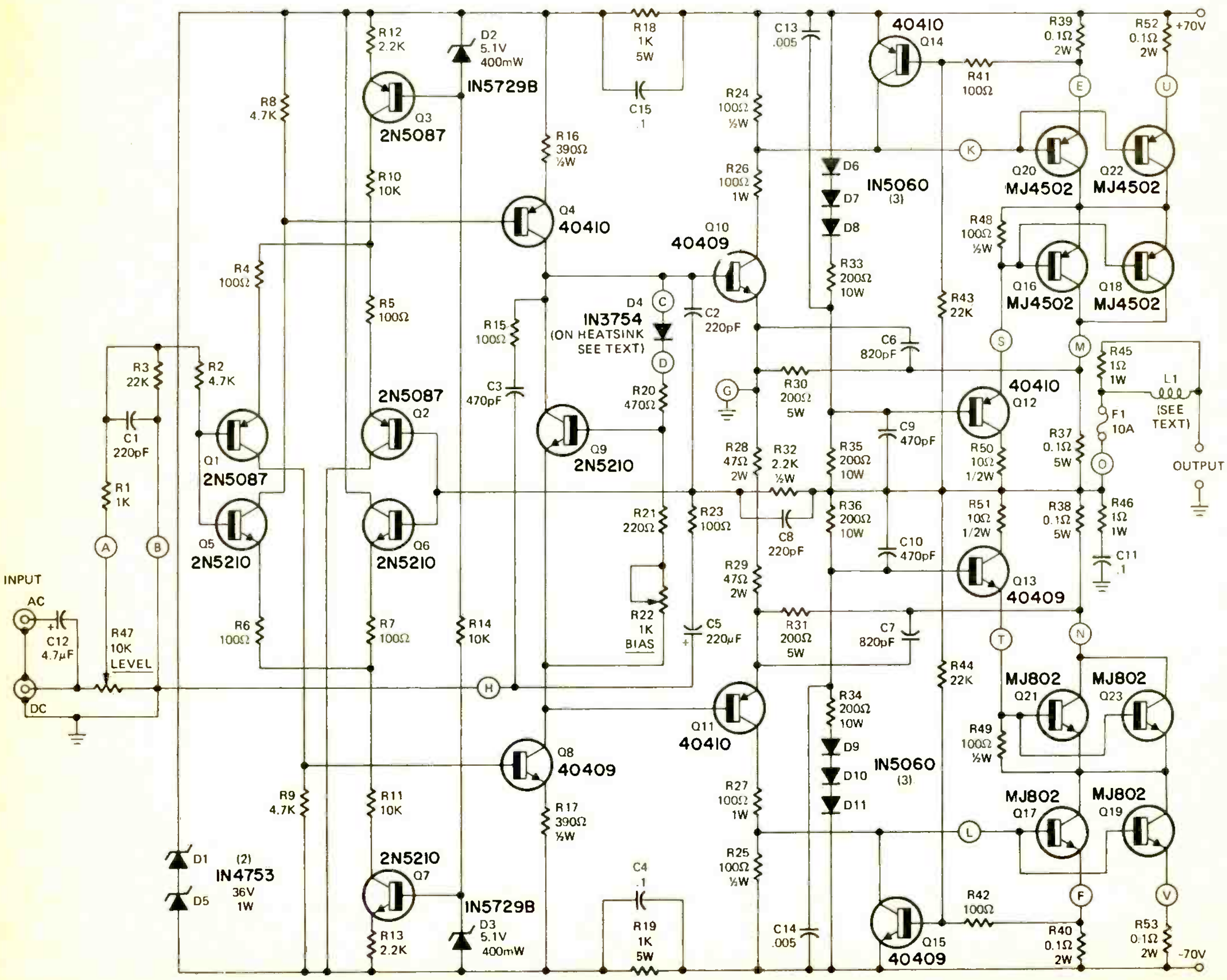


FIG. 3—RESISTIVE LOAD LINE is straight and becomes oval as reactance is added. Curve should not enter into shaded area.

Many present day speakers become quite reactive at the resonant point on the low end and at frequencies over 10,000 Hz, so this is not a minor consideration. It is quite possible to make a high power amplifier

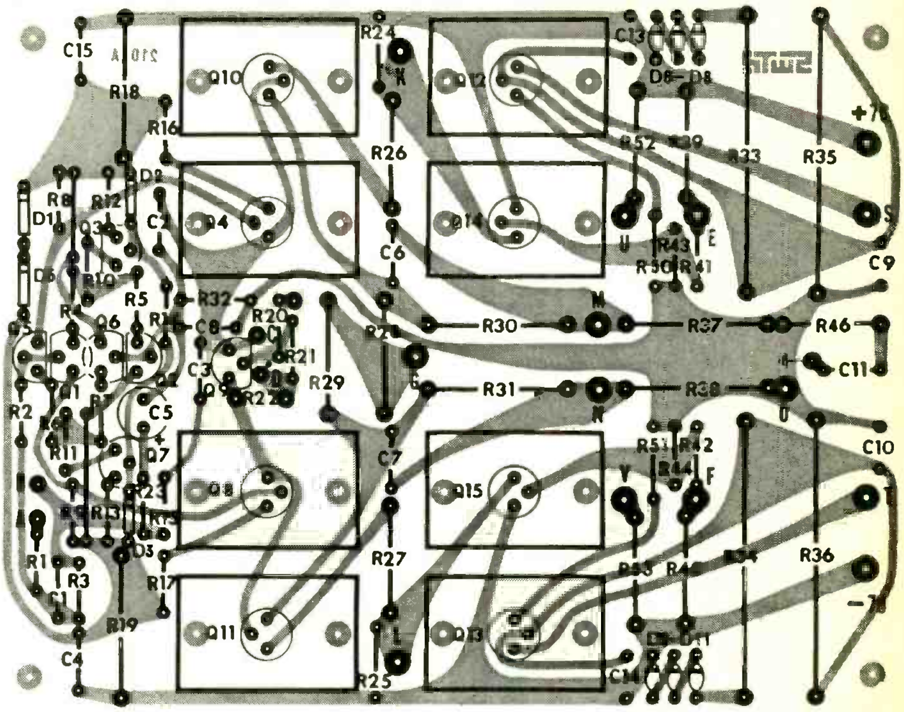
FIG. 2—COMPLETE SCHEMATIC of the amplifier. Single-ended input to Q1 and Q5 develops a push-pull signal all the way to the output.

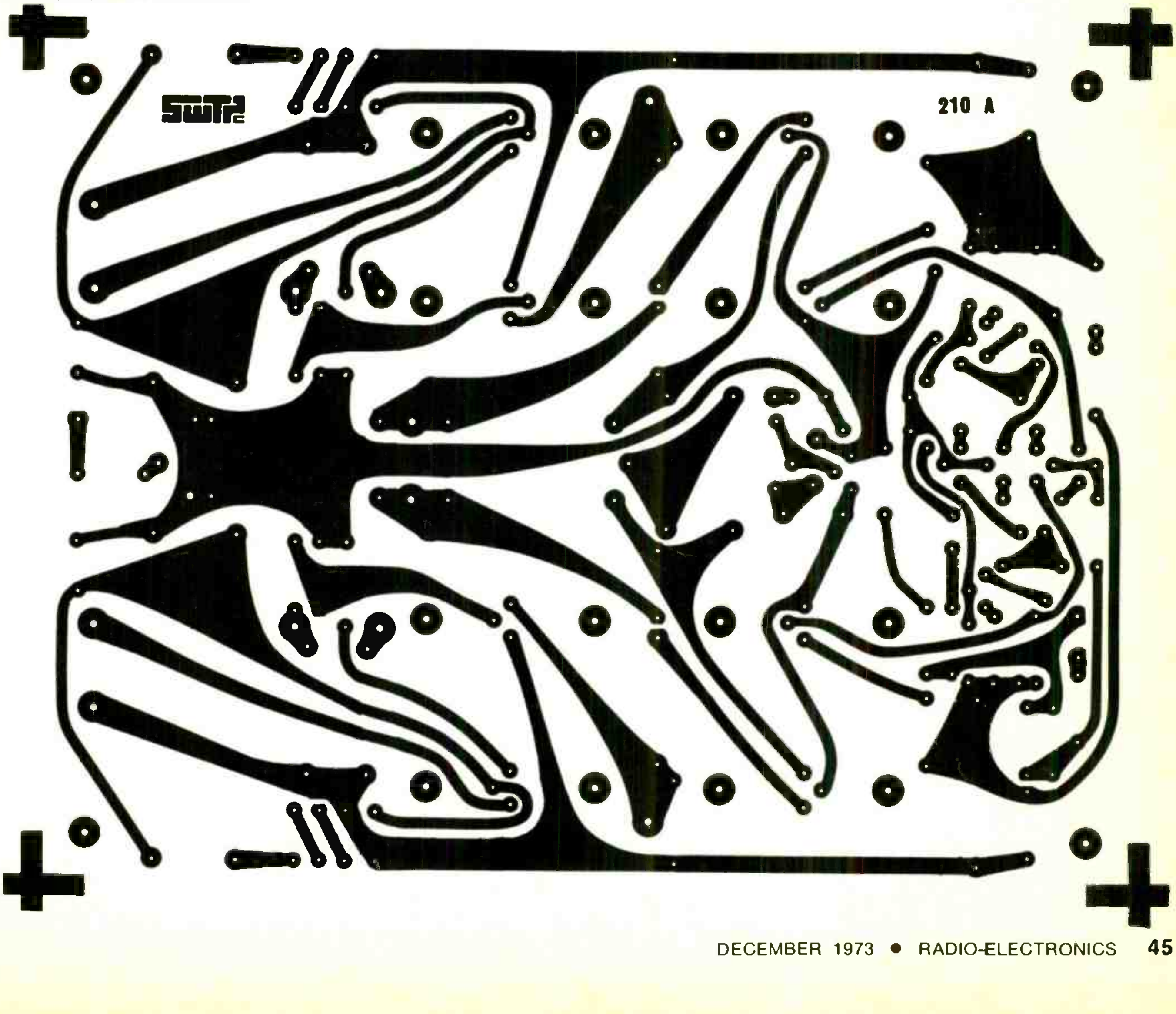


PARTS LIST

All resistors ¼-watt 10% unless noted
R1—1000 ohms
R2, R8, R9—4700 ohms
R3, R43, R44—22,000 ohms
R4, R5, R6, R7, R15, R23, R41, R42—100 ohms
R10, R11, R14—10,000 ohms
R12, R13—2200 ohms
R16, R17—390 ohms, ½W
R18, R19—1000 ohms, 5W
R20—470 ohms
R21—220 ohms
R22—1000 ohms, trimmer
R24, R25, R48, R49—100 ohms, ½W
R26, R27—1000 ohms, 1W
R28, R29—47 ohms, 2W
R30, R31—200 ohms, 5W
R32—2200 ohms, ½W
R33, R34, R35, R36—200 ohms, 10W
R37, R38—0.1 ohm, 5W
R39, R40, R52, R53—0.1 ohm, 2W
R45, R46—1 ohm, 1W
R47—10,000 ohms, linear taper potentiometer
R50, R51—10 ohms, ½W
C1, C2, C8—220-pF polystyrene
C3—470-pF polystyrene
C4, C11, C15—0.1-μF
C5—220-μF electrolytic
C6, C7—820-pF polystyrene
C9, C10—470-pF disc
C12—4.7-μF tantalum
C13, C14—0.005-μF disc
D1, D5—1NA753; 36-volt, 1W Zener
D2, D3—1N5729B; 5.1-volt, 400-mW Zener
D4—1N3754; temperature compensating
D6 thru D11—1N5060; silicon
Q1, Q2, Q3—2N5087 silicon
Q4, Q11, Q12, Q14—40410 silicon
Q5, Q6, Q7, Q9—2N5210 silicon
Q8, Q10, Q13, Q15—40409 silicon
Q16, Q18, Q20, Q22—MJ4502 silicon
Q17, Q19, Q21, Q23—MJ802 silicon
F1—10A
L1—6 turns of No. 16 insulated wire wrapped on the body of a power supply filter capacitor.

FIG. 4 (bottom)—FULL-SIZE PATTERN for the amplifier circuit board. FIG. 5 (below)—LOCATION OF PARTS ON THE CIRCUIT BOARD. The MJ4502 and MJ802 power transistors are on heatsinks mounted on each side of the rear of the chassis as described in text.





which tests beautifully on a resistive load, but which cannot provide enough power into a slightly reactive load to match much lower rated amplifiers. Figure 3 shows the resistive load line of the Tigersaurus "250" and the dc safe operating areas of the output stage. If the load becomes reactive then the load line becomes eliptical as indicated by the dashed line. As you can see, in this case there is considerable margin for operation into a reactive load before the boundaries of the safe operating area are exceeded.

In a properly designed amplifier the protection circuits will prevent operation outside the safe areas, but although this will prevent destruction of the output transistors, it does cause distortion when the protection circuits are put into operation. A rough check of the amount of useful power that can be expected from a transistor power amplifier can be made by determining how much current can be safely drawn by the transistors when subjected to peak output voltage. For equal power output ratings, the one with the largest current rating at peak voltage swing will be the amplifier with the best margins for reactive loads. It will be less likely to introduce curious little distortions when driven hard. You will not be faced with the decision of either having distortion, or getting the power.

The protection circuit in Tigersaurus consists of transistors Q14 and Q15. These transistors monitor the current through the emitter resistors R39 and R40 and also the voltage level at the output of the amplifier. If the current, or the voltage, or a combination of voltage and current exists that would cause the output stage to operate outside the safe operating area for this device the protection transistor goes into conduction and bypasses enough of the drive current going into the base of the driven output transistor to keep operation within the desired safe area.

The protection transistors can operate almost instantly since there are no capacitors to charge, or other reactances in the protection system. They clamp the output cleanly and with no bursts of oscillation when they go into operation. This is possible because the design of the output stage provides limiting resistance automatically for both the driver and the protection transistor. Resistors R28 and R26 on the positive side of the circuit and R27 and R29 on the negative side limit the maximum driver current to slightly more than 1 amp under any conditions. The less gain enclosed by the protection circuit loop, the less chance for oscillation and the more gradual will be the transition into the clamped, protection mode of operation. This more gradual clamping action produces fewer distortion products and is a bit less obnoxious in its effect than sudden sharp clamping action.

Phase compensation of the amplifiers response is provided by C1, C2, C3, C8 and C11 in combination with R1, R15 and R46. This controls the high frequency gain of the amplifier and insures stable operation with the negative feedback loop connected. The metering circuit (Fig. 6) is well isolated from the amplifier output by the resistor in series with the meter rectifier, and has no effect on performance. The meter is calibrated to read in percent of full output.

Construction is quite straightforward. The full size circuit board pattern (Fig. 4) and parts location (Fig. 5) help keep it simple. The heat

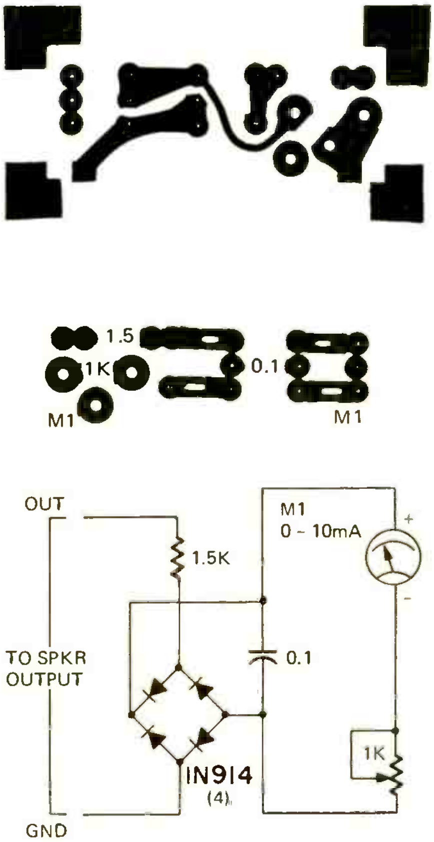


FIG. 6—THE METERING CIRCUIT PC board pattern with the schematic diagram below. Meter reads percent of full output.

sinks (8 of them) are "Wakefield" type 641K drilled so that they may be mounted back-to-back on each side of the rear of the chassis. Two transistors are mounted on each heat sink and are insulated from the heat sink with mica washers. Base and emitter pin connections may be soldered, or pin connectors may be used if desired. The connection from point **O** to the output jacks must be made with at least a 20-gage wire, since up to 12 amps can flow through this circuit. L1 is formed by winding the wire around the bottom of the filter capacitor can nearest the rear of the chassis five times.

The only connection to the chassis should be at the input ground. All other grounds should be made to a heavy bus wire connecting the common sides of the two filter capacitors. These include the output ground jack, point **G**, etc. This will insure that you will have no hum producing ground loops, or oscillation producing common impedances.

After construction is completed, the circuit should be tested in stages to insure that any problems, or errors are found and corrected before they can do serious damage. Test the power supply first (Fig. 7). Disconnect the +70 and -70-volt circuits from the amplifier and measure from each filter capacitor terminal to common. The meter should show an initial low reading which should increase as the filters charge.

If this looks okay, plug the line cord in and measure the voltage at the filters. You should have approximately +75 and -75 volts dc. If this is right pull the plug and allow the filters to discharge, or discharge them by putting a 1k resistor across each one for a few seconds. Now connect the supply to the amplifiers circuit board. Leave the power transistors disconnected. DO NOT connect points **K, L, T** or **S;** or either supply voltage to the output stage as yet.

Turn trimmer R22 to maximum resistance and apply power to the board. First measure the voltage at point **O.** It should be no more than +1V, or -1V. Now measure the voltage *across* (not to ground) R24 and R25. You should have less than 0.6 volt across either resistor. If you have a large reading on either one, or both

SPECIFICATIONS—TIGERSAURUS "250"

Power Output—200 watts 8.0-ohm load
250 watts 4.0-ohm load
300 watts typical at clipping

Distortion—Less than 0.2% up to full rated output

Frequency Response—3 dB down at 5 Hz and 400,000 Hz

Hum and Noise—more than 90 dB below full output.

Sensitivity—2.0 volts rms in for full 250-watt output

Damping Factor—Greater than 100 with 8.0-ohm load, 20–20,000 Hz.

Size—17¾ x 10¾ x 5 inches

Weight—28 lbs

Power Required—120 Vac @ 5 amps or 240 Vac @ 2.5 amps check for problems in the bias system. Typical would be a reversed D4. If bias voltage from base to emitter of Q9 is normal—not over 1.5 volts dc—check for missing ground connections at the input point **B**, or at point **G**, or possibly between the supply common and the input jack.

Once you have normal operation to this point, check points **S** and **T** for +37 and -37 volts respectively. If all of this looks normal take a deep breath and connect your output stage. Double check to be sure you don't have shorts from any case to the chassis. *Be absolutely sure that all wiring is as shown in the schematic. A mistake here can cost you eight rather expensive output transistors. $40 to $50 worth of parts is nothing to be careless with.*

If you are not the "hero" type you might want to put a 1k limiting resistor in series with R39, R40, R52 and R53 the first time you apply power to the complete circuit. These will possibly prevent disaster if all is not well after all. Once you have the limiting resistors in place, apply power to the amplifier and quickly measure the voltage drop across the added 1k resistors. It should be less than 5.0 volts and in most cases will be near zero if operation is normal. You should be able to increase the voltage across the resistors by advancing the bias trimmer.

Now remove the resistors and connect the emitters directly to points **E, F, U** and **V.** Put the bias trimmer back at maximum resistance. Turn the amplifier "on" and check for a near zero dc reading across the output jacks. If you get any reading on the output meter, you have oscillation problems and should turn the amplifier off as quickly as possible.

If everything looks "go" connect an oscillator and a load resistor. Turn the level control up until you get a 40-volt rms output at 1,000 cycles across that 8.0-ohm load resistor. Turn the calibration trimmer on the meter to get a reading of 100%. Now reduce the output to something in the order of 2 or 3 volts rms and switch the oscillator to 10,000 cycles. Adjust the bias control for a smooth crossover. Don't overdo it, or your idle current will be excessive. This adjustment may also be made more exactly with an IM analyzer if you have one, or can get the use of one. Just set the control for minimum IM at an output level of 1 to 3 watts. Stop when the reading will not drop any further with continued rotation of the bias trimmer.

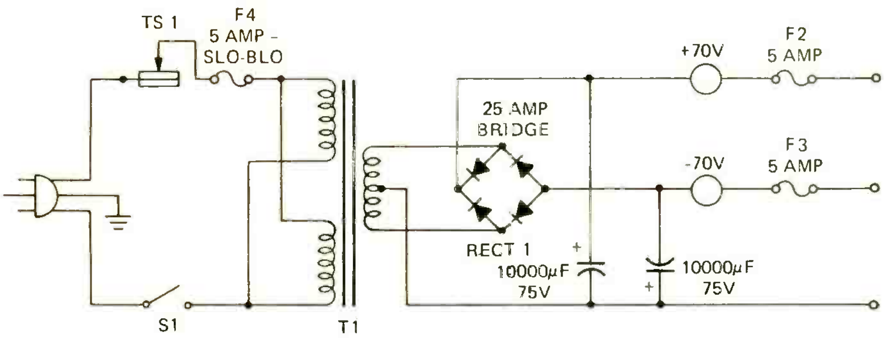
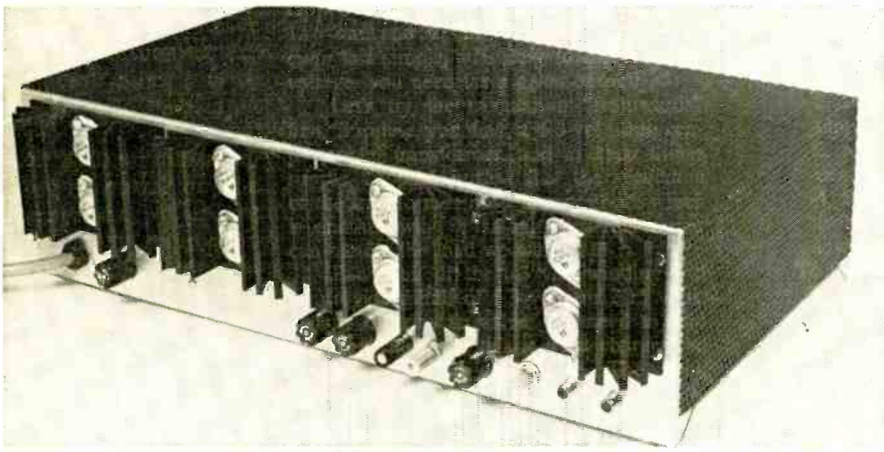
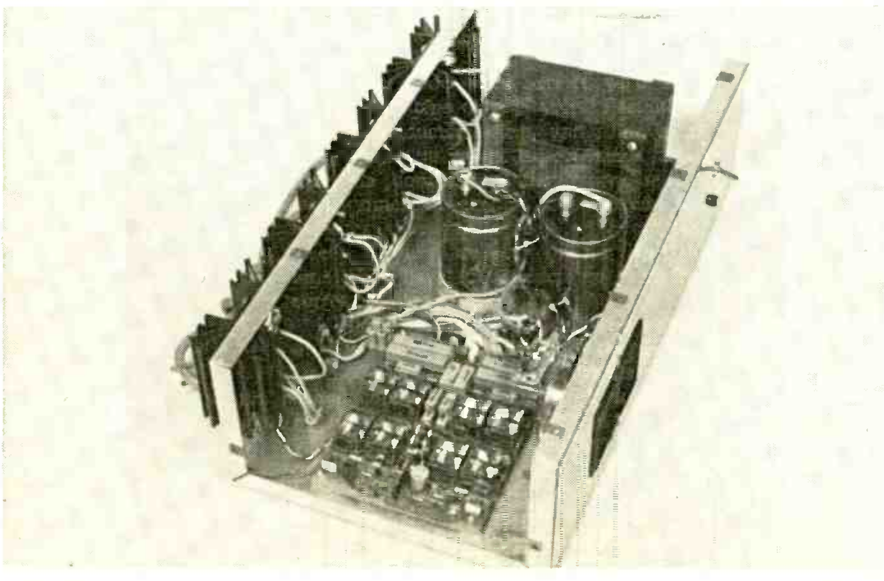


FIG. 7—POWER SUPPLY CIRCUIT. The power transformer shown has dual primary windings for use on both 120- and 240-volt ac lines. Positive and negative voltages are supplied.





The following parts are available from Southwest Technical Products, 219 West Rhapsody, San Antonio, Texas 78216.

Circuit board; etched and drilled. $5.50 postpaid.

Power Transformer. $30 plus postage and insurance (22 pounds).

Complete kit of all parts. $150 plus postage and insurance (28 pounds)

THE TWO PHOTOS on the left show the rear and interior of Tigersaurus. Note that each of the power transistor heat sinks consists of two assemblies bolted back to back. If you skimp on these heat sinks the power transistors will overheat and burn out.

NOISE IN GE "PORTA-FI"

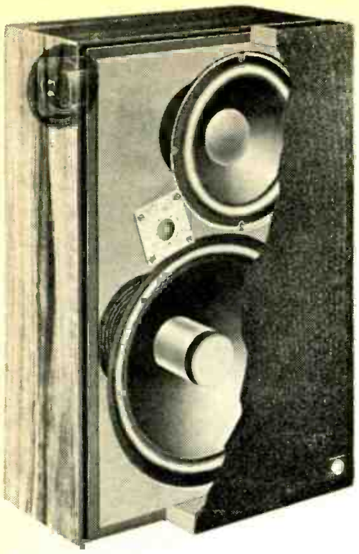
They brought in a GE receiver unit, and called it a "Porta-Fi". Works with a big console stereo, and picks up the music, etc. Never ran into one before.

Anyhow, it works, but it's very noisy. Has a loud harsh buzz. Turn volume down, no buzz. I'm puzzled.—J.M., Donora, Pa.

Un-puzzle. This is a "carrier-current" device, like a wireless intercom. The transmitter, in the console, generates a low-frequency rf signal, which is carried to the receiver over the ac power lines. Works on one of two channels, 250 or 300 kHz.

Your buzz could easily be unfiltered fluorescent lights, or SCR light dimmers, etc. Turn them off and see if this stops the noise. If so, filter *them*, not the receiver unit.

Alternative: the receiver unit may not be correctly tuned to the transmitter. Normally, the receiver should "quiet" with a strong carrier.



2 New HI-FI Speaker Systems

New innovations, embodying standard physics principles, are used in the development of two new speaker systems that feature exceptional low-frequency response for their small size

THE OLD SAW ABOUT "NECESSITY" being "the mother of invention" is particularly applicable in the realm of high-fidelity music reproduction. In the one-speaker-system era of mono, serious listeners who had no objection to using massive loudspeaker enclosures which were highly efficient, capable of good bass reproduction, and easily driven to loud sound pressure levels with 10- or 12-watt vacuum tube amplifiers.

Increased acceptance of stereo in the early 1960's (and its attendant requirement for *two* speaker systems) clearly spelled the doom of the 10-cubic foot floor-standing speaker enclosure as a viable stereo sound producer in the "average" living room. Smaller, vented enclosures, followed by still smaller sealed enclosures utilizing the so-called "acoustic suspension" or "air suspension" principle for bass reproduction gained popularity along with two-channel listening.

The inefficiency of these bookshelf systems was immediately recognized as a problem that amplifier designers would have to solve. Small sealed enclosures required considerably more power input to achieve acoustic sound levels equal to those delivered by their large predecessors. Happily, designers of power output transistors were then producing devices of ever increasing reliability and power dissipation capability. Before long, power amplifiers and receivers of 50, 75 and even higher output watts per channel became the rule rather than the exception in high-quality component systems.

Today there are solid-state amplifiers which can safely deliver 300 or more watts of continuous audio power per channel—and there are speaker systems which not only can *withstand* such levels of power input but actually require that kind of power to produce the ear-shattering discotheque levels demanded by a great many listeners. Such amplifiers are, however, quite expensive. Amplifier prices generally increase linearly along with power output capability.

Now we are faced with four-channel sound and a whole new set of aesthetic and economic considerations. With *four* loudspeaker systems now needed in the listening room no one is inclined to revert to large speaker systems for the sake of efficiency. On the other hand, quadriphonic amplifier and receiver manufacturers are faced with a very real pricing problem. To include four channels of amplification, *plus* matrix decoding circuitry (usually more than one kind), *plus* CD-4 discrete disc demodulating circuitry, *plus* front panel controls needed for convenient selection and adjustment of the new surround sound—all at a selling price that would not discourage prospective buyers—meant that something would have to give. Looking at the first quadriphonic amplifiers and receivers to be marketed it is clear that that "something" is power output per channel.

Speaker designers and manufacturers were quick to recognize the emerging dilemma. Many have already come up with solutions in the form of small, but efficient enclosure designs and more are sure to follow. Two new approaches to the problem of bass audio reproduction will be examined here.

The BIC Venturi speaker systems

BIC, for the benefit of the uninformed, stands for British Industries Company, the people who are perhaps best known for their U.S. distribution of British-made Garrard automatic turntables. Venturi, on the other hand, was an 18th century Italian scientist who discovered a principle of gas and fluid flow in the late 1700's. The principle itself is quite simple and has been used for many years to control and measure liquid and gas flow. The carburetor in your car probably uses a Venturi tube.

When a fluid or gas, moving at low velocity in a relatively large cubic enclosure is channeled into a constricted cubic volume, its velocity increases. Specific formulations of this principle have been applied to the problem of bass reproduction in the three introductory models of the BIC Venturi Speaker Systems. Figure 1 illustrates the principle diagramatically. The relatively large volume of air in the chamber directly behind the speaker element is activated by the motion of the speaker cone. At very low frequencies the ability of the speaker element to move this large volume of air is restricted and the air velocity in that chamber is relatively low. As the air moves around the curved structure and into the constricted Venturi path, its velocity increases markedly. The curvature leading to the path, the size and suspension of the speaker, the cubic volumes of the large chamber and the constricted path are all mathematically interrelated.

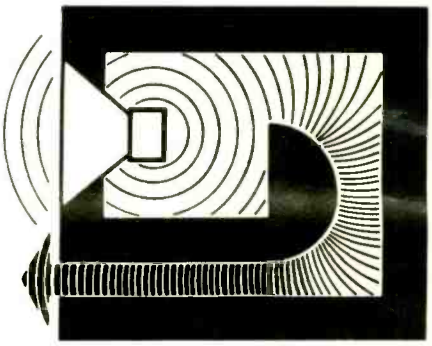


FIG. 1—VENTURI PRINCIPLE applied to sound reproduction. The action differs from that in conventional ported or vented enclosures.

At first glance this approach would seem to resemble other types of "ported" or "vented" enclosures (bass-reflex, ducted bass-reflex, etc.), but there are two important and fundamental differences. A classical bass re-

by LEN FELDMAN
CONTRIBUTING HIGH-FIDELITY EDITOR

flex enclosure uses a "tuned port"—an opening which, in conjunction with the total resonance, tends to use the "back wave" produced by the motion of the speaker cone to reinforce the front-radiating sound waves over a relatively narrow band of frequencies—usually at or slightly below the self-resonant frequency of the loudspeaker itself. The effect is one of *resonant* reinforcement, and its useful range is determined by the "Q" of the system, the self-resonance of the entire enclosure and other parameters.

In the case of the BIC Venturi systems, the enclosure itself is designed to be resonant well below the lower frequency limits of audibility. Bass reinforcement emanating from the Venturi opening, seen in Fig. 2,

FIG. 2—PARTIAL FRONT VIEW of BIC Venturi Formula Six, with foam grille removed. Venturi opening can be seen at bottom of the enclosure.

extends over a fairly broad range of frequencies and sound pressure levels at the opening are much greater than those observed from the direct radiating cone of the speaker element. Scope photos of the output of a microphone held in front of the speaker and at the Venturi opening are reproduced in Fig. 3. Note, that in addition to having low amplitude, the waveform seen at the front of the cone is somewhat distorted. The frequency used was 23 Hz—well below the ordinary capability of the 12-inch driver to produce fundamental tones free of "doubling".

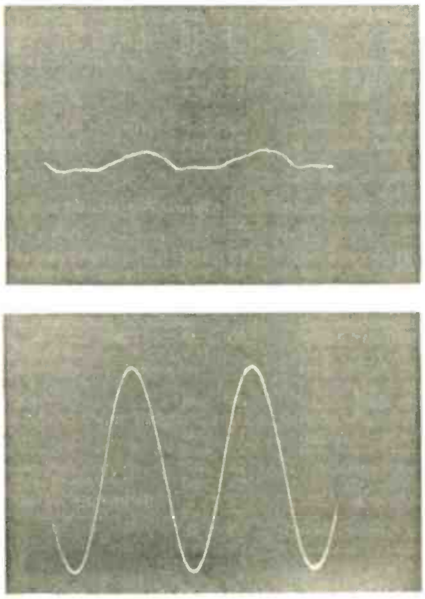


FIG. 3—MICROPHONE HELD IN FRONT of direct-radiating speaker (a) picks up low-amplitude, distorted waveform when 23 Hz is applied to the BIC Venturi Formula 6 system. Microphone held at Venturi opening (b) under same conditions picks up high-amplitude waveform that is sinusoidal and distortion free.

The waveform observed coming from the Venturi opening itself, besides being much greater in amplitude (actually about 20 dB greater), is free of this distortion. Thus, in addition to the "step-up" action of the Venturi structure, the Venturi acts as a mechanical low-pass filter. To illustrate this point, suppose for example that the Venturi structure becomes effective at a frequency of approximately 65 Hz, and that it's response curve is that shown in Fig. 4. Suppose, further, that the waveform in Fig. 3-a contains 10% distortion—primarily third harmonic (69 Hz). At 23 Hz, the sonic contribution of distortion-free energy coming from the Venturi opening is 20 dB greater than that coming from the speaker cone itself.

Thus, in terms of total sound pressure heard by the listener, the distortion contribution of the direct-radiating sound is only 1% (1/10th of the total). Lower roll-off of the Venturi response depends, of course, upon size of cabinet, diameter of the woofer, and the calculated Venturi path but it can be expected to extend at least one full octave below what might have been expected from a conventional, sealed enclosure. The increased efficiency over the Venturi range of frequencies can be matched by using more efficient, stiffer-suspension woofers in the systems, since this principle does not require the soft-suspension

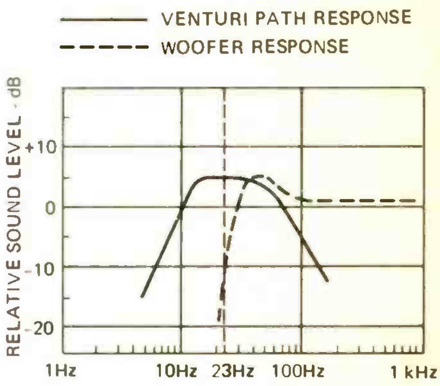


FIG. 4—LOW-PASS FILTER ACTION of Venturi system.

types of drivers normally associated with smaller enclosures.

Dimensions of the largest of the three models (the one used for the scope photos) are 25⅞" x 15½" x 15¾" deep and it is called *Formula 6.* Smaller models, *Formula 4* and *Formula 2,* measure 25" x 13¼" x 13" deep and 20" x 12" x 11½" deep, respectively. All systems contain a newly developed mid-range horn, constructed of sonically inert material, that handles frequencies from about 1000 Hz to 15,000 Hz and a super-tweeter which takes care of that last important octave from about 15,000 Hz to 23,000 Hz. Efficiency of the systems is anywhere from 3 to 10 dB greater than most popular bookshelf enclosures and about 2 dB greater than relatively efficient bass reflex designs. If these numbers are not, of themselves, impressive, remember that a 3-dB increase in sound pressure level in a given speaker system requires a doubling of amplifier input power, 6 dB is a four-to-one change in power, etc. All three models are shown with foam grilles in place in Fig. 5.

Electro-Voice Interface: A

Electro-Voice Company, one of the "old timers" in the loudspeaker business, has come up with a small enclosure design which is down only 3 dB at 32 Hz. Dimensions of the enclosure are 22" x 14" x 7¾" deep—which adds up to about 1¼ cubic feet of volume on the inside of the box. As Electro-Voice is quick to point out in their very complete piece of literature describing the new system, "vented" systems are nothing new and have been and are used in a variety of ways, most popular and familiar of which is the "hole-in-the-box" classical bass reflex enclosure. Studies made by E-V engineers led them to conclude that, if all other things are equal, a vented box design (compared to a sealed box) can provide any one of the following:

(1) One half octave more bass, (2) 4 dB greater efficiency, or (3) an enclosure size one-third as large. Rather than choosing one of these advantages, E-V chose to design a little of each into the *Interface: A*. Thus, the final design offers ⅓ extra octave of bass, 2 dB greater efficiency and half the enclosure size that would be required in a sealed box design.

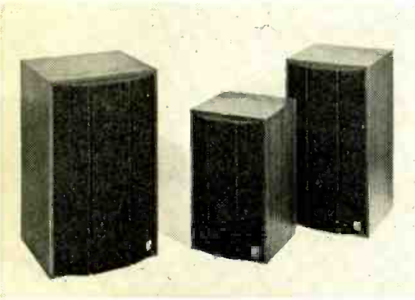


FIG. 5—ALL THREE BIC VENTURI speakers use the Venturi principle to increase the efficiency of bass reproduction.

Where's the vent?

If you remove the grill from in front of an *Interface: A* (Fig. 6) you won't see any "opening" or hole at all. As E-V points out, the smallest usable hole required to tune this small box to 32 Hz would require a duct several feet long. What looks like a 12-inch woofer in the photo of Fig. 6 is really not a woofer at all. It has no voice coil and no magnet and is, in fact, a 10-inch diameter piston with a centrally mounted steel tube, the combination of which serves as the mass equivalent to the amount of air that would have been required to reach 32-Hz tuning. E-V calculated that a real vent of this diameter would have had to be 20 feet long!

FIG. 6—LARGE "WOOFER LIKE" RADIATOR serves as an equivalent "vent" in the new Electro-Voice Interface: A speaker system.

This piston is, in every sense of the word, a low-frequency radiator but, because it has no voice coil or magnet, only the suspension non-linearities of the device contribute to distortion at low frequencies, and these are relatively low and easy to avoid compared to distortion contribution of voice coil motion and magnetic flux variation with increased woofer excrusion in conventional radiators. E-V claims a distortion figure of only 1% at 32 Hz with full power input—a figure that is considerably lower than one might expect from sealed enclosures.

The rest of the spectrum

The primary tweeter used in the *Interface: A* incorporates a 2-inch diameter piston with a 5-inch diameter aluminum dome. You cannot see it in the photo of Fig. 6 because it is mounted behind a square of felt with a hole in it. Tweeter output radiates through foam and felt squares to maximize dispersion as frequency increases. In effect, the tweeter size is reduced above about 5000 Hz so as to maintain high dispersion, whole the entire piston area radiates at lower frequencies enabling the tweeter to be used down to 1500 Hz.

A second tweeter, located on the rear of the enclosure, operates above 7000 Hz and is said to maintain constant acoustic power in the upper octave of the system. E-V maintains that, unlike other rear-radiating designs, placement of the system is not critical.

Accessory equalizer

A separate equalizer is supplied with the *Interface: A*. As you will recall, frequency response of the unequalized system is down about 3 dB at 32 Hz. Since this is a relatively small amount of roll-off, E-V felt that a moderate amount of external bass-boost equalization could, at once, restore flat response to the system without making undue demands upon the driving amplifier and, at the same time, provide desirable roll-off of the amplifying system below the useful range of the system and help to eliminate unwanted rumble from turntables, etc. The low-frequency characteristic of this separate equalizer (which is installed at the tape monitor jacks or between amplifier and preamplifier on "separates") is plotted in Fig. 7, and, as you can see, its addition to the system results in uniform response down to 32 Hz.

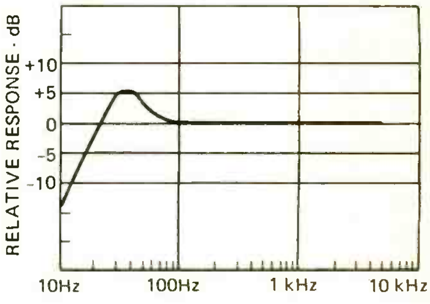


FIG. 7—RESPONSE OF AUXILIARY equalizer of E-V Interface: A at low frequencies restores uniform power output down to 32 Hz.

Having decided to "trim" the system with an external equalizer, E-V has also provided three switch-selected positions of equalization for the high-frequency end of the system, thereby eliminating the sometimes troublesome "tweeter control" often incorporated in the cross-over networks of many speaker systems. Frequency re-

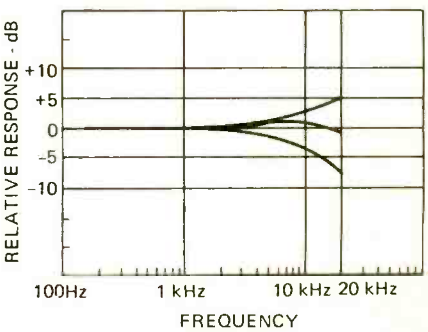


FIG. 8—SEPARATE EQUALIZER supplied with EV Interface: A offers three high-frequency response settings.

(continued on page 90)

10 Ways To Use Your VECTORSCOPE

The ten tests spelled out in this article, for low-level circuits, are illustrated with six vectorscope displays showing correct demodulation

by ROBERT G. MIDDLETON

THERE IS NO SHARP DIVIDING LINE BEtween low-level and high-level chroma circuits. We generally regard driver stages as low-level signal points, and output stages as high-level signal points. For example, we think of the demodulators as operating at low level, whereas the R–Y, B–Y, and G–Y amplifiers operate at high level. We define the input circuits of these chroma amplifiers as low-level points, and their output circuits as high-level points. (The input circuits of the color difference amplifiers are the same as the output circuits of the demodulators.) In a given example, the input circuit of the R–Y amplifier may operate at approximately 6 volts peak-to-peak, and its output circuit at 100 volts peak-to-peak.

A signal level of 100 volts peak-to-peak is ample to drive a conventional vectorscope,[1] in which the test signal is coupled directly to the deflection plates of the CRT. But a signal level of 6 volts peak-to-peak requires amplification for satisfactory deflection on the CRT screen. There is a definite trend toward vectorscopes with built-in vertical and horizontal amplifiers, so that vectorgrams can be displayed in low-level chroma circuits. Modern vectorscopes have identical vertical and horizontal amplifiers, so that no phase error is produced in the display. Vertical and horizontal low-capacitance probes are also provided, to minimize chroma-circuit loading.

Test Procedures

1. X and Z demodulator outputs

Equipment: Vectorscope, keyed rainbow generator.

Connections: Connect equipment as shown in Fig. 1.

Procedure: Adjust vectorscope controls to obtain a vectorgram display like that in Fig. 2.

Evaluation: Observe the vectorgram for X and Z peak-to-peak voltages (vertical and horizontal amplitudes) as specified in the receiver service data. Inspect the pattern for symmetry (freedom from overloading or nonlinear circuit action). Note the demodulation phase angle, as shown in the ellipticity of the pattern.

Note 1: Observe in Fig. 2 that the horizontal-blanking interval appears at the upper right-hand part of the vectorgram. This is due to the 180° phase change in the chroma signal from grid to plate of a tube, or from base to collector of a transistor. Compare the display in Fig. 2 with the phase relations shown in Fig. 3. In the example of Fig. 2, the demodulation angle is 120°. (Fig. 4 depicts a 120° ellipse in comparison to a circle.) The XZ demodulation arrangement is not a quadrature (90°) system. Various XZ designs employ demodulation angles from 105° to 130°.

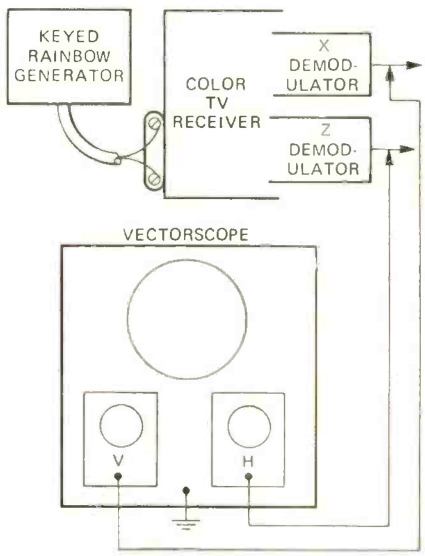


FIG. 1—EQUIPMENT AND CONNECTIONS used in the ten vectorscope demodulator checks.

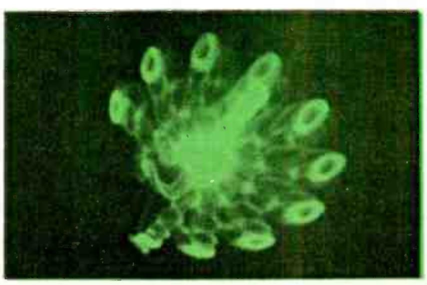


FIG. 2—XZ DEMODULATOR VECTORGRAM

2. X and Z demodulator outputs prior to filtering

Connections: As in Test Procedure 1, except that the vectorscope probes are applied at the input ends of the demodulator filters (Fig. 5).

Procedure: Adjust vectorscope controls to obtain a vectorgram display like that in Fig. 6.

Evaluation: We observe that the pattern has the same general characteristics as displayed in Fig. 2. However, the vectorgram in Fig. 6 includes various small loops, due to

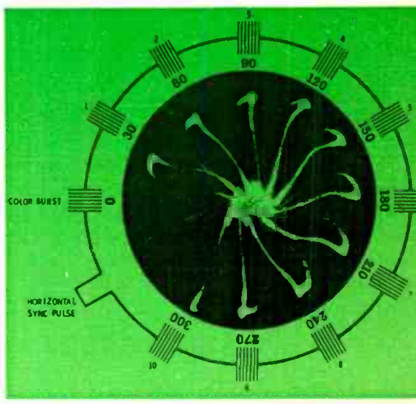


FIG. 3—VECTORGRAM WITH SIGNALS shifted 180° in phase from pattern of Fig. 2.

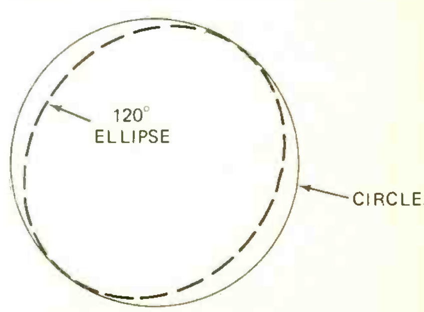


FIG. 4—COMPARISON of ellipse and circle.

chroma-demodulation byproducts that have not been filtered out.

3. R and B color demodulator outputs

Connections: Connect equipment as shown in Fig. 1, except that you are connecting to red and blue color demodulators.

Procedure: Adjust vectorscope controls to obtain a vectorgram display such as illustrated in Fig. 7.

Evaluation: Observe the vectorgram for R and B peak-to-peak voltages

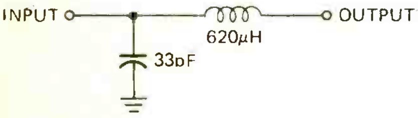


FIG. 5—TEST PROBES are applied at the input end of the filter in Test Procedure No. 2.

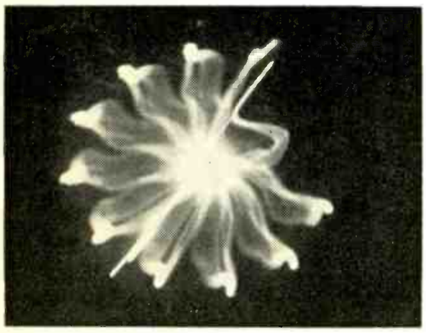


FIG. 6—XZ VECTORGRAM of signal taken off before the chroma demodulator output filter.

(vertical and horizontal amplitudes) as specified in the receiver service data. Inspect the pattern for symmetry (freedom from overloading or nonlinear circuit action). The demodulation phase angle is normally 120°, as seen from Fig. 8. That is, demodulation is along the red and blue axes. In turn, the vectorgram normally has the eccentricity shown in Fig. 4.

Note 2: If the chroma-demodulator output voltages are not specified in the receiver service data, it may be possible to make a comparison check against a similar receiver which is known to be in good operating condition.

4. B and G color demodulator outputs

Connections: Connect equipment as shown in Fig. 1, except that you are connecting to blue and green color demodulators.

Procedure: Adjust vectorscope controls

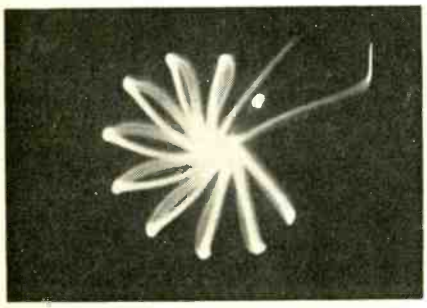


FIG. 7—RB DEMODULATOR VECTORGRAM.

to obtain a vectorgram display like that illustrated in Fig. 9.

Evaluation: Observe the vectorgram for correct peak-to-peak voltages. Note from Fig. 8 that the normal demodulation phase angle for a B and G vectorgram is 105°. In turn, the eccentricity of the vectorgram is half-way between the circle and the 120° ellipse depicted in Fig. 4. Note in the example of Fig. 9 that the pattern is not symmetrical. When

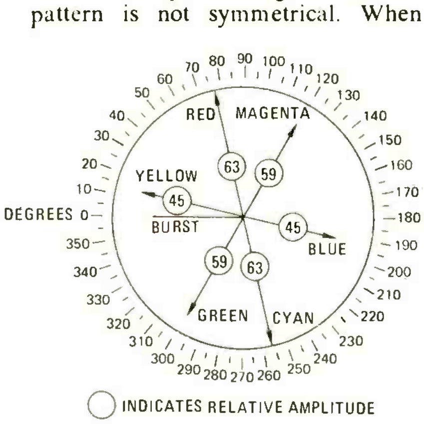


FIG. 8—RB DEMODULATORS OPERATE along the red and blue axes, about 120° apart.

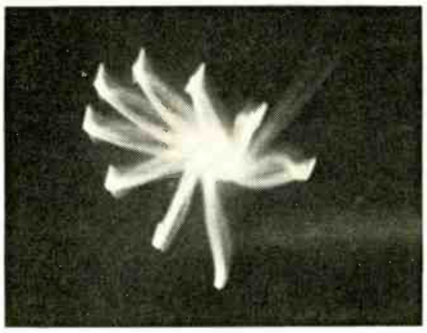


FIG. 9—BG VECTORGRAM DISPLAY.

there is dissymmetry at the demodulator outputs, check the front-to-back ratios of the demodulator diodes. Unless the demodulator diodes are reasonably well matched, the positive-peak and negative-peak output voltages will be unequal.

5. R and G color demodulator outputs

Connections: Connect equipment as in Fig. 1, except that R and G color demodulators are the ones connected to.

Procedure: Adjust vectorscope controls to obtain a vectorgram display like that illustrated in Fig. 10.

Evaluation: Observe the vectorgram for correct peak-to-peak voltages. Note from Fig. 8 that the normal demodulation phase angle for an R and G vectorgram is 135°. We perceive that the demodulation phase angle is incorrect in the example of Fig. 10. In this situation, we start troubleshooting by checking the capacitors in the associated 3.58-MHz subcarrier injection circuit.

6. Quadrature chroma demodulator outputs

Connections: Connect equipment as in Fig. 1, except that the demodulators are quadrature types such as R-Y and B-Y, or I and Q.

Procedure: Adjust vectorscope controls to obtain a vectorgram display such as shown in Fig. 11.

Evaluation: A normal quadrature vectorgram is circular. We observe in the example of Fig. 11 that the petals do not extend all the way to the center of the pattern. This indicates that the chroma-channel bandwidth is somewhat subnormal. However, in practice, we must take standard tolerances into account. If the bandwidth is definitely subnormal, we start troubleshooting by checking the alignment of the chroma band-

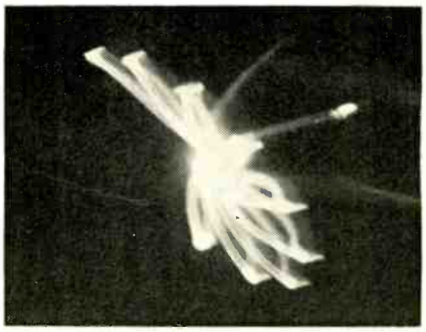


FIG. 10—THE RG VECTORGRAM.

pass amplifier.

7. R-Y demodulator and G-Y matrix outputs

Connections: Connect equipment as shown in Fig. 1, except that the V connection is to the R-Y and the H connection to the G-Y (matrix) output.

Procedure: Adjust vectorscope controls to obtain a vectorgram display as explained previously.

Evaluation: The R-Y and G-Y chroma axes are separated by approximately 147°. In turn, a 147° ellipse is normally produced by the

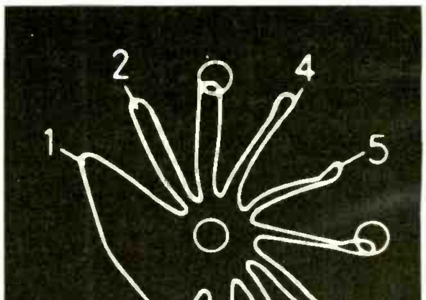


FIG. 11—QUADRATURE VECTORGRAM. (Courtesy Sencore)

vectorgram pattern.

Note 3: Some receivers employ a G–Y matrix, whereas other receivers have a G–Y demodulator. The G–Y signal output is normally the same, whether a matrix or a demodulator is used. Therefore, Test Procedure 7 applies in principle to either receiver arrangement.

8. B–Y demodulator and G–Y matrix outputs

Connections: Connect equipment as in Test Procedure 7, except that the vectorscope probes are applied to the B–Y and G–Y output terminals.

Procedure: Adjust vectorscope controls to obtain a vectorgram display as explained previously.

Evaluation: The B–Y and G–Y chroma axes are separated by approximately 123°. In turn, a 123° ellipse is normally produced by the vectorgram pattern.

Note 4: We occasionally encounter an older receiver that employs G–Y demodulation and B–Y matrixing. However, the B–Y and G–Y signal outputs are normally the same, regardless of the demodulator-matrix relations. Many modern receivers have a G–Y demodulator and a B–Y demodulator. Test Procedure 8 applies in principle to this arrangement also.

9. "Extra petals" in a vectorgram pattern

Connections: Connect equipment as described in any of the foregoing test procedures.

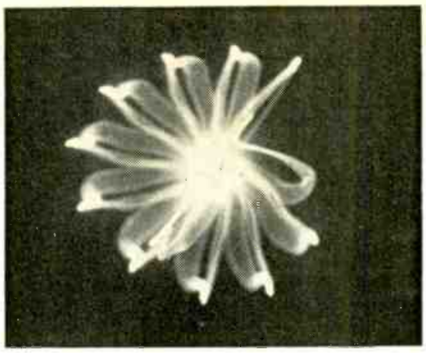


FIG. 12—THE "EXTRA PETALS" HERE may be part of the horizontal blanking pulse.

Procedure: Adjust vectorscope controls as previously described.

Evaluation: If we observe "extra" petals in the vectorgram pattern, as in Fig. 12, we should not jump to the conclusion that there is trouble in the demodulator or matrix circuits. In this example, the "extra" petals are actually part of the horizontal-blanking pulse, and are a normal part of the vectorgram display. To analyze the "extra" pulses, turn down the color-intensity control of the receiver, and advance the gain of the vectorscope. If the "extra" petals now move out of the vectorgram toward the edge of the screen, or off-screen, we conclude that they are merely a part of the blanking pulse.

10. "Missing petals" in a vectorgram pattern

Connections: Connect equipment as in any of the foregoing test procedures.

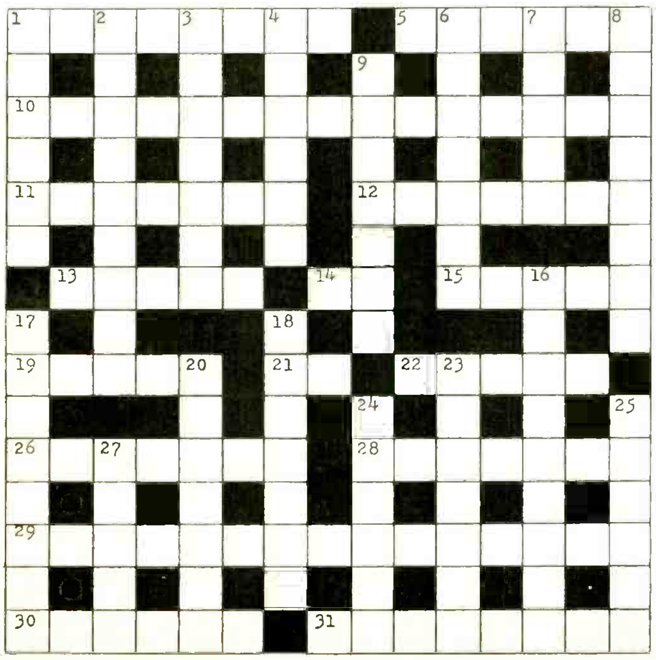
Procedure: Adjust vectorscope controls as previously described.

Evaluation: If we observe that there are 9 petals in the pattern, instead of 10, we should not conclude immediately that there is trouble in the demodulator or matrix circuits. For example, one of the petals may have been deleted by the horizontal-blanking pulse. To check for this, turn the tint control on the receiver and watch the vectorgram pattern. The vectorgram will rotate on the CRT screen as the tint control is turned. In most cases, the "missing" petal will move out from the blanked region. Of course, if a receiver defect results in a "stretched" blanking pulse, the "missing" petal cannot be brought in by adjusting the tint control. **R-E**

electronic crossword puzzle

ACROSS

1. A type of signal.
5. To proceed.
10. Light emitted without tangible heat.
11. A network of four resistors connected in series to form a closed circuit.
12. A substance used to dissolve another substance.
13. High-vacuum or other tube in which a leak has developed.
14. Chemical with atomic number 27. Abbrev.
15. To place a binary cell in the initial or "zero" state.
19. A type of gas that will not combine with another element.
21. A type of force. Abbrev.
22. Highly skilled.
26. Electromagnetic unit of magnetic potential.
28. Heating metals and shaping them again.
29. A device whose functions involve both electric current and sound-frequency pressures.
30. To wish or long for.
31. A vacuum-tube device that is not connected to any circuit.



DOWN

1. An antenna whose length is one half of the electromagnetic wave length to which it is resonant.
2. Frequency that is higher than 1600 kHz.
4. An instrument used to test wave forms of a current or voltage.
6. Used in regenerative circuits.
7. Extent of coverage or effectiveness.
8. A mineral used to form insulators and high dielectric strength sheets.
9. Potential difference or voltage.
16. A clipping circuit in television receivers that divides the control impulses from the video signal.
17. A magnetic device where the material forms an enclosure with one or more air gaps and is in contact to the pole piece on one side.
18. A particle having about the same mass as a proton.
20. A type of speaker.
23. Process by which reflected energy is distributed over a wide range of angles.
24. A colored thread in wire insulation that aids in identification.
25. To avoid giving a direct reply.
27. A sly look.

Answer on page 96

by **MICHAEL KRESILA**

Design Your Own Regulated POWER SUPPLY

New IC regulators are so inexpensive and easy to use that you can build a regulated, short-circuit proof power supply for less than the old unregulated kind

INTEGRATED-CIRCUIT VOLTAGE REGULATORS have been around for quite a while, but they have been expensive and have needed lots of "outboard" parts to get them to work. Today, there's a new breed of voltage regulators here. These are low in cost ($2–5 in singles), very easy to use, and take very few outside additional parts. Some directly handle up to ¾ of an amp; others easily handle an amp or more with external pass transistors. Some are fixed-value outputs; others are variable. Some are dual pairs that give you two output voltages (one positive, one negative) out of the same package.

Why bother to regulate a power supply? For openers, the hum essentially disappears. Besides a rock-stable output voltage that is independent of temperature, line, or load variations, most designs are also short-circuit proof, shutting down or current limiting automatically. This protects the regulator and the supply against damage from shorts, and the current limiting will usually (but not always!) also protect the load from damage caused by wrong biasing or polarity mixups. Finally, a regulated power supply may actually be *cheaper* than an unregulated one, particularly if you need very low hum on the supply lines. This happens because you can usually use a much smaller filter capacitor. For instance, if you wanted a 5-volt, 200-mA supply with less than 20 millivolts of ripple, single capacitor "brute-force" filtering might take around a 80,000 μF capacitor. With a regulator, you might design a power supply with a 16-volt output and four volts of peak to peak ripple, and do the job with a 400-μF capacitor, with the regulator absorbing the "lumps" and giving a smooth output. Often times, the difference in capacitor cost is greater than the price of the regulator, particularly if the capacitor makes the case bigger, and regulated supplies can be cheaper than unregulated ones.

Of course, the problem with any power supply design is figuring out what size and voltage transformer you need, where to get it, what size capacitor to use, and how much fusing to provide. After that, we can tack a regulator onto the output.

Start with an unregulated power supply

Let's assume you're interested in output voltages that are low compared to the 117-volt power line, and are interested in currents between 50 mA and an ampere or two. Let's also assume you are working with a 60-hertz, single-phase power line, as usual. For this particular type of power requirement, the transformer-coupled, full-wave capacitor-input circuit of Fig. 1 is recommended.

The transformer drops the voltage to a chosen value and provides safety isolation. When its anode is positive diode D1 conducts and charges capacitor C. On the next half-cycle, diode D2 conducts and charges capacitor C. If there isn't too much load on the capacitor, it doesn't discharge very much between cycles and so the conduction time of each diode turns out to be *very short*. Very high currents flow very briefly during the diode conduction time and the current to the capacitor is delivered in narrow spikes. The amount of the current and the time width of the spikes depend on the load, the capacitor, and the internal resistance of the transformer, but the time spacing between the spikes is precisely half of a 60 hertz power line cycle, or a time period of 8.33 milliseconds.

Figure 1 also shows the waveform at the capacitor and the load. It is essentially a fixed dc value from which a *sawtooth* waveform is subtracted. The frequency of the sawtooth is 120 hertz (for a full-wave rectifier), and its depth depends on how fast the capacitor discharges. The greater the load for a given size capacitor, the more the capacitor can discharge between the charging current spikes and the higher the sawtooth ripple.

There are two other possible circuits, the half-wave single diode one, and the full-wave one using a single (untapped) transformer winding and a bridge rectifier. The half-wave circuit takes twice the capacitor size and has twice the peak diode current. It also takes a bigger transformer as unbalanced currents and a resultant dc flow through the transformer windings. The full-wave circuit takes four diodes instead of just two and presents an additional diode drop between load and transformer. Besides this, you can only get one voltage from any given winding, while the Fig. 1 circuit can easily get you several voltages since the transformer center tap is grounded. Thus, unless you have a good reason not to, stick with the center-tapped.

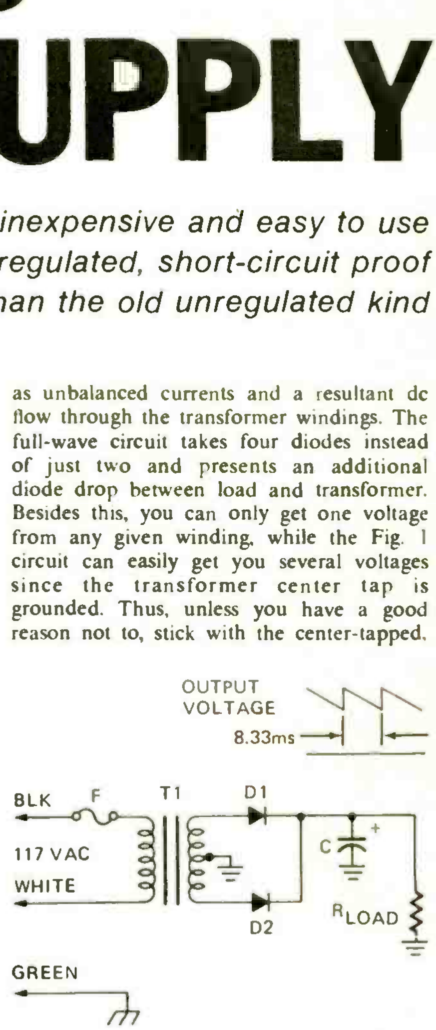


FIG. 1—FULL-WAVE POWER SUPPLY with capacitor-input filter is a good choice for a low-voltage regulated supply. Regulator is added between capacitor and output.

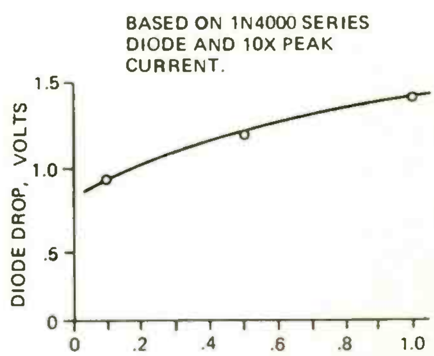
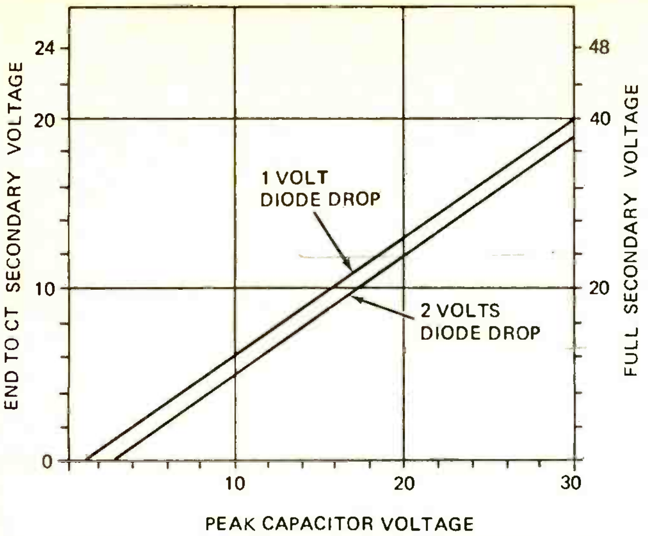


FIG. 2—VOLTAGE DROP ACROSS SILICON DIODE can be approximated from this chart if you do not have data on your diode.



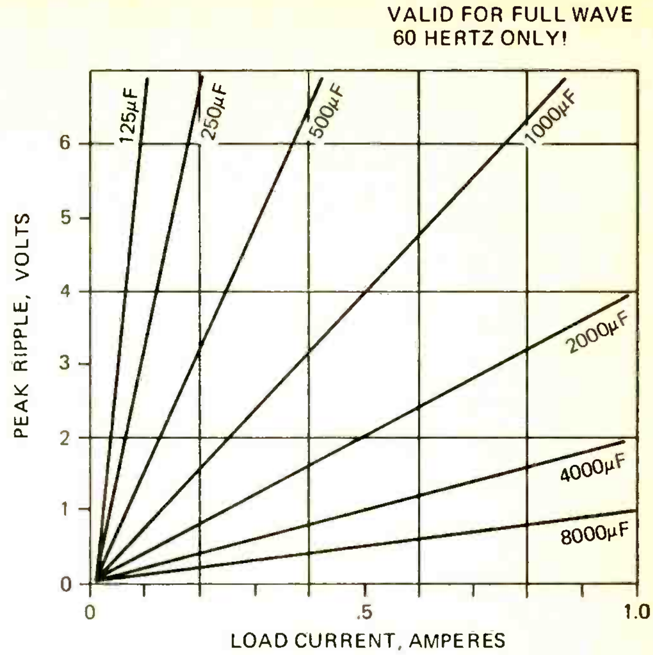


FIG. 3—TRANSFORMER VOLTAGE VERSUS CAPACITOR VOLTAGE. Remember that actual transformer secondary voltage depends on the power-line voltage level and the magnitude of the load.

FIG. 4—PICKING THE FILTER FOR LOAD AND RIPPLE. Chart is valid for full-wave, 60-Hz supply only. Note that ripple varies inversely as capacitor value.

two-diodes, full-wave, capacitor-input circuit of Fig. 1.

Some numbers

There is no obvious "one-to-one" relationship between the transformer voltage and the output voltage. You do **not** get 6.3 volts of dc output from a 6.3-volt center-tapped-transformer, or 12.6 volts from a 12.6 one and so on. While the game isn't *quite* this simple, it is easy to calculate the voltages you need for a given output.

Let's try the calculation "frontwards" first. Suppose you had a 6.3-volt rms center-tapped transformer, and to keep things simple, suppose further that the *regulation* of the transformer itself is very good, which is another way of saying the transformer can handle the load we want it to.

Each half of the 6.3 volt winding will be providing half of 6.3 volts or 3.15 volts. This is the rms ac value. We need to find the *peak* value, for this is what charges the capacitor through the diode. The peak value is 1.41 times the rms value or $3.15 \times 1.41 = 4.45$ volts. (Note you can "speed math" this calculation by taking one-tenth the rms voltage, doubling it, doubling it again, and then adding the original voltage to it.)

If the diodes were perfect, we'd get a capacitor voltage of 4.45 volts. The diodes have a conduction drop, and quite a bit more than you might expect, since, *when* they are conducting, they carry *ten* to *twenty* times the average load current. Remember that the diodes only conduct briefly. If they are only on for 1/10 the time, they have to conduct ten times the current the load needs.

The accurate way to find the voltage drop is to use a data sheet for the particular diode you are using and calculating the actual conduction angle, which is a pain. Figure 2 gives you a curve that is exactly valid for a 1N4000 series diode and a conduction time of 1/10 a complete cycle. This is close enough so long as you are using any reasonable silicon power diode. From Fig. 2, we see that the drop will be around a volt for lower currents; let's use this figure. The diode drop subtracts from the available voltage, so the voltage across the capacitor is 3.45 volts. This is a peak value, from which we subtract the ripple voltage.

Figure 3 is a chart that relates the transformer voltage to the filter capacitor voltage for several values of diode drop. Use the chart directly or else use the following rules:

To find the peak output voltage:

1. Start with the transformer secondary rms voltage
2. Divide by two to get the center-tapped voltage
3. Multiply this by 1.4 to get the peak value
4. Subtract the diode drop, estimated from Fig. 2, or subtract 1 volt for lower current operation.

To find the transformer voltage:

1. Start with the peak capacitor voltage.
2. Add the diode drop
3. Multiply by 0.707 to get the rms value
4. Double this for the center-tapped rms value

It turns out that you always design for much more output voltage than you really need if you are using a regulator. The regulator has a minimum *dropout* voltage above its output it needs for proper operation. The maximum voltage is limited by regulator breakdown or power dissipation. We'll see more on this in just a bit, but first. . . .

What size capacitor?

The size of the filter capacitor and the maximum load current determine the amount of sawtooth ripple you get. The accurate analysis of this is also a pain. We can make a very good approximation if we assume our ripple sawtooth voltage recharges very fast and decreases linearly. This both simplifies the math and puts us on a conservative side of things.

With this simplification, the relationship between the load current and the capacitor size is given by:

$$\text{Load current} = \frac{V_{load}}{R_{load}} = \frac{C \times \Delta V}{8.33 \times 10^{-3}}$$

where:
V_{load} = Load voltage, volts
R_{load} = Load Resistance, ohms
ΔV = Ripple in volts
C = Capacitance in *farads*

Even this is a messy and confusing formula. Figure 4 gives it in graphical form. A simple way to forever remember how to calculate capacitor size is:

Use an 8000-μF capacitor and the ripple in VOLTS will Equal the current in AMPS.

Use an 8-μF capacitor and the ripple in VOLTS will Equal the current in MILLIAMPS.

Double the capacitor to halve the ripple and so on. For instance, with our rule, a 4000-μF capacitor gives us 1 volt of ripple at 500 mA, and so on. Rules-of-thumb like we are giving you may not be exactly accurate, but they are quick, easy, and they *work*. And that's all we need to worry about.

Picking the parts

The choice of a capacitor isn't too hard to make—use the best quality electrolytic you can afford, of a voltage rating at least equal to, and preferably double your output voltage. Ordinary computer-grade aluminum electrolytics are a good choice. Tantalum capacitors are an expensive luxury unless you happen on to some surplus units or are going to put your circuit into orbit. Silicon power diodes are tough and readily available. Use the 1N4001 or 1N5060 or their surplus equivalents for the 1-amp or less applications. For higher currents, use the 3-ampere diodes such as a 1N5624 or a 1N4721 or something larger.

These diodes run very hot. Their leads should be short and routed to some sort of heat radiator such as lots of foil on a PC board, or a large terminal strip. The heat removal process is mostly by conduction—out the leads. For long diode life, provide some place for this heat to go. Phenolic PC boards may char under direct heat exposure, so the epoxy-glass versions are preferred for power supply work. Also be sure that a power diode doesn't end up in direct contact with an electrolytic or the heating can shorten the capacitor's useful life.

The maximum voltage across the diode is *twice* the *output* voltage. Use a PIV rating at least double this. If in doubt, go to a 200- or a 400-PIV unit; they don't cost that much more and may be easier to get.

This brings us back to the transformer. If you possibly can, use a stock filament transformer, as these are inexpensive and easy to get. Unfortunately, these often turn out to be rather large, particularly if you are working with compact gear, and offer only a limited choice of voltages.

One source of transformers I've found extremely handy—at twice the usual filament transformer cost—is Signal Transformers, 1 Junius Street, Brooklyn, New York, 11212. They have an incredible variety of stock very small to enormous transformers, some of which mount directly on a PC board without any hardware. For instance, a PC-mount 10-Vct transformer that can handle 120 mA, measures 1¼" square by 1½" long and sells for around $4.37, plus postage.

The input fuse and third wire ground on the supply is simply good practice. Use a slow-blow fuse whose amperage is *above* 1/50th the load *power*. For instance, a 5-volt, 1-amp unregulated supply provides 5 watts at full load. Use a 5/50=0.1 ampere unit. The actual current may be found by dividing the load power and the transformer losses by the line voltage and then making some power factor adjustments and then adding a safety factor. The 1/50th load power current (measured at the capacitor—not the regulator) formula is a lot quicker and gives the same result.

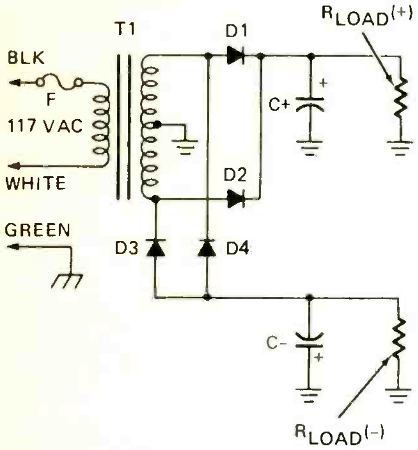


FIG. 5—NEGATIVE SUPPLY may be added to basic supply. The transformer current rating must be high enough to handle both loads.

Figure 5 shows a dual unregulated power supply, where we have added two more diodes and a new capacitor to pick up a negative voltage. You might like to use only the bottom half of this circuit if you need a negative-only supply

Adding regulation

By now, we should know how to design a power supply that has a given output voltage and a given output ripple. All we have to do now is add a regulator.

Figure 6 shows how a typical positive-only regulator may be added. The regulator senses the output voltage and then absorbs the difference between the instantaneous supply voltage and the desired output. The minimum *extra* voltage you can live with is called the *dropout voltage*, and is typically 2 to 3 volts above the regulated output voltage. Thus most 5-volt regulators need at least 8 volts to work with.

The *maximum* permissible input voltage is usually set by a breakdown limit and the allowable internal power dissipation. The load current times the extra voltage drop must be internally dissipated by the regulator. This is determined by the size of the regulator, the load, the available heat-sinking, and whether external *pass* transistors are used with the regulator.

Several add-ons normally go with the regulator circuit. An output capacitor, usually in the 0.1 to 1 μF range is almost always needed for regulator stability, and it has to be a good Mylar or tantalum capacitor. The current-limiting circuitry may be internal, or you may have to add a chosen resistor to get a desired current limit. You may be able to add a voltage or a resistance to *change* the output voltage, and finally, you may be able to add external transistors to extend the current capability.

Regardless of what regulator you use, be sure and have a data sheet on hand and study it carefully. Most regulators need at least one stabilizing capacitor on the output. Almost all of the newer ones are very easy to use, but you must sit down with the individual data sheets to make sure you aren't exceeding a limit.

TABLE I
SOME LOW COST AND EASY TO USE VOLTAGE REGULATORS
(Typical unit pricing on these run from $2 to $4.)

7800 Series	Fixed voltage, positive only. To 750 mA without extra parts. 7805 is 5 V. Also available as 6 V (7806), 8 V (7808), 12 V (7812), 15 V (7815), 18 V (7818) and 24 V (7824).	
	Data Sheets from	FAIRCHILD SEMICONDUCTOR 313 Fairchild Drive Mountain View, California, 94040
	or	MOTOROLA SEMICONDUCTOR Box 20912 Phoenix, Arizona, 85036
7900 Series	Fixed Voltage, negative only. Similar to above.	
SG4501T	Dual 15 V regulator, adjustable from 8 to 24 V. To 60 mA without external transistors. 2 A or more with external transistors.	
	Data Sheet from	SILICON GENERAL INC. 7382 Bolsa Avenue Westminster, California, 92683
4195DN	Dual 15 V regulator, fixed voltage. 100 mA without external transistors. Only two external parts needed.	
	Data Sheet from	RAYTHEON SEMICONDUCTOR 350 Ellis Street Mountain View, California, 94040

Several popular low-cost regulators are shown in Table I along with their manufacturers. Prices range from $2 to $5 if you pick the room-temperature versions and the economy package. Most data sheets have extensive applications and design information attached to them. Once again, don't try to do any regulator design without a specific data sheet on hand, for there are lots of differences between apparently similar devices.

The best way to show you how to design your own regulator circuits is with three quick examples—a fixed +5-volt 750

(Continued on page 85)

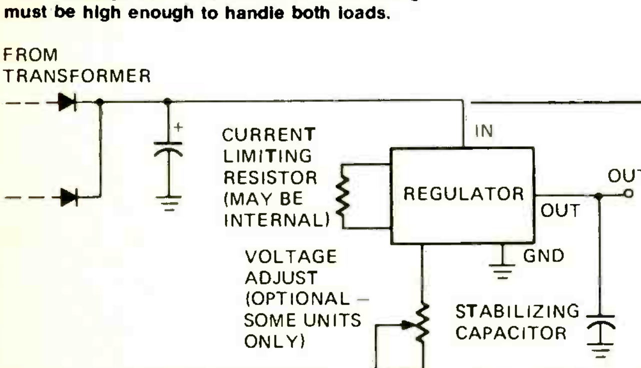
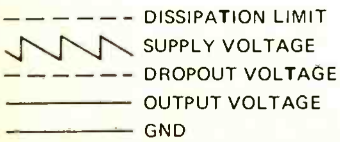


FIG. 6—TYPICAL POSITIVE REGULATOR CIRCUIT. The regulator senses and then dissipates as heat, the instantaneous difference between the supply voltage and the output voltage. Very little current flows in the regulator circuit's ground lead.



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Code

- *—Construction article
- †—Part of article
- Ckt—Circuits
- CI—Service clinic
- Corr—Correction
- Corres—Correspondence
- ER—Equipment report

(continued on page 87)

R-E's substitution guide for replacement transistors

PART X

compiled by ROBERT & ELIZABETH SCOTT

ARCH—Indicates the Archer brand of semiconductors sold only by Radio Shack and Allied Radio stores. Allied Radio Shack, 2725 W. 7th St., Ft. Worth, Texas 76107

DM—D. M. Semiconductor Co., P.O. Box 131, Melrose, Mass. 02176

GE—General Electric Co., Tube Product Div., Owensboro, Ky. 42301

ICC—International Components, 10 Daniel Street, Farmingdale, N.Y. 11735

IR—International Rectifier, Semiconductor Div., 233 Kansas St., El Segundo, Calif. 90245

MAL—Mallory Distributor Products Co., 101 S. Parker, Indianapolis, Ind. 46201

MOT—Motorola Semiconductors, Box 2963, Phoenix, Ariz. 85036

RCA—RCA Electronic Components, Harrison, N.J. 07029

SPR—Sprague Products Co., 65 Marshall St., North Adams, Mass. 01247

SYL—Sylvania Electric Corp., 100 1st Ave., Waltham, Mass. 02154

ZEN—Zenith Sales Co., 5600 W. Jarvis Ave., Chicago, Ill. 60648

Radio-Electronics has done its utmost to insure that the listings in this directory are as accurate and reliable as possible; however, no responsibility is assumed by Radio-Electronics for its use. We have used the latest manufacturers material available to us and have asked each manufacturer covered in the listing to check its accuracy. Where we have been supplied with corrections, we have updated the listing to include them. The first part of this Guide appeared in March 1973.

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	ZEN
2N2209	RS276-2004	T-253	GE-2	ICC-253	TR-05	PTC 102	HEP-253	SK 3005	RT-118	ECG 100	ZEN 304
2N2210	NA	T-233	GE-4	ICC-233	TR-03	PTC 106	HEP-233	SK 3012	NA	ECG 105	ZEN 327
2N2211	NA	NA	NA	NA	NA	NA	HEP-625	NA	NA	NA	NA
2N2212	RS276-2006	T-232	GE-25	ICC-232	TR-27	PTC 138	HEP-232	SK 3009	RT-127	ECG 121	ZEN 326
2N2214	NA	NA	NA	NA	NA	NA	HEP-722	NA	NA	NA	NA
2N2216	NA	T-706	GE-27	NA	IRTR-78	NA	NA	NA	NA	NA	NA
2N2217	NA	TS-3001	GE-18	ICC-S3001	NA	PTC 136	HEP-S3001	NA	NA	NA	NA
2N2218	NA	TS-3001	GE-18	ICC-S3001	NA	PTC 136	HEP-S3001	SK 3124	RT-100	ECG 123	NA
2N2219	NA	TS-3001	GE-18	ICC-S3001	NA	PTC 136	HEP-S3001	SK 3024	NA	NA	NA
2N2220	RS276-2009	T-55	GE-20	ICC-55	IRTR-51	PTC 136	HEP-55	SK 3122	RT-102	ECG 123A	ZEN 103
2N2221	RS276-2009	T-55	GE-20	ICC-55	IRTR-51	PTC 136	HEP-55	SK 3122	RT-102	ECG 123A	ZEN 103
2N2222	RS276-2009	T-736	GE-20	ICC-736	IRTR-51	PTC 136	HEP-736	SK 3122	RT-102	ECG 123A	ZEN 120
2N2223	NA	T-714	GE-18	NA	TR-87	PTC 123	NA	NA	NA	NA	NA
2N2224	NA	TS-3020	GE-63	NA	TR-21	PTC 144	HEP-S3011	NA	NA	NA	NA
2N2225	NA	T-2	GE-2	ICC-2	TR-17	PTC 102	HEP-2	NA	NA	ECG 160	ZEN 300
2N2226	NA	NA	NA	NA	TR-59	NA	NA	NA	NA	NA	NA
2N2227	NA	NA	NA	NA	TR-36	NA	NA	NA	NA	NA	NA
2N2234	NA	T-53	GE-20	NA	NA	PTC 136	HEP-S3023	SK 3124	RT-100	ECG 123	NA
2N2235	NA	T-53	GE-20	NA	NA	PTC 136	HEP-S3020	SK 3124	RT-100	ECG 123	NA
2N2236	RS276-2009	T-53	GE-18	ICC-53	TR-65	PTC 125	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N2237	RS276-2009	T-53	GE-18	ICC-53	86	PTC 125	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N2238	NA	T-2	GE-1	ICC-2	TR-17	PTC 109	HEP-2	NA	NA	ECG 160	ZEN 300
2N2239	NA	TS-3020	GE-63	NA	NA	PTC 144	HEP-S3020	NA	NA	NA	NA
2N2240	RS276-2009	T-53	GE-18	ICC-53	TR-65	PTC 125	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N2241	RS276-2009	T-53	GE-18	ICC-53	TR-65	PTC 125	HEP-53	SK 3122	NA	ECG 123A	ZEN 102
2N2242	RS276-2009	T-50	GE-17	ICC-50	TR-21	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N2243	NA	T-714	GE-18	NA	TR-85	PTC 144	HEP-714	NA	NA	NA	NA
2N2244	RS276-2009	T-50	GE-17	ICC-50	IRTR-51	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N2245	RS276-2009	T-50	GE-17	ICC-50	IRTR-51	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N2246	RS276-2009	T-50	GE-63	ICC-50	IRTR-51	PTC 123	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N2247	RS276-2009	T-50	GE-18	ICC-50	IRTR-51	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N2248	RS276-2009	T-50	GE-18	ICC-50	IRTR-51	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N2249	RS276-2009	T-50	GE-17	ICC-50	IRTR-51	NA	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N2250	RS276-2009	T-50	GE-17	ICC-50	IRTR-51	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N2251	RS276-2009	T-50	GE-17	ICC-50	IRTR-51	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N2252	RS276-2009	T-50	GE-63	ICC-50	IRTR-51	PTC 123	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N2253	RS276-2009	T-50	GE-18	ICC-50	IRTR-51	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N2254	RS276-2009	T-50	GE-18	ICC-50	IRTR-51	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N2255	RS276-2009	T-50	GE-63	ICC-50	IRTR-51	PTC 123	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N2256	RS276-2009	T-50	GE-10	ICC-50	TR-21	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N2257	RS276-2009	T-50	GE-10	ICC-50	TR-21	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N2258	RS276-2003	T-3	GE-9	ICC-3	TR-17	PTC 107	HEP-3	NA	NA	ECG 160	ZEN 301
2N2259	RS276-2003	NA	GE-9	ICC-3	TR-17	PTC 107	HEP-3	NA	NA	ECG 160	ZEN 301
2N2266	NA	T-231	GE-4	NA	NA	PTC 106	NA	SK 3012	NA	ECG 105	NA
2N2267	NA	T-231	GE-4	NA	NA	PTC 106	NA	SK 3012	NA	ECG 105	NA
2N2268	NA	T-231	GE-4	NA	NA	PTC 106	NA	SK 3012	NA	ECG 105	NA
2N2269	NA	T-231	GE-4	NA	NA	NA	NA	SK 3012	NA	ECG 105	NA
2N2270	NA	TS-3001	GE-63	NA	TR-87	PTC 144	HEP-S3001	SK 3024	RT-114	ECG 128	ZEN 305
2N2271	RS276-2005	T-254	GE-53	ICC-254	TR-82	PTC 135	HEP-254	SK 3004	RT-120	ECG 102	ZEN 102
2N2272	RS276-2009	T-53	GE-18	ICC-53	IRTR-76	NA	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 301
2N2273	RS276-2003	T-3	GE-9	ICC-3	TR-54	PTC 107	HEP-3	NA	NA	ECG 160	NA
2N2274	RS276-2023	T-52	GE-22	ICC-52	TR-54	PTC 131	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2275	RS276-2023	T-52	GE-22	ICC-52	TR-54	PTC 131	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2276	RS276-2023	T-52	GE-22	ICC-52	TR-54	PTC 131	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2277	RS276-2023	T-52	GE-22	ICC-52	TR-54	PTC 131	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2278	RS276-2023	T-52	GE-22	ICC-52	TR-54	PTC 131	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2279	RS276-2023	T-52	GE-22	ICC-52	TR-54	PTC 131	HEP-52	SK 3114	NA	ECG 159	NA
2N2280	RS276-2023	T-52	GE-22	ICC-52	TR-54	PTC 131	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2281	RS276-2023	T-52	GE-22	ICC-52	NA	PTC 131	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2282	NA	T-230	GE-3	NA	NA	NA	NA	SK 3009	RT-124	ECG 104	NA
2N2285	RS276-2006	T-232	NA	ICC-232	TR-35	NA	HEP-232	SK 3014	RT-147	ECG 179	ZEN 326
2N2286	RS276-2006	T-232	NA	ICC-232	NA	NA	HEP-232	SK 3014	RT-147	ECG 179	ZEN 326
2N2287	RS276-2006	T-232	NA	ICC-232	TR-01	NA	HEP-232	SK 3014	RT-127	ECG 121	ZEN 326
2N2288	RS276-2006	T-230/ 232	GE-16	ICC-230/ 232	TR-01	PTC 105	HEP-230/ 232	SK 3009	RT-127	ECG 121	ZEN 325/ 326
2N2289	RS276-2006	T-232	GE-3	ICC-232	TR-01	NA	HEP-232	SK 3009	RT-127	ECG 121	ZEN 326
2N2290	RS276-2006	T-232	GE-3	ICC-232	TR-01	NA	HEP-232	SK 3009	NA	ECG 127	ZEN 326
2N2291	RS276-2006	T-230	GE-25	ICC-230	TR-01	PTC 105	HEP-230	SK 3009	RT-127	ECG 121	ZEN 325
2N2292	RS276-2006	T-232	GE-25	ICC-232	TR-01	NA	HEP-232	SK 3009	RT-127	ECG 121	ZEN 326
2N2293	RS276-2006	T-232	GE-25	ICC-232	TR-01	NA	HEP-232	SK 3009	RT-127	ECG 121	ZEN 326
2N2294	RS276-2006	T-230	GE-25	ICC-230	TR-01	PTC 105	HEP-230	SK 3009	RT-127	ECG 121	ZEN 325
2N2295	RS276-2006	T-232	GE-25	ICC-232	TR-01	NA	HEP-232	SK 3009	RT-127	ECG 121	ZEN 326
2N2296	RS276-2006	T-232	GE-25	ICC-232	TR-01	NA	HEP-232	SK 3009	RT-127	ECG 121	ZEN 326
2N2297	NA	T-714	GE-27	ICC-714	TR-87	PTC 144	HEP-714	SK 3104	NA	NA	NA
2N2303	RS276-2021	T-51	GE-21	ICC-51	TR-19	PTC 127	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N2304	RS276-2018	T-243	NA	ICC-243	TR-76	NA	HEP-243	SK 3024	NA	NA	NA
2N2305	NA	T-247	NA	ICC-247	TR-26	PTC 119	HEP-247	SK 3027	RT-131	ECG 130	NA
2N2309	RS276-2009	T-53	GE-18	ICC-53	TR-21	PTC 125	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N2310	RS276-2009	T-53	GE-18	ICC-53	IRTR-51	PTC 121	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N2311	NA	T-706	GE-27	NA	IRTR-78	PTC 125	HEP-713	NA	NA	NA	NA

NA = NOT AVAILABLE

(turn page)

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	ZEN
2N2312	RS276-2009	T-53	GE-18	ICC-53	IRTR-51	PTC 121	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N2313	NA	T-706	GE-27	NA	IRTR-78	PTC 125	HEP-713	NA	NA	NA	NA
2N2314	RS276-2009	T-53	GE-62	ICC-53	IRTR-51	PTC 121	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N2315	RS276-2009	T-53	GE-62	ICC-53	IRTR-51	PTC 121	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N2316	NA	T-714	GE-18	NA	NA	PTC 125	HEP-713	NA	NA	NA	NA
2N2317	NA	T-714	GE-18	NA	NA	PTC 121	HEP-S3020	NA	NA	NA	NA
2N2318	RS276-2010	T-50	GE-17	ICC-50	TR-21	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N2319	RS276-2009	T-53	GE-61	ICC-53	TR-21	PTC 121	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N2320	RS276-2009	T-53	GE-20	ICC-53	IRTR-51	NA	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N2322	NA	SR-1221	GEMR-5	NA	NA	NA	NA	NA	NA	NA	NA
2N2323	NA	SR-1221	GEMR-5	NA	NA	NA	HEP-R1101	NA	NA	NA	NA
2N2324	NA	SR-1221	GEMR-5	NA	NA	NA	HEP-R1102	NA	NA	NA	NA
2N2325	NA	SR-1221	GEMR-5	NA	NA	NA	HEP-R1103	NA	NA	NA	NA
2N2326	NA	SR-1221	GEMR-5	NA	NA	NA	HEP-R1103	NA	NA	NA	NA
2N2330	NA	NA	GE-63	NA	NA	PTC 144	NA	SK 3124	RT-100	ECG 123	NA
2N2331	RS276-2010	T-50	GE-17	ICC-50	TR-21	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N2332	RS276-2023	T-52	GE-22	ICC-52	TR-20	PTC 131	HEP-52	SK 3114	RT-115	ECG 123A	NA
2N2333	RS276-2023	T-52	GE-22	ICC-52	TR-20	PTC 131	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2334	RS276-2023	T-52	GE-21	ICC-52	TR-20	PTC 131	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2335	RS276-2023	T-52	GE-21	ICC-52	TR-20	PTC 131	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2336	RS276-2023	T-52	GE-21	ICC-52	TR-20	PTC 131	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2337	RS276-2023	T-52	GE-21	ICC-52	TR-20	PTC 131	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2338	NA	NA	NA	NA	NA	NA	HEP-S5001	NA	NA	NA	NA
2N2339	NA	TS-3020	GE-66	NA	NA	NA	HEP-243	NA	NA	NA	NA
2N2340	NA	NA	NA	NA	NA	NA	HEP-S3020	NA	NA	NA	NA
2N2341	NA	NA	NA	NA	NA	NA	HEP-S3020	NA	NA	NA	NA
2N2342	NA	NA	NA	NA	NA	NA	HEP-714	NA	NA	NA	NA
2N2343	NA	NA	NA	NA	NA	NA	HEP-714	NA	NA	NA	NA
2N2344	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N2345	NA	T-641	GE-8	NA	TR-08	PTC 108	NA	NA	NA	NA	NA
2N2349	RS276-2009	T-53	GE-20	ICC-53	TR-70	NA	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N2350	NA	TS-3020	GE-63	NA	TR-21	NA	HEP-S3020	NA	NA	NA	NA
2N2351	NA	T-714	GE-18	NA	NA	PTC 144	HEP-S3011	NA	NA	NA	NA
2N2352	NA	TS-3020	GE-63	NA	NA	PTC 144	HEP-S3020	NA	NA	NA	NA
2N2353	RS276-2009	T-53	GE-63	ICC-53	TR-65	PTC 144	HEP-53	SK 3122	RT-102	ECG 123A	ZEN 102
2N2354	RS276-2001	T-641	GE-59	ICC-641	NA	PTC 134	HEP-641	SK 3124	RT-122	ECG 103	ZEN 315
2N2355	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N2356	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N2357	RS276-2006	T-232	GE-3	ICC-232	NA	NA	HEP-232	SK 3009	RT-127	ECG 121	ZEN 326
2N2358	RS276-2006	T-232	GE-3	ICC-232	NA	NA	HEP-232	SK 3009	RT-127	ECG 121	ZEN 326
2N2360	NA	T-2	GE-9	ICC-2	NA	PTC 102	HEP-2	NA	NA	ECG 160	ZEN 300
2N2361	NA	T-2	GE-9	ICC-2	NA	PTC 107	HEP-2	NA	NA	ECG 160	ZEN 300
2N2362	NA	T-2	GE-9	ICC-2	NA	PTC 107	HEP-2	NA	NA	ECG 160	ZEN 300
2N2363	RS276-2003	T-3	GE-9	ICC-3	TR-12	NA	HEP-3	SK 3006	NA	ECG 126	ZEN 301
2N2364	NA	T-714	GE-18	NA	NA	PTC 125	HEP-714	NA	NA	NA	NA
2N2368	RS276-2009	T-50	GE-20	ICC-50	TR-21	PTC136	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N2369	RS276-2009	T-50	GE-63	ICC-50	TR-21	NA	HEP-50	SK 3122	RT-102	ECG 123A	ZEN 100
2N2370	RS276-2021	T-51	GE-22	ICC-51	TR-19	PTC 131	HEP-51	SK 3114	RT-115	ECG 159	ZEN101
2N2371	RS276-2021	T-51	GE-22	ICC-51	TR-19	PTC 131	HEP-51	SK 3114	RT-115	ECG 159	ZEN 101
2N2372	RS276-2023	T-52	GE-22	ICC-52	TR-20	PTC 131	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2373	RS276-2023	T-52	GE-22	ICC-52	TR-20	PTC 131	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2374	RS276-2005	T-254	GE-2	ICC-254	NA	PTC 102	HEP-254	SK 3004	RT-120	ECG 102	ZEN 305
2N2375	RS276-2005	T-254	GE-1	ICC-254	NA	PTC 102	HEP-254	SK 3004	RT-120	ECG 102	ZEN 305
2N2376	RS276-2005	T-254	GE-53	ICC-254	NA	PTC 102	HEP-254	SK 3004	RT-120	ECG 102	ZEN 305
2N2377	RS276-2023	T-52	GE-22	ICC-52	TR-21	PTC 131	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2378	RS276-2023	T-52	GE-22	ICC-52	TR-21	PTC 131	HEP-52	SK 3114	RT-115	ECG 159	NA
2N2379	NA	T-231	GE-4	NA	NA	NA	NA	NA	NA	NA	NA
2N2380	RS276-2009	NA	GE-18	ICC-756	IRTR-87	PTC 144	HEP-736	NA	NA	NA	ZEN 120
2N2381	NA	T-2	GE-51	ICC-2	NA	PTC 107	HEP-2	NA	NA	ECG 160	ZEN 300
2N2382	NA	T-2	GE-51	ICC-2	NA	PTC 107	HEP-2	NA	NA	ECG 160	ZEN 300
2N2383	NA	T-704	GE-14	NA	NA	NA	HEP-S5000	NA	NA	NA	NA
2N2384	NA	T-704	GE-14	NA	NA	NA	HEP-S5004	NA	NA	NA	NA
2N2386	NA	T-803	NA	ICC-803	NA	NA	HEP-803	NA	NA	NA	NA
2N2387	NA	T-736	GE-61	NA	IRTR-51	PTC 133	HEP-729	SK 3122	RT-102	ECG 123A	NA
2N2388	NA	T-736	GE-62	NA	TR-87	PTC 153	HEP-728	SK 3122	RT-102	ECG 123A	NA
2N2389	NA	T-53	GE-18	NA	TR-87	PTC 123	HEP-S3020	SK 3124	RT-100	ECG 123	NA
2N2390	NA	T-53	GE-18	NA	NA	PTC 123	HEP-S3020	SK 3124	RT-100	ECG 123	NA
2N2393	NA	NA	GE-21	NA	TR-87	PTC 103	HEP-716	SK 3114	RT-115	ECG 159	NA
2N2394	NA	NA	GE-21	NA	TR-87	PTC 103	HEP-716	SK 3114	RT-115	ECG 159	NA
2N2395	NA	NA	GE-20	NA	TR-30	PTC 123	HEP-S0004	NA	RT-126	ECG 106	NA
2N2396	NA	NA	GE-20	NA	TR-87	PTC 123	HEP-S0004	SK 3124	RT-100	ECG 123	NA
2N2397	NA	NA	GE-20	NA	TR-87	PTC 123	NA	SK 3124	RT-100	ECG 123	NA
2N2398	NA	T-2	GE-9	ICC-2	TR-17	PTC 102	HEP-2	NA	NA	ECG 160	ZEN 300
2N2399	NA	T-2	GE-9	ICC-2	TR-17	PTC 107	HEP-2	NA	NA	ECG 160	ZEN 300
2N2400	RS276-2003	T-3	GE-1	ICC-3	NA	PTC 107	HEP-3	NA	NA	ECG 160	ZEN 301
2N2401	RS276-2003	T-3	GE-1	ICC-3	NA	PTC 107	HEP-3	NA	NA	ECG 160	ZEN 301

NA = NOT AVAILABLE

(continued next month)

R-E's Service Clinic

Off Color Stories

Three basic symptoms; causes are myriad

JACK DARR
SERVICE EDITOR

THESE AREN'T THE KIND OF OFF-COLOR stories we tell each other after service meetings. It's the kind of annoying things we run into when the colors are "*almost right, but not quite*" in color TV work. Most of the time we get nice definite symptoms, like colored bars up and down the picture, green faces and blobs of color floating around.

These troubles can be divided into two major groups. One, where there is no normal color in the picture, but there are colors on the screen, in blobs or bars. Two, where there is color in the right places, but it's the *wrong* color. Then there's a sub-group where the whole screen is tinted.

To get rid of this second one fast, it's usually the picture tube, or an incorrect setting of a screen control, that's causing the trouble. The set that came on a bright green, then delivered a good picture after about five minutes had a slow-heating *pair* of guns, red and blue. The green gun wasn't gassy, as we suspected. A heater-cathode short in one gun will cause a similar symptom, though this is usually permanent. This type of trouble can often be cured with an isolation-type "brightener" set to isolate only.

Screen-circuit voltage problems produce the same symptom. In another set, the green screen control wouldn't put the raster out at all. However, since we were able to get the other two set to match it, and make a perfect black-and-white and color picture, we left it for the next time when it *had* to go to the shop.

Most of the true off-color problems are due to defects in 3.58-MHz oscillator phasing, distortion in the color demodulators, and odd defects in parts in and around the demodulators. All of them will respond to a little serious reasoning, and the right interpretation of the clues on the picture-tube screen.

Intermittent colors

In the intermittent-color or wrong-color department, look out for funny things happening in the horizontal oscillator/afc output section. This can affect the shape and size of the keying pulses used in the color section, since these come from the flyback. The important thing here, is the *phasing* of the keying pulse.

Even though the picture seems to be fairly stable horizontally, it's possible for the pulse to be far enough off for the keying pulse to be out of range, which in turn upsets the burst-amplifier stage. This results in an intermittent, or weak burst. Then, you get a "*colors jump in and out*" complaint. Before making any other tests, be sure that the horizontal-hold control is set as near to the center of its range as possible.

The fine-tuning can also cause trouble here, for the same reason, and aft can, too. These circuits are simply discriminators; and incorrect alignment or a leaky transistor can make the fine-tuning drift, just the opposite of the intended effect.

In cases where colors are correct, but have a tendency to jump in and out very suddenly, look to the color bandpass amplifiers. These stages handle all color signals, and they are the most likely source for this complaint.

No color—odd color cases.

One of the "*no color in picture but color present*" cases was a Zenith 20X1C38 chassis. The symptoms were a bluish screen, with two vertical color bars, red and green, about 1.5 inches wide, at the far left edge of the screen. No normal colors in the picture at all. To make things simpler, this was an intermittent condition. The black-and-white picture was slightly brownish, but with good detail, indicating that the Y channel was probably OK.

Turning the color control full-on made the picture bright blue, with the vertical color bars much stronger. This also caused a very bad defocusing.
(continued on page 66)

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

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

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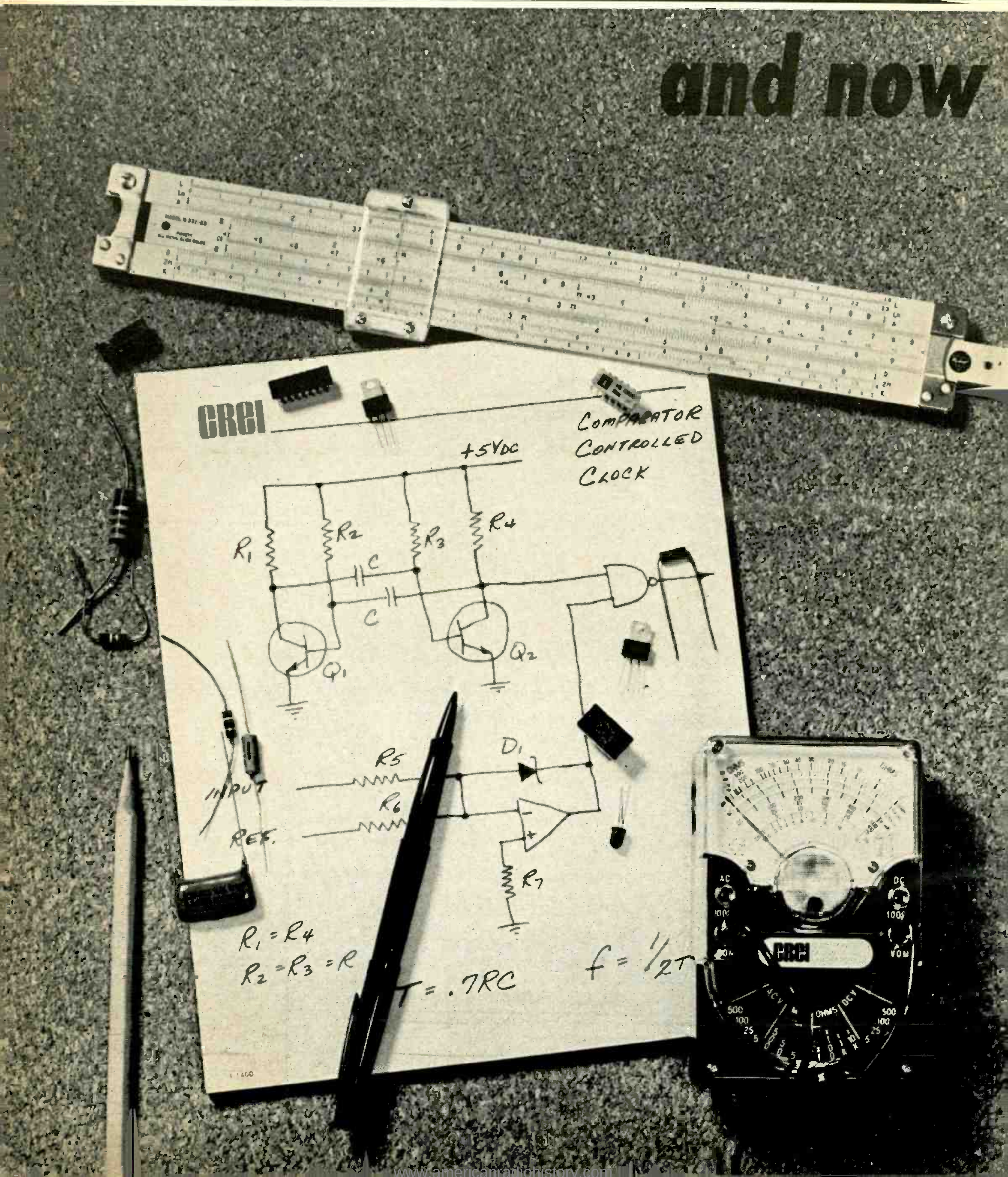

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SERVICE CLINIC
(continued from page 61)

Brightness and contrast controls worked. Tubes in the color circuits were changed, without results.

The dc voltages were "odd". None were missing completely, as I'd hoped, but all were off. Some were high, some low. Voltages on the phase-detector and killer diodes were well out of balance, which gave me a starting point. The 3.58-MHz oscillator was running. Color signal patterns on the R-Y demodulator were low, but the B-Y signal looked almost normal.

Fine-tuning reaction was normal, with color fringes (worms) showing. So the bandpass amplifiers (color amplifiers, in this set) were working. This confirmed the suspicion that the trouble was somewhere in or around the 3.58-MHz oscillator. The drastic unbalance in the control voltages could mean that the oscillator was running but was being thrown so far off normal frequency that it couldn't make normal colors, or indeed any at all.

Killing the burst and checking the reactions of the color oscillator showed that it was working. OK, it has to be something in the burst amplifier. A little judicious punching and hammering around finally disclosed an intermittently-open screen-bypass capacitor, on the burst amplifier tube. (see Fig. 1).

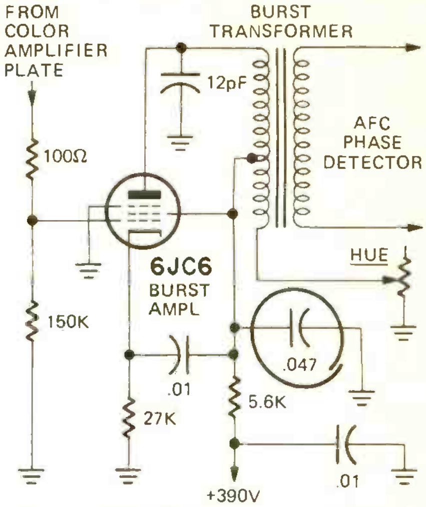

FIG. 1—INTERMITTENT screen-grid bypass capacitor in burst amplifier of Zenith 20X1C38 caused all kinds of symptoms.

This was apparently allowing the stage to develop some kind of parasitic oscillation, that threw the burst far off-frequency, and caused some kind of ringing reaction, with transient bursts of oscillation which made the colored bars on the left side of the screen, and the blue-screen symptom.

On a Zenith 20Y1C37 chassis, colors were present, but odd. Flesh tones *"just didn't look right"*, and there was a certain amount of drift in the color. To make a long story short, this was finally traced back to an unbalance in one of the 6ME8 high-level demodulator tubes. The dc voltages on the deflection-plates of this tube were unequal (see Fig. 2). These should always be equal, or within about 5 volts of each other. Plate voltages weren't too close, either. For a quick-check on this, just swap the tubes. If the unbalance moves with the tube, throw the tube out! Check against the other tube. Incidentally, if both tubes are fairly old, it's a good idea to replace both of them. I changed only the unbalanced one, and had to go back a week later to replace the other one. (Same symptoms, different colors.)

Grid leakage in a diode?

Some very odd color problems can be caused by a bad tube or crystal diode, if it's in the color afc/acc stage. The diodes must be perfectly balanced if they're going to work. A lot of sets use the 6JU8 quadruple diode tube. If this tube develops leakage between sections, look out! This is undoubtedly something like mount-contamination inside the tube, but it reads as *grid emission* on that type of tube-tester. If

(continued on page 70)

SOUTHWEST TECHNICAL PRODUCTS CORPORATION

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December, 1973

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Daniel Meyer

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SERVICE CLINIC

(continued from page 66)

everything else seems to be in fairly good shape, try a new 6JU8 before you start digging into other circuits, and most especially before you try any *realignment!*

Sparkle plenty

In a GE KC chassis, colored sparkling and flashes were seen on the screen, mostly at the right and left sides. This eventually turned out to be a bad horizontal output tube, even though the raster was full width, and there was plenty of high voltage. Seemed to be something similar to a Barkhausen oscillation, though there were no vertical bars on the screen. Try a new tube first.

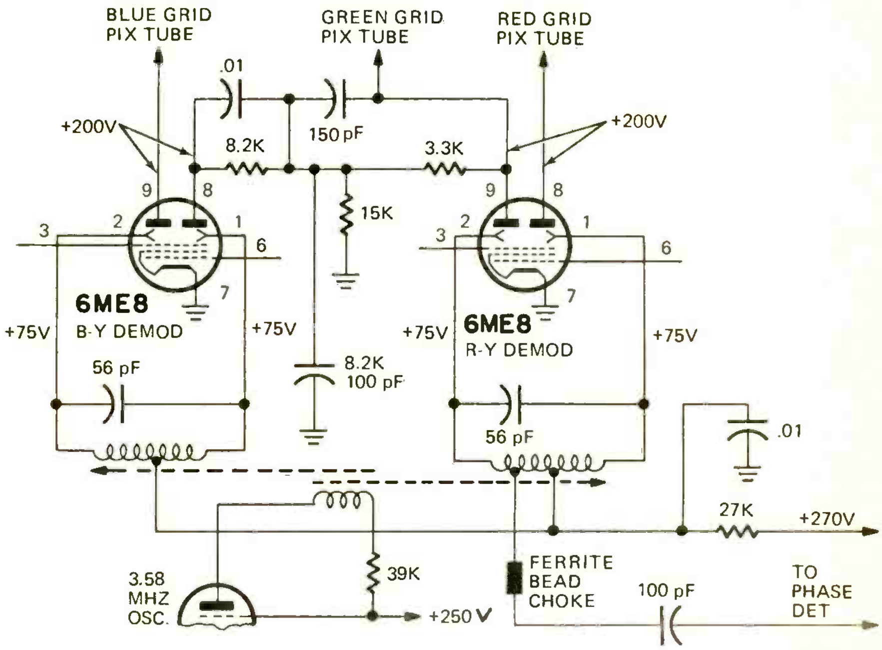


FIG. 2—DC VOLTAGES ON DEFLECTION PLATES of 6ME8 color demodulators should be equal.

Hybrid video amplifier stages

Y-channel or video problems can cause "color troubles" (In quotes because these aren't really color trouble, but they sure look like it.) This is especially true in sets with tube/transistor video amplifiers. We can have troubles that we don't expect if we forget that transistors can do things that tubes can't, such as shorting between input and output.

One of these is a shorted transistor, that lets the video signal go through. However, it is slightly weak, and most important, it loses one phase inversion of the *signal-polarity.* So we arrive at the picture tube with the brightness or Y-signal exactly opposite to what we'd like. In other words, a nice but *negative* picture.

You have never seen anything more peculiar-looking than a good color picture with the video signal upside-down. Make it a habit to check for this; it's easy. Just turn the color control all the way off, and look to see if the black-and-white picture is negative.

Beside the shorted transistor, it is possible to develop shorts on the printed-circuit board which will have the same effect. Also, if the video transistor is a plug-in type, you can pull the transistor and accidentally reinsert it reversed. (I thought this would blow the transistor, but it didn't.) It will make a negative picture, though. **R-E**

reader questions

TRIPLE TROUBLE

This one came into my place, and turned out to be a good illustration of the principle "Fix all the simple things first, then take the hard ones one at a time". It was a Zenith 12A10C52 with a bright green screen, a light horizontal bar halfway down, and a bad flicker. The picture looked very pale and the focus was poor.

So one at a time; the green screen was cleared up by running a grey-scale adjustment HEIGHT and VERTICAL LINEARITY controls were checked. They reacted properly, but the picture was still bad. It finally dawned on me; this was a very familiar symptom; I had two pictures, with a very bad flicker. This is a characteristic symptom of shorted capacitors in the feedback loop. Turned out to be the first one I checked, the .0047 μF.

Now the vertical problem was fixed. I had a very pale picture, poor focus and the agc control wouldn't react normally. The focus problem was cleared up by adjusting the focus control. (Evidently this set had suffered some REA "Random Experimental Adjustments".)

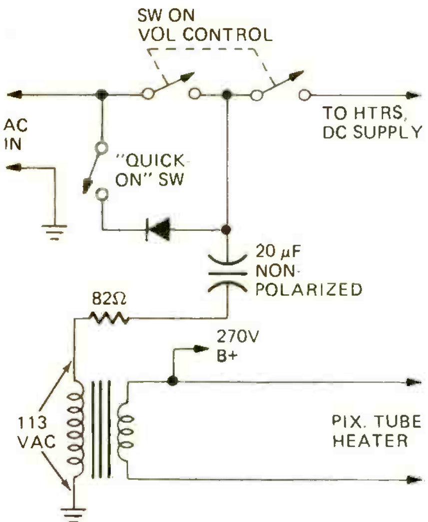
Checking the agc, I found that the voltage was normal going into the solid-state i.f. strip. Control varied it, but no reaction in picture. Signal at i.f. output much too low. Taking the i.f. stage off the chassis, and checking it carefully under a big magnifying glass, two leads of the first i.f. transistor were found touching each other. Base and emitter, of course.

Clearing this short fixed the i.f. problem, and the agc now worked as it should. Only one problem now; the set had been on its side; when I turned it right side up, it quit. This was tough; I had to plug one of the leads to the i.f. stage in more firmly, and that cleared that up. Now it worked.

PICTURE TUBE HEATER DEAD

This Emerson 129021 "Montclair" has a series heater string. All other tubes are lit, but the picture tube heater is dead. The tube tests OK.–R.R., De Queen, Ark.

The picture-tube heater in this set is fed from a small transformer: this is



for "Quick-on" circuit. The primary of this transformer has a diode, and a non-polarized electrolytic capacitor in series as shown in the diagram. Check for ac voltage across the transformer primary. If you don't get the normal 113 volts ac, either the diode or the capacitor is open.

COLOR POPS IN AND OUT

The color is intermittent on this Zenith 12B8C15. Acts like color-killer trouble, but this one doesn't have a killer. I can rap on the chassis near the IC demodulator, and make it act up.–A.M., Philadelphia, Pa.

Check the IC socket; if it is tight and clean, I believe I'd try a new demodulator chip. This has been the cause of this kind of trouble, in some of these chassis.

VERY SLOW HEATER

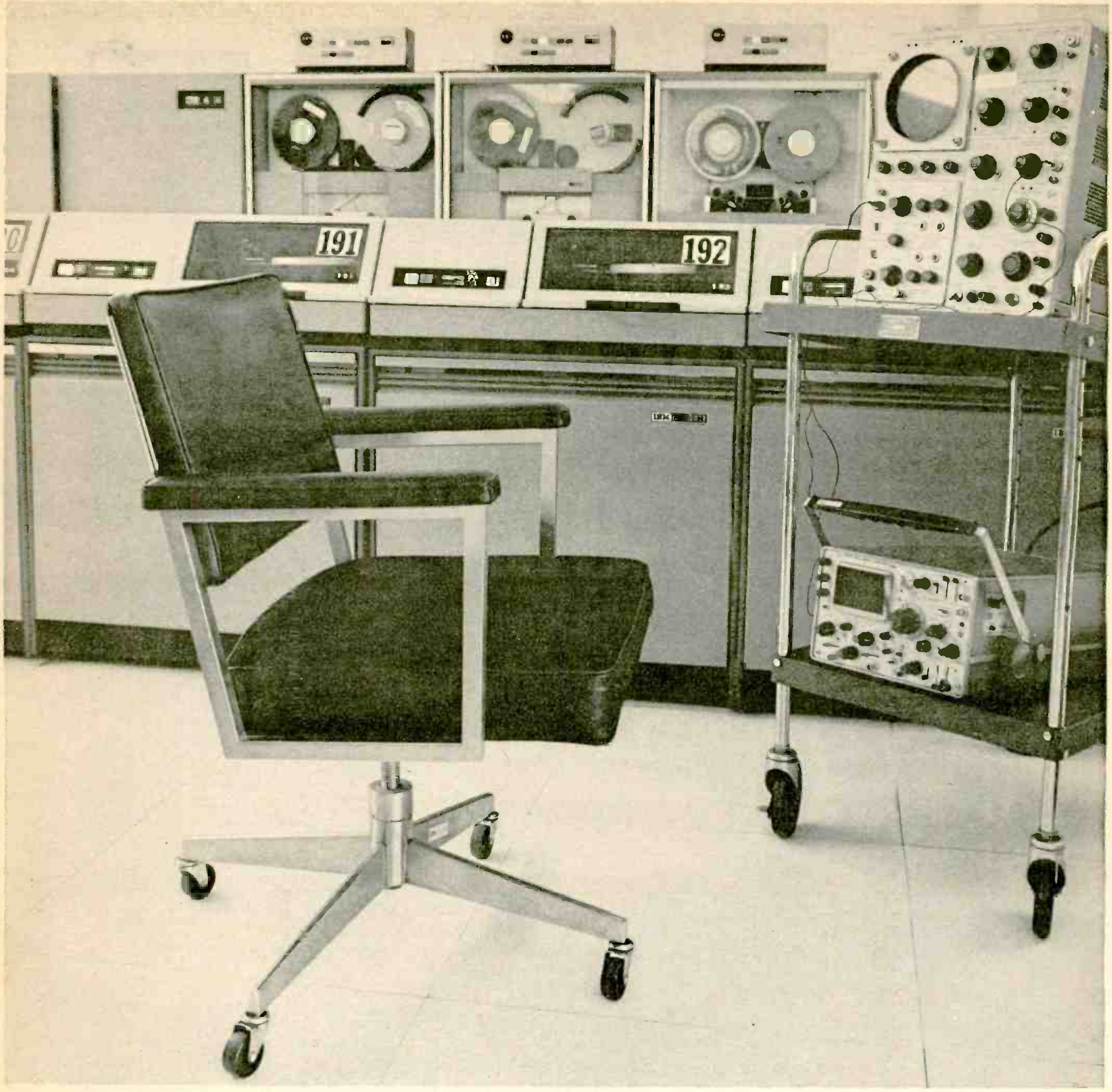
Tony Brzewiski, of Starco Communications, Campbell, N.Y. writes, "I've run into the same problem that L.F., of Poughkeepsie, N.Y. had; the set which was a very slow heater (**Radio-Electronics** December 1972, page 70) ***In mine, the resistance of the flyback, from high-voltage rectifier plate cap to horizontal output plate cap read 50,000 ohms. It would get up to about 5kV in 20 minutes, and up to almost full voltage in an hour. Resistance went down to about 5,000 ohms. Changing the flyback cleared up the problem."***

Thanks, Tony. Evidently, you and L.P. had the same problem.

SYNC CLIPPING

The complaint on this Philco 12N50A was loss of horizontal sync. I

(continued on page 76)



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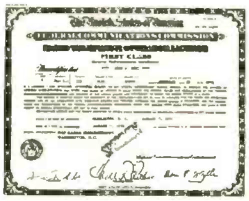

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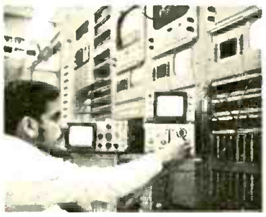

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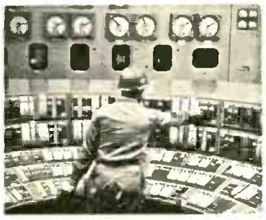

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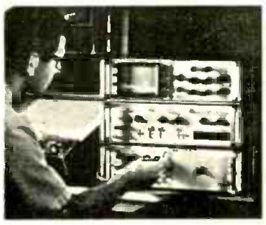

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READER QUESTIONS

(continued from page 71)

found that if I kept the contrast control below half-on, it worked fine. When I turn it up, it works just like an agc control turned too far. The agc works, by the way.—A.W., Mascoutah, Ill.

The contrast control in this set varies the gain of the video output tube by changing the screen grid voltage. I'd suggest checking the values of all resistors in that circuit. More likely, perhaps, that 5-μF electrolytic screen by-pass. If it is open, you'd get a severe degeneration, and this could be causing what looks like a very severe sync clipping. The video signal for the sync separator and agc comes from taps in the video plate circuit. So if you're clipping, it would upset all of them.

PICTURE DISAPPEARS

The picture will disappear on this RCA CTC-17X. It goes so quickly that I can't tell whether it's blooming or just fading out. After the raster goes dark, I can see a couple of faint lines at the left side. These weave and bend. The high-voltage stays up, pretty well.—W.R., Spokane, Wash.

If you're losing the raster, but the high-voltage stays up to say not less than 20kV, then the root cause of this would be something in the picture tube *biases*. In other words, the tube is simply being cut off, either by too much positive voltage on the cathode or too much negative voltage on the grids. Monitor both of these, and see which one changes when the picture goes out. You'll probably see a change of about 50 volts, to cut the tube off completely. Check the blanking circuitry, too, and the kine-bias control.

FOUR BLACK BARS

The screen of this Zenith 20Y1C48 shows four black bars, covering the right 2/3 of the screen, about 3 inches apart—D.W., Rochester, N.Y.

The most common cause of this kind of trouble in these sets is the horizontal blanking diode. If it gets slightly leaky, or shorts, it will let the blanking pulse and the ringing along the baseline get through. It's not supposed to let that baseline get by.

This is a tiny diode, located under the chassis, in the center of a triangle formed by the 6EJ7 burst amplifier, 6JU8 and 6KT8 second bandpass amplifier tubes. Take it loose, and check it; better still, try a new one.

There's one other possible cause for this, but let's hope it's just the diode; the other one requires a new flyback. (Usually makes *white* lines, if this is it.)

LOSS OF VOLUME CONTROL

This Westinghouse BP19A770 TV has an odd volume control problem. Most of the time, the volume control won't reduce the volume at all. Full on. You can turn it off and on, and then it works for a while.—A.S., Northfield, N.J.

This problem is almost certainly caused by a poor *ground* connection on the control itself. All volume controls like this are "audio voltage dividers." If the ground opens, all you have is series resistance, and this isn't enough to hold down the volume.

The control itself is on the front panel, connected to the chassis through a shielded cable. The shield of this is used as the ground return for the audio signal. This does not go to chassis ground in this model, but to the top of a 330-ohm resistor in the 6AQ5 tube's cathode. Trace this, and fix the bad joint.

BLANKED COLOR

This GE H-3 portable color TV has a peculiar problem. According to the owner, several months ago the color

started disappearing on the right side of the raster. Now, it gets color only on the left ¼ of the screen! The monochrome picture is good over the whole screen. Color and tint controls have what seems to be a normal effect on what color there is. I'm puzzled!—M.M., Los Angeles, Calif.

So am I. Let's rub on the crystal ball and see what we can see. Obviously, your *blanking* circuitry is overdoing things just a little. In this chassis, blanking is fed into the cathodes of the 6AC10 color difference amplifiers. So, you're actually blanking only the color.

It sounds as if the blanking pulse is far too wide, or badly distorted. Check the coupling capacitor between the blanker and the 6AC10 cathodes, as well as the blanker tube and 6AC10 itself, and all resistors.

60-HZ HUM BAR

This RCA CTC-36 came in with a bad circuit-breaker. Now, it has a 60-Hz hum-bar and it can be moved and controlled by the vertical hold control. It's not a very dark bar, but I can see it even with the switch in the Raster position. I've scoped all of the filters, with no luck.—A.D., Salidas, Colo.

If this is a single hum-bar, then it's definitely 60-Hz, and not too apt to be due to power-supply ripple, which is 120 Hz. Source must be the vertical output stage, which draws a high pulse of current once each field. So! This pulse can get into the video in two ways; one through the dc power supply, and also by *coupling*. If you can't see the pulse on the dc power supply lines, check around the video input to see if there is any place where it could be coupled into this. Move some of the wires, etc., and see if this won't help. Also, check for heater-cathode shorts, in the video output tube.

COLOR BLOOMING

This Zenith 20X1C38 has an odd symptom. There is little or no blooming on a monochrome picture. However, on color programs, it blooms. The higher the color control is set, the worse the bloom. Everything seems to be normal, except that the picture tube screens have to be set about 300 volts higher to get normal brightness, when the service switch is returned to normal. What causes this?—R.H., Aurora, Ill.

I think *you* just told *me*. I started to say "Check to see if the picture-tube screen controls aren't set too high." This will often cause color blooming or plain blooming. This would be necessary, if you have some other fault which makes it necessary to run the screens up to get a picture.

The most likely place for this would be in the picture tube grid circuits. If these voltages are too low (too far toward negative) this would reduce the beam current; this could be "corrected" by advancing the screen controls. However, the real fault will be in something that affects the grid voltages on the picture tube.

Since all colors are affected, check the *supply* voltage for the grid circuits, including the tubes. You'll probably find a dropping resistor that has increased in value, or something like that.

FALSE KEYSTONE

This Zenith 14A9C51 chassis has a bad blooming; picture goes out of focus, pulls in from the sides and then disappears. Just as it goes out, the raster keystones, pulling in at the bottom half, before it dims out entirely. The high-voltage goes way down. 6LB6 control grid reads −60 volts, but the screen read +190 volts.—G.W., Pittsburgh, Pa.

OK, let's see. You've tried all the tubes, so that takes care of the high-voltage rectifier (most common cause). Your 6LB6 grid voltage shows that you have enough drive, so that looks good. However, the high screen grid voltage seems to be telling us that this tube isn't drawing *enough* current. In other words, not putting out enough power, which is a basic cause of blooming.

Try this; read the boost voltage. If it is low, read the 6LB6 cathode current. If this current goes *higher* when the high-voltage goes out, something is loading it down; shorted turns in the yoke, possibly indicated by the keystoning. A short here would also cut the boost. (Look for open boost capacitor, while you're there.)

There's a Zenith factory note on "false keystone," caused by an open 18- or 30-µF electrolytic capacitor (depending on which chassis), in the waveshaping circuit of the pincushion corrector. It is connected from the screen grid of the vertical output tube to ground. Check it, just for luck.

HORIZONTAL DISPLACEMENT

I've got a peculiar trouble in a GE CW chassis. Vertical lines in the picture, or on a crosshatch pattern, are displaced to the right when they cross a

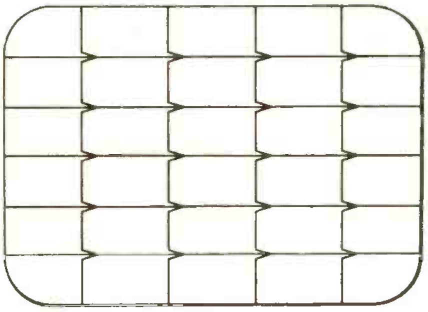


Fig. 1

horizontal line. (Fig. 1) In a picture, I've also got a group of scanning lines that are too widely spaced; this covers about a couple of inches, and sometimes floats up and down a little. What causes all of these weird symptoms?—R.G., Reno, Nev.

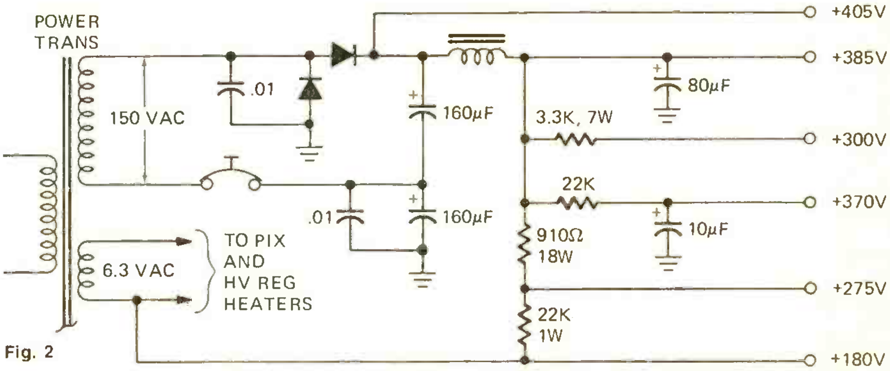


Fig. 2

Whenever you find a large group of weird symptoms, apparently due to trouble in several stages at once, look for something *common* to all of them. In other words, the power-supply.

Most likely culprit in this case, and one that I've seen cause just the same thing, is one of the doubler capacitors. Probably the lower 160-µF electrolytic in the dc supply (see Fig. 2). If its capacitance has decreased or if it has a high power factor, you'll have a very odd ripple in the dc. This will get into the horizontal oscillator.

VTVM DRIFT

My Heathkit IM-13 vtvm has a drift. When it's on dc volts, the meter needle slowly swings to the right, all the way off scale. Acts up on ac volts, also. The ohms scale seems to be OK.—E.N., Hensall, Ont.

The most likely cause for this would be an unbalanced "meter tube". This Heathkit uses the "meter between cathodes" circuit, standard in many VTVM's. If the two triodes of the tube have unequal emission, or grid emission, you'll get this kind of trouble.

Age a new 12AU7 tube, by letting it sit in the tube-tester all day with only the filament voltage on it. Then try it. Recalibrate the meter on dc volts as per the instructions. You *might* have to try one or two new tubes, but I doubt it. One good tube will usually do it.

CIRCUIT BREAKER POPS

The circuit breaker opens up this 12-inch RCA HSK-T1, which I built from a kit. I've checked everything they told me to, no results. The only way I can get it to hold is pull the high rectifier. If I hold a neon lamp near the plate lead, it glows brightly. I've tried a new high-voltage rectifier; no help.—M.R., Gregory, Mich.

Most likely cause is some kind of short or leakage in the high-voltage lead from the rectifier socket to the picture tube. Since you eliminated the chance of a shorted high-voltage rectifier by replacement, this is about all that's left.

CONVERGENCE BOARD PARTS HEATING

After I replaced the picture-tube in an Admiral H1 chassis, I noticed that the blue controls on the convergence board were overheating. R201 burned up. I replaced it, and the diode, and the new control smoked too.—A.K., Struthers, Ohio.

Most likely cause, a misadjustment of the BLUE SHAPER coil. Try this: Connect an ac vtvm to "P" on the convergence board, common lead to convergence panel frame. Adjust L604, the BLUE SHAPER for maximum reading, then turn the slug two turns counterclockwise.

A factory note recommends replacing R201, a 2-watt control, with a 3-watt type (Admiral part No. 75C64-39), and adding a 30-ohm 5-watt resistor in series with it. You can cut the foil and mount the fixed resistor on the foil side of the board.

CALIBRATION DRIFT

My RCA WO-33A scope has a problem! After adjusting the calibration, and using it for about 10 to 15 minutes, the vertical deflection drops to about half of normal. Vertical gain control won't bring it back. If I turn it off and wait a while, it comes back.—J.C. Palm Beach, Fla.

You seem to have a really good thermal. Since changing tubes didn't help, this is apt to be a resistor that is drifting in value as it gets hot. Take a full set of dc voltage readings on the 6BR8 and 6BK7 tubes, in the vertical amplifier, with the scope cool and working normally.

Wait until the problem shows up, then repeat the voltage readings. This should show up something. You can also use the old faithful "Heat and/or Cool" tests for thermal resistors. Heat them up with a soldering iron, or spray coolant on them after the trouble shows up. Replace any that show a change in voltage.

QUESTION ON RESISTOR BURNOUT

In "Reader Questions", June 1973, p. 70, you said that "The only thing that causes current to flow through this resistor is the tube" ("Resistor Burnout" Zenith 15L33.) Something is wrong here! You would have current flowing through the 1500-ohm resistor from the +270 volts and those two 56,000-ohm resistors, too, wouldn't you?—Alex Billos, Bayonne N.J.

You're correct, as far as this goes. *Some* current would flow through the clamp circuit resistors. However, adding this up (112,000 ohms total), and using Mr. Ohm's Law, you'll see that this will be only 2.38 mA. This minute current will not develop enough *power* ($I^2 \times R$) to damage the 1500-ohm resistor. A direct short in the tube will (and did!). The resistor can handle around 18 mA with good ventilation and air flow.

The statement that "*only* the tube will cause current to flow through the 1500-ohm resistor", in *this* circuit, isn't precisely correct. I should have clarified that, and thanks. **R-E**

new products

More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card inside the back cover.

4-CHANNEL RECEIVER, *Eight Deluxe* accepts three sets of speakers and drives any two of them simultaneously. Rated at 60 watts (rms) per channel into 8-ohm speakers. Bass and treble controls are stepped in five 3-dB gradations at 50 Hz and 15,000 Hz. Bass and treble controls are variable at ±15 dB and mid-range at 1 kHz varies ±5 dB in 5 steps.

Signal strength and center tuning meters, pushbuttons for high and low filters, loudness control, mono switch; noise reduction adaptor switch, two tape monitors, 4-channel adaptor and FM muting switch.

Frequency response for power amplifier is 5 to 50,000 Hz ±0.5 dB, - 1 dB with less than 0.2% distortion at rated

output. FM tuner provides IHF sensitivity of 1.7-mV with total harmonic distortion in stereo of 0.5%. Capture ratio is 1.5 dB, selectivity better than 80 dB, signal-to-noise ratio of better than 65 dB. Separation at 400 Hz is better than 35 dB. 17⅝"W x 5-9/16"H x 12-15/16"D; 35.7 lbs. $599.95.—**Sansui Electronics Corp.,** 55-11 Queens Blvd., Woodside, N.Y. 11377.

Circle 31 on reader service card

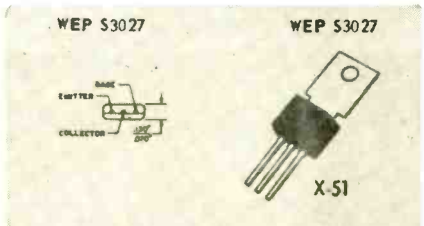
MULTIMETER COUNTER, *3420* combines a 4-digit multimeter that measures ac and dc voltage and resistance, with a 5-digit 20-MHz counter. For frequency

measurements, this unit offers 100-mV sensitivity to 20 MHz. With full 5-digit display, 99999 maximum reading frequency can be made. Maximum resolution to 0.01 Hz on any measurement.

As a multimeter, it has five dc voltage ranges from 10-mV to 1,200 V; five ac voltage ranges from 10-mV to 1,000 V; and six resistance ranges from 10 milliohms to 10 megohms. Accuracy of basic dc function is ±0.01% of reading ±1 digit. AC bandwidth is from 30 Hz to 50 KHz. 3½" x 8⅜" x 13"; 10 lbs.; $750.00.—**Hickok Electrical Instrument Co.,** 10514 Dupont Avenue, Cleveland, Ohio 44108.

Circle 32 on reader service card

SOLID-STATE SEMICONDUCTORS, *WEP series* are uniform, pre-priced and color-coded packs contain full specifications, basing diagram with symbol and ratings on reverse side. Consists of about 200 numbers that provide one-for-



AUDIO POWER AMPLIFIER

Characteristics	Symbols	Rating	Unit
Collector-Base Voltage	BV_{CBO}	35	Vdc
Collector-Emitter Voltage	BV_{CEO}	35	Vdc
Emitter-Base Voltage	BV_{EBO}	4	Vdc
Collector Current	I_C	1.5	Amps
Total Dissipation	P_D	8	Watts
Small-signal Cut-off Freq.	f_t	50	Mhz
Current Gain (beta)	h_{fe}	110 Typical	

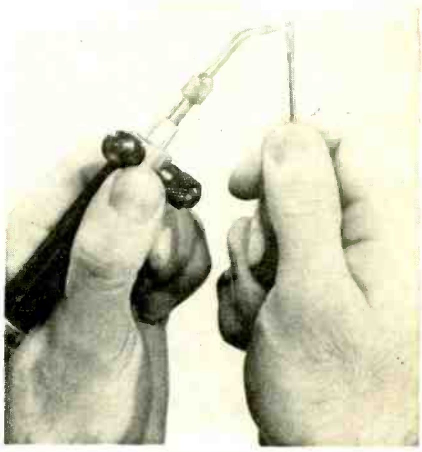
Complete cross reference of all WEP devices with JEDC and manufacturers numbers, available

one replacement against competitive numbers and complete cross-referencing enables them to replace up to 1,000 numbers in other lines.—**Workman Electronic Products, Inc.,** Box 3828, Sarasota, Fla. 33578.

Circle 33 on reader service card

MINIATURE TORCH, *Little Torch* operates on oxygen and fuel gas; produces up to 6000°F. flames that are so small they can go through the eye of a needle. Five different size tips can be swivelled 360° to provide extra handling ease.

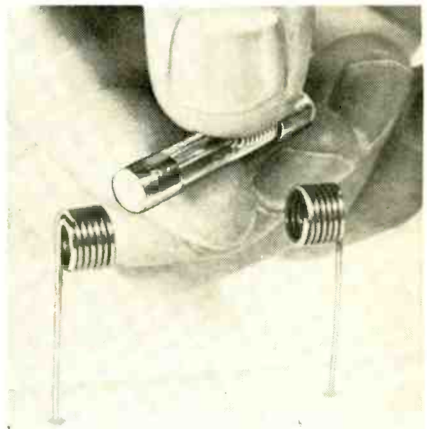
Welds metal smaller than .002" wire up to 16 gauge steel. Used for heat bonding, welding and soldering; used on glass, ceramics and most experimental metals with high melting points. Operates with gas pressures from 2 to 4 lbs per square inch and consumes gas at the rate of .023 to 2.54 standard cubic



feet per hour.—**Tescom Corp.,** 2600 Niagara Lane North, Minneapolis, Minn. 55441.

Circle 34 on reader service card

COIL-SPRING FUSE HOLDER replaces permanently installed pig-tail fuses by soldering leads of new spring holder to



stubs of removed pig-tail fuse. Accommodates TV, radio, hi-fi and other electronic device fuses. Spring steel with dip-soldered leads.—**Oneida Electronics,** Meadville, Pa. 16335.

Circle 35 on reader service card

AUTOMATIC TURNTABLE, *Dual 701* features all-electronic, low-speed, direct-driven, dc motor and two mechanical filters that cancel resonant energies that originate in the tonearm/cartridge system and in the chassis. Motor rotates at the record speed (33⅓ or 45 rpm) and platter is driven directly by the motor. Speed is controlled by a regulated power supply and monitored by two Hall-effect generators.

Two anti-resonance filters designed into the tonearm counterbalance provide smoother frequency response and isolate the stylus from such external sources of

mechanical disturbance as record warp, acoustical feedback and room vibration. $350.00 includes base and dustcover.—**United Audio,** 120 South Columbus Avenue, Mt. Vernon, N.Y. 10553.

Circle 36 on reader service card

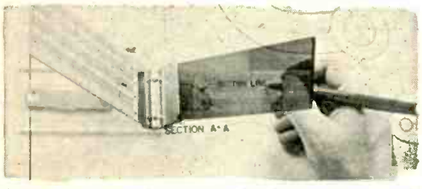
SOUND LEVEL METER, *model 370* determines sound pressure levels and helps pinpoint noise pollution sources. Operational range of from 40 dB to 140 dB in nine steps features omni-directional lead-zirconate-titanate ceramic microphone and selectable A, B and C weighted response; provides switch selectable fast and slow meter response.

Powered by two 9-volt transistor radio batteries; operating temperature

range of from 20°F. to 125°F.; temperature coefficient is + .02 dB/°F. in operating humidity range of 5 to 85% relative humidity 7¼" x 3" x 2"; 1 lb. with batteries; $250.00.—**Triplett Corp.,** Bluffton, Ohio 45817.

Circle 37 on reader service card

OPTICAL LETTERING GUIDE produces guide lines optically for vertical and sloping letters ranging in size from 4/32" to 10/32" and for special arrangements and sizes of letters up to 2" high. Eliminates the need to draw pencil guide



lines on drawings to obtain uniform lettering. Solid acrylic plastic base. Introductory offer: 20% off list price of $4.95.—**Phantom-Line Graphics Co.,** 955 Foothill Drive, Providence, Utah 84332.

Circle 38 on reader service card

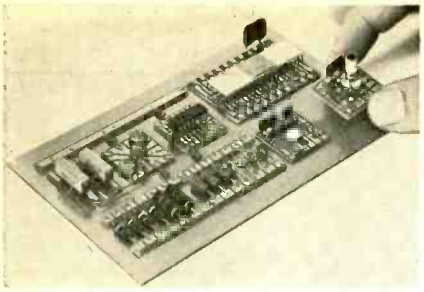
STEREO HEADPHONES, *HD-424* features "open-aire" design that eliminates need for bulky airtight seals. Oversize, soft-foam cushions reduce pressure on the ear. Removable head cushion is also

provided. 2,000-ohm impedance and high sensitivity; smooth, wide-range response.—**Sennheiser Electronic Corp.,** 10 West 37th Street, New York, N.Y. 10018.

Circle 39 on reader service card

BREADBOARDING SYSTEM, *Mini-Mounts* requires no holes to be drilled in the ground plane or mounting pads to produce a working circuit ready for environmental testing. Triple layer of adhesive and polyester film on mounting side of G-10 glass epoxy pad produces rigid, low-leakage structure ready for temperature, humidity and salt-spray testing. Because of low profile and short leads, resulting circuits will work at frequencies

Circle 21 on reader service card

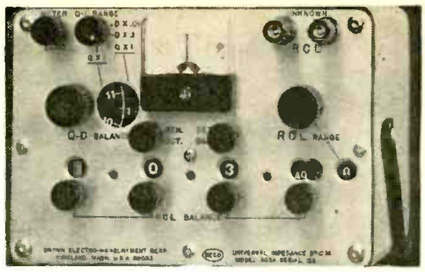


that are limited only by the components themselves.—**Christiansen Radio Inc.**, 3034 Nestall, Laguna Beach, Calif. 92651.

Circle 40 on reader service card

UNIVERSAL IMPEDANCE BRIDGE, *model 303A.* Generator and detector are built in and provide power and sensitivity for wide range of ac inductance and capacitance measurements and for dc resistance measurements. Four built-in ac bridge circuits measure series and parallel capacitance, series and parallel inductance and Q (storage factor) and D (dissipation factor) of the circuit or device under test. Fifth bridge circuit is a dc Wheatstone design for measuring resistance. Sensitivity permits clear 5-digit readout and maximum basic accuracy in all ranges.

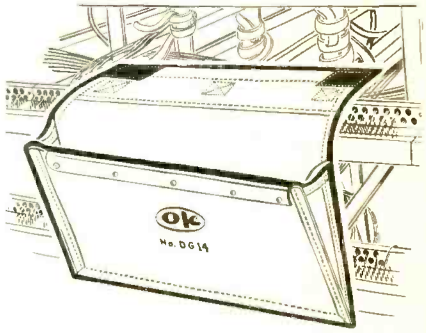
Five-place, direct-digital readout has automatically positioned, lighted decimal display; R, C, L units (ohms, farads, henries) and their magnitude are automatically displayed. No multiplier charts or dials for decimal locating and no slide wires, dials or scales to interpret. $335.00 with batteries.—**Brown Electro-Measurement Corp.**, 11060 118th Place N.E., Kirkland, Wash. 98033.



Circle 41 on reader service card

Circle 22 on reader service card

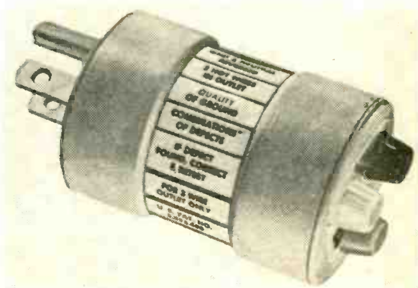
MAIN FRAME BAG, *Part No. D-G14* 17 inches wide and 18 inches high, gives the technician a catch-all for his tools. It prevents clippings and solder splatter from causing shorts. Three straps make attaching to equipment easy. End pockets for tool storage; heavy canvas duck, neoprene lining and web straps.—**O.K. Machine And Tool Corp.**, 3455 Conner Street, Bronx, N.Y. 10475.



Circle 42 on reader service card

RECEPTACLE POLARITY CIRCUIT TESTER *CiroTest* determines whether the wiring in wall receptacles is OK or whether various fault conditions exist. When unit is plugged into a single-phase, 15- or 20-amp, 117-volt, 2-pole, 3-wire, U-ground receptacle, its color-coded set of neon indicating lights signal if circuit is wired properly.

Can also tell if circuit is in reversed polarity; has either an open ground, open neutral or open hot wire; is wired with hot and ground wires reversed; has a hot wire on a neutral terminal or a hot terminal unwired. A glance at the Mylar side band tells the user what the color coding means.—**Circle F Industries,** Box 591, Trenton, N.J. 08604. **R-E**



Circle 43 on reader service card

new literature

All booklets, catalogs, charts, data sheets and other literature listed here with a Reader Service number are free. Use the Reader Service Card inside the back cover.

HARD-TO-FIND TOOLS CATALOG contains portable pump, versatile airbrush, glass cutter (straight or circular), eraser for rust, screwdrivers, drill with clamp, heat shrink plastic tubing, jeweler's saw blades, diamond glass cutter, swivel knife, blind rivets and garden tools. Many pictures; order form inside catalog.—**Brookstone Company,** Brookstone Bldg., Peterborough, N.H. 03458.

Circle 44 on reader service card

NC FLASHER, 70-page booklet features new precision instruments for photo equipment testing. Describes Shutter Timer and Comparasystem as well as repair shop equipment, precision tools kits, drawing and drafting equipment, precision layout tools, hi-intensity lamps, soldering irons, books, files and accessories.—**National Camera, Inc.,** Englewood, Colo. 80110.

Circle 45 on reader service card

TEST INSTRUMENTS CATALOG includes autoranging counters, programmable frequency counter, timer and scaler, digital multimeters, VTVM's, solid-state scopes, function generator, oscilloscopes, generators for audio and TV service work, color and audio generators, decade and substitution boxes, low- and high-voltage power supplies, strip chart recorder, recorder systems, mini-computer interface, modules and instrumentation aids, plug-in circuit cards and accessories and Ph meters. Contains complete specifications, photographs and prices.—**Heath/Schlumberger Instruments,** Benton Harbor, Mich. 49022.

Circle 46 on reader service card

TITAN IV CATALOG describes the receiver and receiver features, general features, transmitter and transmitter features and engineering, assembly and quality control of this CB communication system. Specification are on back page.—**Tram Corp.,** Lower Bay Road, P.O. Box 187, Winnisquam, N.H. 03289.

Circle 47 on reader service card

SINGLE SIDEBAND TRANSCEIVER CATALOG. Four-page brochure describes operational features of the 18-channel, 20-watt, para-military single sideband transceiver with unique side-step technique for 2-18 MHz usage. Focuses on operator performance features.—**Hallicrafters Company,** 600 Hicks Road, Rolling Meadows, Ill. 60008.

Circle 48 on reader service card

ELECTRONIC COMPONENTS CATALOG. 24 pages of electric counters, relays, capacitors, potentiometers miniature lamps, semiconductors, diodes, IC's, transistors, resistors, terminal kit, connectors, precision test equipment, vacuum components, high-voltage power supplies, transformers, indicator lights, pilot lights, electron microscope, power generators and vibration fatigue test machines. Includes many pictures and prices.—**Brigar Electronics,** 10 Alice Street, Binghamton, N.Y. 13904.

Circle 49 on reader service card

AUDIO COMPONENTS CATALOG, *Maxi-Fi* gives complete descriptions for eight receivers, ten speaker systems, nine tape decks for cassette and 8-track, couple of integrated amplifiers, FM tuner, turntables, headphones and accessories.—**Hitachi Sales Corp. of America,** 48-50 34th Street, LIC, N.Y. 11101.

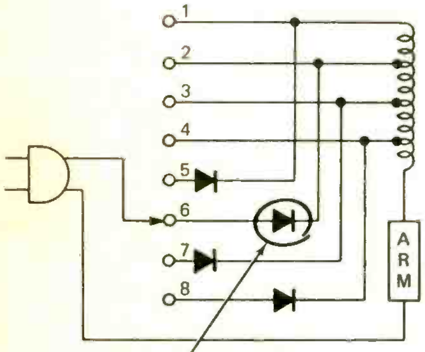
Circle 50 on reader service card

DIGITAL PRODUCTS CATALOG is a 6-page brochure that describes programming instruments and controls, timers, clocks, counting and measuring devices. Included is a complete listing of modular display units for custom digital instrumentation and a section that outlines their digital clock, multimeter and frequency counter kits.—**E S Enterprises,** 10418 La Cienega Blvd., Inglewood, Calif. 90301. **R-E**

Circle 51 on reader service card

APPLIANCE CLINIC
(continued from page 26)

you disconnect any of the wires, make a rough but detailed sketch of the black box, the shape of the control unit, the location of the motor, and, most important of all, the *color* and routing of all wires. That is, if they are color-coded, which I hope they will be. If they're not, stick little tabs of plain white surgical tape on *each*



THIS DIODE SHORTED

wire, and assign it a number. Then clip the wires so that the black box comes out and leaves the wiring in the unit.

Most of these control units are specially designed for this model only. So you'll probably have to get a new one from the dealer or distributor for that make. Take the make, model and serial number of the unit, and the old part itself, so that you can be sure that you get an exact duplicate. As far as I know, there are no such things as universal replacements for such things. Some of them may (and should be) interchangeable among different models from the same company, but that's probably about as far as we'll get, for a while anyhow. **R-E**

VERTICAL TROUBLE

This Zenith 14N22 has a bad case of vertical foldover. What's the most likely cause and which capacitor in this circuit is the most critical?—R.M., Wellsburg, W.Va.

All of them. However, with foldover, the most likely one would be the coupling capacitor between the input-section plate and output-section grid. See if it's leaky.

LOST SYNC

This Magnavox U21 chassis won't stay in sync. If it's set up for a good picture, it soon loses sync, both vertical and horizontal. I need help.—J.B., Va. Beach, Va.

No, you need some *sync.* Since you are losing both vertical and horizontal sync, look for a loss of output in the stage that handles *both;* the sync separator. Check the amplitude of the composite sync output, on the plate of the 6AN8, or possibly the 12AU7 sync inverter. Also bridge that 30-μF electrolytic on the +260 volt line.

BREAKER POPS WITH GOOD DIODE

Here's a weird one! If I remove diode D1 in this Admiral 5H10 chassis, the set works; good high voltage and focus. If I put D1 back in, the breaker trips. Even if I take off the loads, and unhook the degaussing coil, it still does it. What is this?—M.H., Del Rio, Tex.

Check that thermal switch. I think you'll find that it is grounded, or perhaps stuck closed. Certainly, *something* is causing this, and that's the only thing left outside of the bridge rectifier itself.

MIDDLE-STRETCH IN RASTER

This is a new one on me. I've seen pictures stretch at top or bottom, but never seen one stretch in the middle. What causes this?—M.P., Del Rio, Tex.

Most likely cause, the deflection yoke. Frankly, I don't know the exact nature of this defect, but I've cleared up quite a few cases of it by replacing the deflection yoke. Probably some odd short. **R-E**

REGULATED POWER SUPPLIES
(continued from page 56)

mA logic supply, a dual plus-minus 15-volt, 100-mA op-amp supply, and finally a dual, variable, 1-amp supply you can use for general lab use. If these basic circuits can't be used directly, you should be able to adapt them to fit your custom needs pretty well.

The 5-volt, 570 mA logic supply: We'll use the fixed 7805 positive regulator for this. It internally current limits at 750 mA and should be just what we need for a TTL or DTL system power supply. The dropout voltage is 2 volts. The maximum power dissipation at room temperature with a good heatsink is slightly over 5 watts. This means the maximum permissible voltage *across the regulator* is 5/0.75 = 6.7 volts. For this circuit, the permissible range of supply voltage is then 7 to 11.7 volts. Let's aim for a 10-volt supply with 2-volts worth of ripple, splitting the difference on both ends.

First, our capacitor size. An 8000-μF and 1 amp would give 1 volt of ripple. Similarly, reducing capacitance and current by one-quarter would still give 1 volt of ripple, or 6000 μF for 750 mA. Halve the 6000 μF for double the ripple, or 3000 μF for 2 volts of ripple. We can probably cheat just a bit and get by with a 2500-μF, 15-volt electrolytic.

Output voltage at the capacitor, in absence of ripple, should be 10 volts. Add a volt for the diode to get 11 volts. Multiply
(continued on page 86)

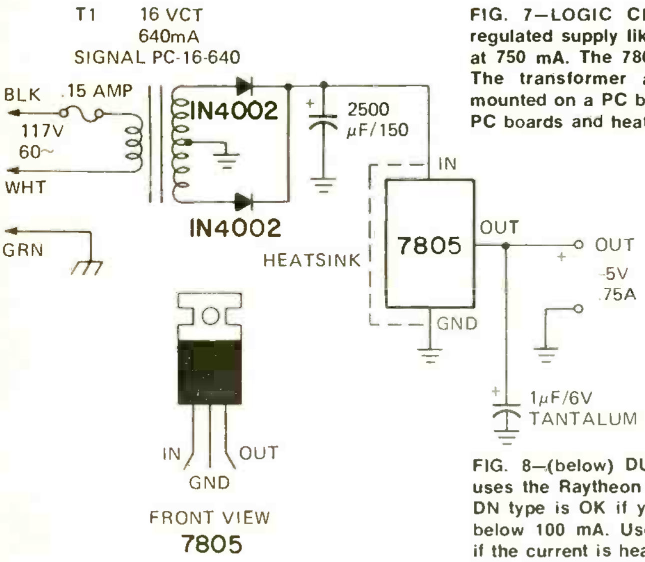


FIG. 7—LOGIC CIRCUITS often require a regulated supply like this that delivers 5 volts at 750 mA. The 7805 needs a good heatsink. The transformer and other parts can be mounted on a PC board. See text reference to PC boards and heat dissipation.

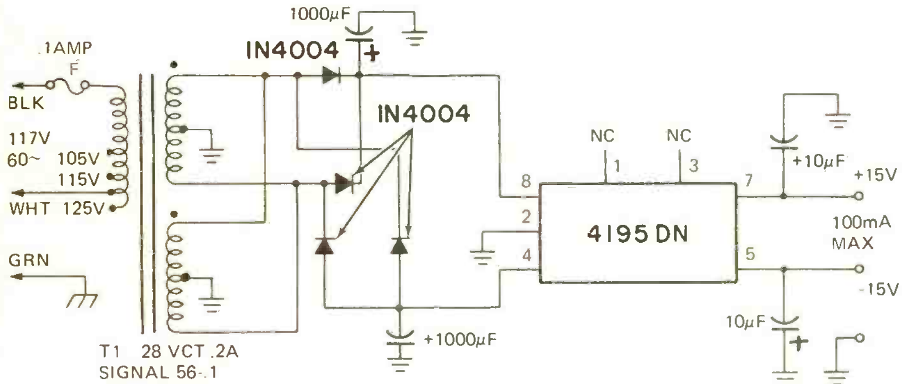


FIG. 8—(below) DUAL REGULATED SUPPLY uses the Raytheon 4195 series regulator. The DN type is OK if you keep current drain well below 100 mA. Use a more rugged regulator if the current is heavy.

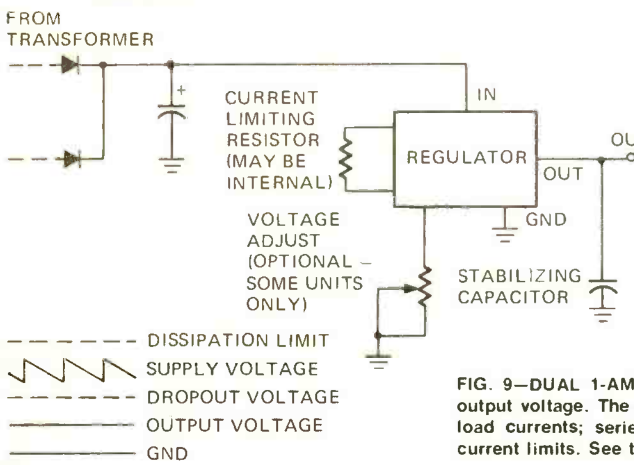


FIG. 9—DUAL 1-AMP SUPPLY has adjustable output voltage. The two transistors handle the load currents; series resistors determine the current limits. See text for details.

REGULATED POWER SUPPLIES

(continued from page 85)

by 0.707 and get 8 volts. Double this for a 16-volt center tapped transformer. We need a 16-Vct transformer at 750 mA. Let's cheat again just a bit and use a 640-mA transformer, the Signal PC16-640. 1½ × 1⅝ × 2", PC mount, and costing around $4.88, plus postage.

Figure 7 shows the circuit. A high quality 1-μF, 6-volt tantalum is used on the output for stability. The output power measured at the capacitor at maximum load is 10 volts × .750 ampere = 7.5 watts. The fuse should be 7.5/50 amp = 0.15 ampere. Load current limiting is automatic and internal. Any reasonable-sized standing-up type of heatsink can be used, or the regulator may be bolted to the case (be sure to insulate it!).

If we wanted a negative supply instead, there's several things we could do. If we *only* want a negative supply, simply call the +5 line "ground" and the common line "-5". Note that if we do this, we don't use the transformer winding for *any* other voltages, positive or negative.

Another alternative is to turn the whole circuit upside down and use a negative regulator. Devices such as the 78N05 or the 7905 have been announced and should be readily available by the time you need them.

Dual 15-volt, 100-mA op-amp supply: Would you believe only three parts? This time we use the Raytheon 4195, in the low-cost DN minidip plastic package if we aren't going to be using things at the 100-mA end too much, or in the more expensive and more powerful T or TK packages if we are.

The dropout voltage is 3 volts; the dissipation limit is 6 (with the minidip). Let's work on a 4–5 volt differential range as an input. One volt of ripple with 100 mA takes 800 μF. Let's use 1000. The input voltage has to be 20 volts (15 + 5). Add a volt for the diode to 21 volts. Multiply by 0.707 for rms to get 14.5. Double this for 29Vct. Use a 28-volt transformer. The Signal 56-0.1 does the job with both secondaries in parallel. Two inches square by 1¾" ($4.66 plus postage). Chassis mount this time.

This particular regulator takes larger, quality output capacitors; 10-μF tantalums are recommended. The final circuit is shown in Fig. 8. Input taps on the 56-1 transformer let you trim for optimum voltage range for your particular line voltage.

Variable 8–15-volt, 1-amp bench supply: This circuit is shown in Fig. 9. We add two pass transistors to a SG4501 regulator and properly heatsink them. About 5000 microfarads should do, and the transformer can be a 1 amp (one per side) such as the Signal 56-1. Voltage is adjusted with the potentiometer shown. You can set the current limit by changing the two 0.6-ohm series resistors. Doubling the value to 1.2 ohms gives you a 500 mA limit; 2.4 ohms a 250 mA limit and so on.

With these basic circuits as guidelines, you should be able to build up most any low-voltage regulator circuit you want. Always remember to work directly with a data sheet, provide the needed stabilizing and outboard components, and keep the input voltage to the regulator above the dropout voltage and below a value that causes excessive internal dissipation at high load currents.—*Don Lancaster* **R-E**

ANNUAL INDEX

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CMOS
(continued from page 36)

noise and wander around from a one to a zero and back again. If you find an experimental circuit that works for a few seconds or maybe even half a minute and then quits, chances are there is a floating input messing things up.

Rule 2 involves connecting test equipment. If you ever apply test signals from a low-impedance generator to a turned OFF piece of CMOS (One with the supply power removed), you can drive the protecting diodes into conduction. Get above 50-mA through the diode and you kill the IC. The way around this is to make sure that no input or output can deliver more than 10-mA or so under short or reverse supply conditions; this will protect everything. A good practice is to leave a K resistor in series with all input test signals, particularly if they come from a low-impedance source.

TABLE ONE
SOME CMOS MANUFACTURERS

HARRIS SEMICONDUCTOR
Box 883
Melbourne, Florida, 32901
305-727-5430

INSELEK
743 Alexander Road
Princeton, N.J., 08540
609-452-2222

MOTOROLA SEMICONDUCTOR PROD.
Technical Information Center
Box 20912
Phoenix, Arizona, 85036
602-244-6900

NATIONAL SEMICONDUCTOR
2900 Semiconductor Drive
Santa Clara, California, 95051
408-732-5000

RCA COSMOS DIVISION
Rte 202
Sommerville, N.J. 08876
201-526-3001

SOLID STATE SCIENTIFIC
Montgomeryville Ind. Park
Montgomeryville, Pa. 18936
215-855-8400

Rule 3 involves a CMOS bug that is being eliminated in newer designs. Its called SCR latchup, and can be caused by a momentary input signal transient or reverse polarity connection. The whole IC literally turns on as a silicon controlled rectifier and draws a bunch of current—like half an amp or more. If you can shut things down in time, there is no damage done; otherwise the chip self-destructs. This normally would only happen if you were very sloppy about testing—if a piece of CMOS ever feels hot, *disconnect power IMMEDIATELY*, and things should get better. With a reasonable amount of care in your experiments, this will never happen.

Rule 4 says to not go out of your way to static damage the devices. Most IC's are properly protected against normal handling and in-circuit operation, but go along with the game anyway. Keep unused devices in their protective foam or aluminum carriers. Return them to conductive foam afterwards. *NEVER USE STYROFOAM to store* CMOS! Don't solder CMOS into a circuit until all other parts are soldered in place, and then do the soldering quickly with a SMALL IRON. Above all, never probe around sloppily on a live circuit or attempt to make circuit changes with the supply power applied.

This may seem like a bunch of don'ts, but if you have had any experience at all with the older logic families, you'll have to agree that CMOS has the least hassle associated with its use.

Some linear tricks

One nice experimental thing about CMOS is that you can convert an inverter into an amplifier simply by connecting a 10-megohm resistor from output to input. Any gate can also be converted by suitable termination of unused inputs. Fig. 6-a shows the basic amplifier which has a gain of 10 to 30 along with a high input impedance and a pretty wide output swing. This is handy for amplifying and limiting test signals and inputs, and anywhere else you might like to do something analog in a predominately digital system. One very handy application is the crystal oscillator in Fig. 6-b. It's one of the simplest logic oscillators you can build and one of the best performing owing to the high circuit impedances. A CMOS buffer stage should be added if you want to reach the outside world with this circuit.

TABLE II
A FEW TYPICAL CMOS DEVICES

CD4001	(MC14001)	Quad Nor Gate
CD4007	(MC14007)	Dual Uncommitted CMOS pair w/inverter
CD4011	(MC14011)	Quad Nand Gate
CD4013	(MC14013)	Dual D Flip Flop
CD4016	(MC14016)	Quad Analog/Digital bilateral switch
CD4023	(MC14023)	Seven stage binary divider
CD4026	(MC14026)	Decade Counter/7 segment decoder
CD4046	(MC14046)	Phase Lock Loop
CD4049	(MC14049)	Hex inverter buffer
CD4050	(MC14050)	Hex non-inverting buffer

There's also a bunch of unique analog switching you can do with circuits like the MC14016, and you can even use the MC14049 and MC14050 as hex, bilateral, symmetrical electrically variable resistors, provided you add a couple of resistors and work with low level signals. This is particularly useful for percussion keying in electronic music. At six notes per package, that's only two IC's per octave needed for a high performance true two quadrant multiplier.

Learning more about CMOS

We're not going to give you any circuits here, mostly because we are out of space. Maybe you can show us some. We can suggest three good ways to get more information and more experience with CMOS:

1. Get the data sheets and data books from the Manufacturers of table 1. Everyone listed offers some sort of book or data file on CMOS. One of the oldest and best is the RCA COSMOS Integrated Circuits Manual and normally costs $2.50. Everybody else on the list will be more than happy to send you something—provided you request it in a professional way. Absolutely type or phone your request; if possible use a business letterhead. Another route is to use the bingo cards from the dozens of electronic trade magazines—available at a library if you can't personally qualify.

2. Get some CMOS and hook it up. A good choice might be two each of the MC14001, MC14011, and MC14007, and one each of the MC14013, MC14016, and MC14046. Even at list prices, this assortment should be under $20, and much less as surplus. Prices are sure to drop. Be sure to watch the Market Center ads in **Radio-Electronics** for CMOS bargains.

3. Watch Radio-Electronics for applications ideas. Steve Leckerts CMOS clock in the April 73 issue was the first major CMOS advanced experimenter project. Many of the plug ins in the Digital Grinchwal series of test equipment (starting November 1972) used or will use CMOS. And, of course, if you come up with a good circuit on your own that other advanced experimenter's might be interested in, we'd probably like to publish it and pay you for it to boot.

Regardless of where you go for more information, now is the time to learn about CMOS, for no other logic now available has as attractive a combination of features, particularly suited for advanced experimental uses. **R-E**

TAPE PLAYER WON'T CHANGE TRACKS

This auto-tape player will not change tracks. Even with the panel pushbutton, nothing happens.—W.H., Dunlap, Iowa

Most of these use a solenoid to move the head for track-changing. Check the dc voltage across the solenoid terminals while holding the TRACK CHANGE button down. If you get voltage, disconnect the solenoid and check it for continuity. In several of these, you'll find a diode shunted across the coil, for transient suppression. If it shorts, the solenoid won't work.

IONIZERS AND AIR-CLEANERS

I want to build some things like ionizers, and electrostatic air cleaners. Where can I find parts for these?—A.B., Fremont, Ohio

The Triad Transformer Co., 305 N. Briant, Huntington, Ind. 46750, makes quite a few special high-voltage power supplies for such things. They'll be happy to send you a bulletin on them. As a matter of fact, the high-voltage power supply of a junked TV set could be used too.

2 NEW SPEAKER SYSTEMS
(continued from page 50)

sponse for each of these three settings is plotted in Fig. 8.

Note that the actual woofer used in the *Interface: A* is an 8-inch speaker which yields an effective 6½-inch piston diameter. However, because of the "equivalent vent" approach, this small box can produce sound levels of 105 dB SPL and better without "break-up" and with only about 60% as much electrical power applied as would be required in the case of sealed enclosures. A photo of the complete *Interface: A* system, with its equalizer, is shown in Fig. 9.

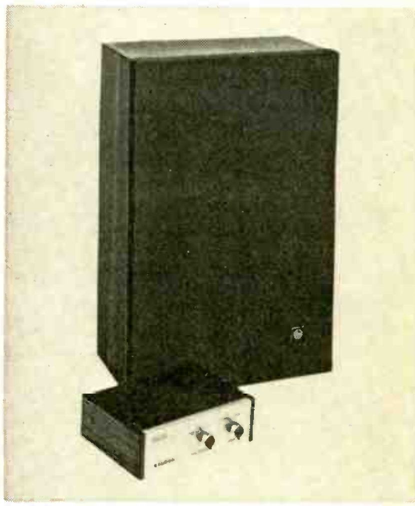
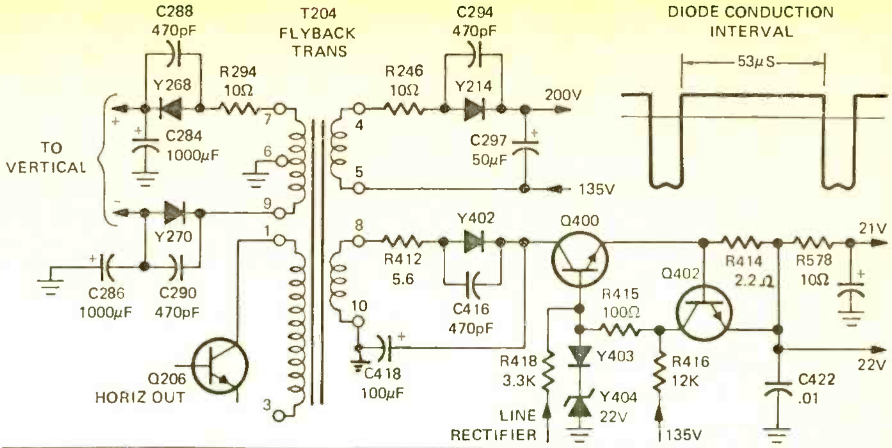


FIG. 9—ELECTRO-VOICE'S INTERFACE: A speaker system consists of speaker system and equalizer.

The BIC Venturi speakers and the Electro-Voice Interface: A are just two examples of products that were designed specifically to meet a new and urgent requirement. Now that the "high efficiency/small enclosure" has been explored by these two companies, you can be sure that others will explore further and come up with new technology to make "living with four channel" easier. And, of course, you 2-channel die-hards will benefit from these advances, too. **R-E**

NEW COLOR CIRCUITS

(continued from page 39)



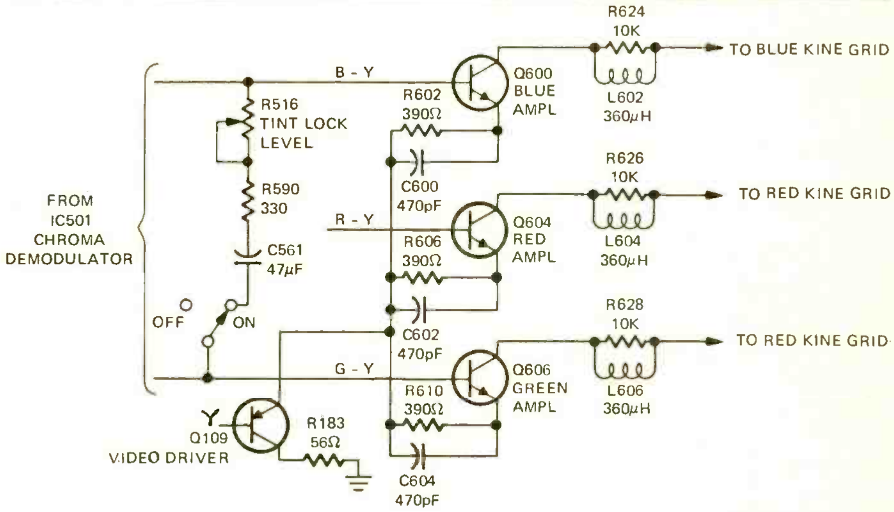


FIG. 8 (right)—SCAN RECTIFICATION is GE's name for this B+ supply that operates on the forward or trace portion of the deflection waveform. FIG. 9 (below)—GE's Tint Lock mixes G-Y and B-Y signal voltages to obtain correction in the flesh-tone range.

tion." This tag refers to the fact that the short flyback pulse is not rectified but rather the lower voltage developed during the longer scan interval. The concept behind scan rectification hinges on two attractive advantages of rectifying an ac voltage of substantially higher frequency than the 60 Hz power line. Filtering is eased by the ratio of the frequencies 15,734/60 or approximately 260 times; 15,734 Hz being the horizontal deflection frequency. Secondly, the expensive bulky iron core power transformer is eliminated with the ferite core horizontal component picking up the load.

Fig. 8 shows how the idea is put to extensive use in GE's QA chassis. First the flyback winding between terminals 4 and 5 is used to boost the line rectified 135-volt supply to 200 volts. The 550-volt pulse on this winding is rectified by diode Y214 and filtered by C297. The capacitor is referenced to the 135 volt supply reducing the voltage stress on the component.

A 21- and 22-volt supply regulator is fed from the pin 8 to 10 winding. In this case the transformer low side pin 10 is grounded and the scan pulse feeds rectifier Y402 and filter C418. Q400 is a series regulator whose base terminal is biased at one V_{BE} above the 22-volt Zener diode Y404. The base-to-emitter drop of Q400 cancels the effect of the Q403 diode drop so the emitter voltage of the transistor is just equal to the Zener voltage. Transistor Q400 functions as an emitter follower with its characteristic low output impedance. Normally non-conducting, Q402 protects the supply against excessive current drain. If an abnormal condition increases the power supply current above 265 mA the drop across sensing resistor R414 turns on Q402 pulling down the base voltage of the Q400 regulator and in turn the power supply output voltage as low as necessary to limit the current.

The vertical output circuitry is also powered from a winding on the same transformer. Winding 7, 6, 9's flyback pulse is scan rectified by Y268 and Y270 to produce the positive and negative vertical supplies respectively. Again, the positive pulse produces the negative supply and vice versa.

General Electric's Tint Lock

(continued on page 94)

next month

JANUARY 1974

Radio-Electronics steps into 1974 with a group of special articles about modern communications.

- **CB Equipment Roundup**
  An up-to-the-minute survey of the latest CB gear; a directory of who makes what; a look at the special features being offered in today's equipment.
- **Modern Receiver Circuits**
  Communications receivers are fascinating components these days. The circuits are new, the concepts are new, and the way they work is changed. Make sure you're up on what's happening.
- **CB Radio Alignment**
  If you've got the license, we've got the repair techniques you need to know. Let's pool our knowledge to make you a better CB technician.
- **New CB Circuits**
  R-E's Technical Editor, Bob Scott, presents the latest developments in CB radio. Discover what's new and how it works.

PLUS THESE OTHER FEATURES:

- **Technical Topics**
  New circuits; new ideas; new ways of using electronics. A special feature for regular readers.
- **Build A Blitzmeter**
  Want to measure how much light your electronic flash puts out? This project does the job. It will give you the answers you need.
- **Improved ASCII Encoder**
  Improve your TV typewriter with an improved encoder. It's easy to build and is all on one circuit board.

ALSO:
Step-By-Step Troubleshooting
R-E's Transistor Replacement Guide
Jack Darr's Service Clinic
Appliance Clinic

January 1974 issue on sale December 18, 1973

NEW COLOR CIRCUITS

(continued from page 92)

shown in Fig. 9 gives flesh-tone correction by cross mixing the B-Y and G-Y color difference signals. Green and magenta color components are squashed prejudicing the colors toward the orange flesh tones. Except that AFC can now be operated independently from Tint Lock these circuits remain essentially the same as last years (See Automatic Color Circuits, **Radio-Electronics,** January 1973).

Black-level clamping and its effect on gray-scale reproduction has been the focus of discussion for many years. Methods of implementing contrast and brightness controls are often reviewed with the optimal arrangement sought out.

'Scene Brightness Tracking Circuit' is what GE calls their 100% dc restoration scheme and is shown in Fig. 10. Positive video sync tips are clamped by diode Y106 charging coupling capacitor C148. R168 the brightness control varies the clamp voltage shifting the video up or down. The correct setup for the control is so that the black picture elements appear black and there is no compression into black of gray picture elements. The contrast control is a video gain adjustment which affects the brightness, since as the peak to peak signal video is increased with black kept fixed as set by the brightness control white going signal excursions become whiter. Interestingly the reasoning has proceeded so that the two controls have been labeled in reverse from last year!

For increased brightness the large-screen 25 MB chassis has evolved from last year's MA with increased 28.5 kV kine anode voltage. To prevent overscan a 60 microhenry horizontal width adjustment was added to the yoke coupling network. **R-E**

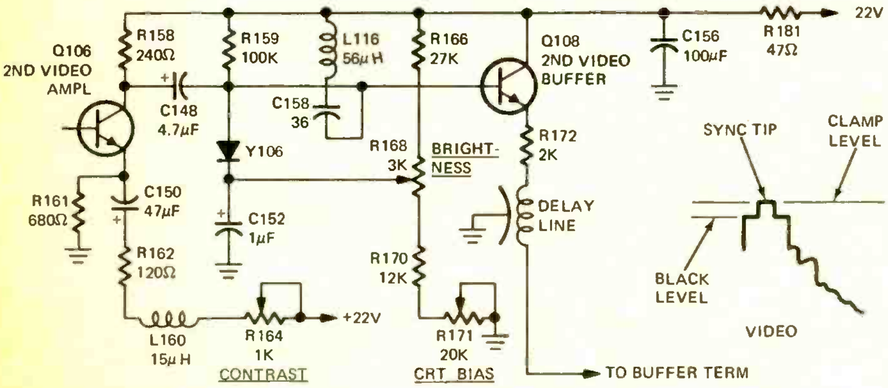


FIG. 10—FULL DC RESTORATION is possible with this circuit innovation—called Brightness Tracking—that operates by clamping the level of the sync tips.

MAKING IC SOCKETS; REMOVAL

You can buy lots of "boards", and things with IC's on them, dirt cheap. The only problem is getting them off the boards without overheating them. Also, how can you make good IC sockets?—R.J., Antioch, Ill.

First, I'd use a low-wattage desoldering iron, and clear out only 2-3 pins at a time. Let it cool between times. Or, spray coolant on the IC itself, as you work. (This could get to be a three-handed job, of course.) Or: clip a heat-sink on the IC while taking it out.

Second, you can get the "strip" contacts, for making IC sockets, from several places. They're made by Molex, and are sold at about 100 for $1.00. They can be soldered into the holes of a PC board, to make a pretty darn good IC socket.

HORIZONTAL OSCILLATOR SETUP

There are four or five pictures across the screen of this RCA KCS-130 chassis. I've changed the oscillator tube, and the stabilizer coil, and it still won't sync.—J.B., FPO, N.Y.

This chassis uses a variation of RCA's famous Synchroguide circuit, and must be set up using the factory procedures, or it won't work properly. Try this: 1. Connect a jumper across the terminals of the sinewave coil. 2. Ground the grid of the sync output tube; pin 9 of the 6EA8, on the same PC board with the oscillator. 3. Adjust the horizontal hold control until you can see only *one* picture. This will float from side to side, but if it will stand still for even a moment, fine. This means that the oscillator is able to free-wheel.

4. Take the jumper off the sinewave coil. If the picture falls out of sync, adjust the core of the sinewave coil until it locks in again. There's still no sync, remember; so, the picture will float; get the sides of the picture straight, and it should hold fairly still. Shorting the sinewave coil should cause only a small sidewise shift.

Final step; take the short off the sync-tube grid, and the picture should lock in very firmly. Change channels and see. **R-E**

new books

SOLID-STATE CIRCUITS FOR HOBBYISTS & EXPERIMENTERS by Jon L. Turino. Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, Ind. 46268. 5¼ x 8¼ in. 208 pp. Softcover, $5.95.

Here, for the serious electronics hobbyist or experimenter is enough information to allow him to design the circuitry for many useful projects and to adapt and modify existing circuit designs to suit his specific purposes. Topics included are creation of a system block diagram, review of practical semiconductor device theory, descriptions of bias polarities for each device, terminal identification drawings, single- and multiple-stage analog amplifiers, special purpose circuits, digital logic, analog IC's and design of several types of power supplies.

BASIC ELECTRICITY: THEORY AND PRACTICE by Milton Kaufman and J.A. Wilson, McGraw-Hill Book Co., 1221 Avenue of the Americas, New York, N.Y. 10020 8½ x 11 in. 528 pp. Softcover, $9.95.

Introductory electrical fundamentals text is written for occupational and trade students with reading and comprehension difficulties. Well-illustrated and self-instructional, the material is presented at a slow pace, then reinforced in programmed reviews. Covers ac-dc topics such as magnetism, voltage, amperage, resistance, inductance, capacitance and Ohm's Law. In addition, motors, generators, simple measuring instruments, transformers, house wiring and other applications are examined. Automotive and home electrical systems are used to present principles and applications. An easily-constructed circuit board is detailed in the appendix for use with experiments in each chapter. Self-test with answers at the back of the book concludes each chapter.

ELECTRONICS DATA HANDBOOK, 2nd Edition (Tab Book No. 118) by Martin Clifford. Tab Books, Monterey & Pinola Sts., Blue Ridge Summit, Pa. 17214. 5½ x 8½ in. 256 pp. Hardbound, $7.95; softcover, $4.95.

Practical working guidebook cuts down the research needed to find specific information. All of the commonly-used formulas are included to provide the user with an all-in-one reference to the data involved with dc and ac circuits, vacuum tubes, transistors, antennas and transmission lines, measurements, conversion factors, abbreviations, equivalents and mathematical data associated with electronics. Contains hundreds of tables, charts, illustrations and formulas.

4-CHANNEL STEREO—FROM SOURCE TO SOUND by Ken W. Sessions, Jr. Tab Books, Monterey & Pinola Sts., Blue Ridge Summit, Pa. 17214. 5¾ x 8¾ in., 176 pp. Hardcover, $6.95.

This book explains the evolutionary developments of sound, including the differences between stereo and binaural listening and lays the groundwork for 4-channel by describing the ear's faculty for localizing sound sources according to frequency, time, phase and level. The differences between discrete, matrix and derived 4-channel sound are given in depth along with projections for the future of surround-sound. Circuits and text show how to use two extra speakers and a resistor to get four channels from two, how to decode a record with four channels matrixed onto two and how to use four individual amplifiers with a special demodulator to produce a 4-channel system that is equivalent to six simultaneously operating stereo sets. Room diagrams of sound dispersion tell what to expect of each arrangement and equipment cost figures plot tradeoffs of performance and price. **R-E**

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NEXT MONTH

Communications is the special subject for January 1973. We've got articles on CB Circuits, New CB Gear, Short Wave Receivers, and CB Repairs. In addition there's a story on New Hi-Fi circuits and a construction article that tells how to build a meter for your electronic flash. Then too there are all the regular monthly features like Step-By-Step Troubleshooting, Service Clinic, Transistor Replacement Guide, and Appliance Clinic. You won't want to miss this one.

Answer to puzzle on page 53

1 D	I	2 S	T	3 R	E	4 S	S	■	5 S	6 T	A	7 R	T	8 S
I	■	H	■	E	■	C	■	9 T	■	I	■	A	■	T
10 P	H	O	S	P	H	O	R	E	S	C	E	N	C	E
O	■	R	■	A	■	P	■	N	■	K	■	O	■	A
11 L	A	T	T	I	C	E	■	12 S	O	L	V	E	N	T
E	■	W	■	R	■	S	■	I	■	E	■	■	■	I
■	13 G	A	S	S	Y	■	14 C	O	■	15 R	E	16 S	E	T
17 R	■	V	■	■	■	18 N	■	N	■	■	■	E	■	E
19 I	N	E	R	20 T	■	21 E	M	■	22 A	23 D	E	P	T	■
N	■	■	■	W	■	U	■	24 T	■	I	■	A	■	25 F
26 G	I	27 L	B	E	R	T	■	28 R	E	F	O	R	G	E
H	■	E	■	E	■	R	■	A	■	F	■	A	■	N
29 E	L	E	C	T	R	O	A	C	O	U	S	T	I	C
A	■	R	■	E	■	N	■	E	■	S	■	O	■	E
30 D	E	S	I	R	E	■	31 F	R	E	E	O	R	I	D

market center

WANTED

QUICK cash . . . for electronic equipment, components, unused tubes. Send list now! **BARRY,** 512 Broadway, New York, N.Y. 10012, 212 Walker 5-7000

WANTED 505R Concertone tape recorders. Send asking price. **ROBERT KING,** SP. 45. 7495 Oakland Road, La Mesa, Calif. 92041

"CASH" paid for unused teletype parts and assemblies. **"PHILMAR",** Box 96, Morrisonville, N.Y. 12962 518-561-3479

WANTED Rider's, Sams', Supreme's, original factory manuals. **BEITMAN,** 1760 Balsam, Highland Park, Ill. 60035

PLANS & KITS

"DIGITAL speedometer with numeric readout Plans $4.50. **KIMTRON,** Box 80134, Chamblee, Georgia 30341"

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DIGITAL IC manual—1973 edition—1500 types. Double listing by type and wiring diagram number. Many cross-referenced. $3.95. **ELECTRONETICS,** Box 278, Cranberry, N.J. 08512

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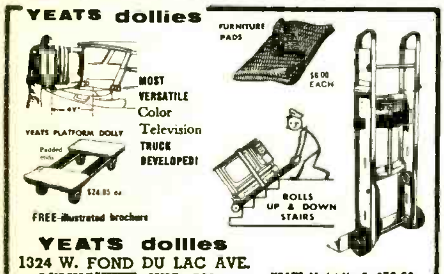

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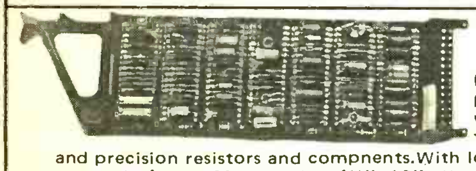

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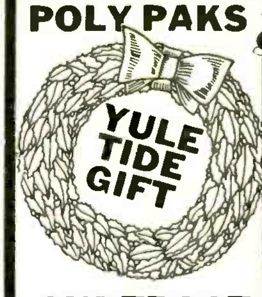
- ☐ 3-ME-3*, infra-red, invisible lite, "pinhead", single lead 1.00
- ☐ 3 ME-4*, infra-red "invisible", TO-18, diff. dome 1.00
- ☐ 3 ME-60*, infra-red, "invisible", axial, micro-mini 1.00

OPTO-COUPLERS

- ☐ MCD1* 4000V Isolation Photo Transistor $3.95
- ☐ MCD2* 1500V Isolation Photo Diode 1.29
- ☐ MCT1* 4000V Isolation Photo Transistor 4.95
- ☐ MCT2* 1500V Isolation Photo Transistor 1.29
- ☐ MCT2-D* 1500V Isolation Twin Photo Transistor 1.49
- ☐ MCT5-10* 10,000V Isolation Photo Transistor 3.95
- ☐ MCT5-25* 25,000V Isolation Photo Transistor 4.95

INFLATION FIGHTER POLY PAKS



SUBTRACT $1.00 FROM ANY $15. PURCHASE

CALCULATOR KEYBOARD KIT

☐ **9.95** 3 for $27

☐ Etched calculator board with holes, as above, less switches . . . . $2.50 Board

Properly etched, drilled "MULTIPLEXED" printed circuit board with 17 switches (as pic shows). Originally designed to work with our Cal Tech single calculator chip CT-5001, selling for $9.95. Kit includes PC board 6-1/2 x 4-1/2 x 1/2", 17 OAK #415 lite-touch switches (0-to-9) white with black numerals, decimal white and black, CE and CL and the 4 functions blue with white characters. With schematic, plus flat 12-terminal cable, plus spec sheet. **wired $12.50**

CALCULATOR KEYBOARD SWITCH KITS

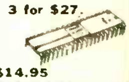
Kit of 17 for $7.50

Each switch made by Oak #415, SPST normally open, 24V 1 amp contacts. Kit includes 0-to-9 (10 switches white with black numerals) decimal, white with black dot, and CE, CL and 4 functions blue with white characters.

12-DIGIT "CALCULATOR CHIP"

☐ CT5001 Chip ☐ **9.95** 3 for $27.

Similar to Mostek 5001. Outperforms Texas 8-digit TMS1802. A 40-pin DIP. Adds, multiplies, subtracts, and divides. Use with 7-segment readouts, Nixies, and LED's. We include schematics, instructions to build calculator.



- ☐ CT5002-9 Volt version of above — $9.95
- ☐ CT5005-Same as above with MEMORY — $14.95

NATIONAL EQUALS ON "DIGITAL CLOCK on a CHIP"

Any "Chip" ☐ **$12.88**

*Money Back Guarantee!

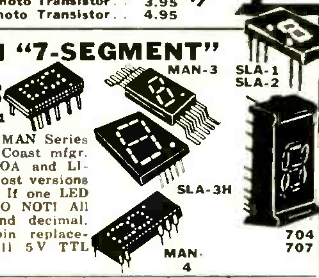
Mfrs #	Description	Sale
☐ 5311	28-pin, ceramic, any readout, 6-digits: A-B-D	$12.88
☐ 5312	24-pin, ceramic, any readout, 4-digits: C-D	$12.88
☐ 5313	28-pin, ceramic, any readout, 6-digits: A-C	$12.88
☐ 5314	24-pin, plastic, LED and incandescent readouts, 6-digits: A-B	$12.88

*With Spec Sheet!

Code: A—Hold Count. C—1 PPS Output. B—Output Strobe. D—BCD

☐ **1-MM5316, DIGITAL ALARM CLOCK FACTORY FALLOUT — $1.49 EACH**

LITRONIX-OPCOA-MAN "7-SEGMENT" LED Readouts



All fit 14-pin IC sockets. All 7-segments. MAN Series "all LED" and made by well-known West Coast mfgr. Others Reflective Bar type made by OPCOA and LITRONIX. The Reflective Bar types are low-cost versions of the MAN's except .33 character height! If one LED blows you lose a segment. MAN's you DO NOT! All readouts 0-to-9 numerals, plus letters and decimal. **Opcoa and Litronix products pin-for-pin replacements for the MAN-1 and MAN-4. All 5V TTL compatible.

ALL LED READOUTS — TYPE	No. Size	Color Display	Decimal	Mils	Driver	Each	Special
☐ MAN-1 equal	.27	Red	Yes	20	SN7447	$4.50	3 for $12.
☐ MAN-1A equal*	.27	Red	Yes	20	SN7447	4.95	3 for $13.
☐ MAN-3 equal	.115	Red	Yes	10	SN7448	2.50	3 for $6.
☐ MAN-3A equal*	.115	Red	Yes	10	SN7448	2.50	3 for $6.
☐ MAN-3M equal*	.127	Red	Yes	10	SN7448	2.50	3 for $6.
☐ MAN-3 equal	.115	Red	***	10	SN7448	1.95	3 for $5.
☐ MAN-3M equal*	.127	Red	Yes***	10	SN7448	1.95	3 for $5.
☐ MAN-4 equal*	.190	Red	Yes	15	SN7448	3.25	3 for $9.
☐ MAN-4 equal*	.190	Red	Yes***	15	SN7448	2.75	3 for $8.
"REFLECTIVE LITE BAR" (Segment LED Readouts)							
☐ 707** (MAN-1)	.33	Red	Yes	20	SN7447	3.25	3 for $6.
☐ 704** (MAN-4)	.33	Red	Yes	20	SN7448	3.25	3 for $6.
☐ SLA-1** (MAN-1)	.33	Red	Yes	20 15	SN7447	3.25	3 for $6.
☐ SLA-2 plus-minus-one		Red	No	15	SN7447	3.25	3 for $6.
☐ SLA-3H Giant	.70	Red	Yes	20	SN7447	8.50	3 for $24.
☐ SLA-11C** (MAN-5	.33	Green	Yes	40	SN7447	7.95	3 for $21.
☐ SLA-12** ±1	.33	Green	No	40	SN7447	4.50	3 for $12.

* Red epoxy case, others clear. ** Litronix and Opcoa's pin-for-pin equals and electrical specs as MAN-1 or MAN-4. *** LED "dot" missing.

ALLEN BRADLEY 'TRANSISTOR' POTS

Type F. Screwdriver adjust. **Any 4 for $1**

Ohms	
☐ 75	☐ 7.5K
☐ 100	☐ 10.0K
☐ 200	☐ 20.0K
☐ 250	☐ 25.K
☐ 500	☐ 50.K
☐ 750	☐ 75.K
☐ 1.0K	☐ 100K
☐ 2.5K	☐ 250K
☐ 5.0K	☐ 2 Meg
	☐ 5 Meg

MOS 40-pin dip IC. Four display modes time, seconds, alarm and sleep, for a variety of digital clocks. Interfaces directly with 7-segment flourescent and liquid crystal displays. Requires single power supply. 12 or 24 alarm setting, featuring 9-minute SNOOZE ALARM and pre-settable 59-minute sleep timer. Low power dissipation only 32mw @ 8V. Operates from 8 to 29 volts. NO REGULATION REQUIRED! Only needs 4-digits. Has seconds provisions, with instant press of button. Has many, many features. The only ALARM CHIP on the market today at this low Poly Pak price. With 5 pages of tech. info. plus applications.

NATIONAL MM5316 EQUAL "ALARM CLOCK ON A CHIP"

☐ Only **$14.95**

HOBBY EXPERIMENTAL 'LED' KORNER

- ☐ 1-OPCOA SLA-11C, like MAN-5, green, seg missing $1.49
- ☐ 2-SPERRY SP332, twin digit, factory rejects, .33" charac. no test $1.00
- ☐ 1-OPCOA SLA-11*, like MAN-5, green, 1-or-more segs gone, .33" charac $1.29
- ☐ 1-OPCOA SLA-13*, 0.7 charac. readout, 1-or-more segs missing $1.29
- ☐ 5-MONSANTO opto isolators, no test, 1500V $1.00
- ☐ 10-LED HOBBY SURPRIZE, asst. types, factory rejects, no test $1.00
- ☐ 2-OPCOA SLA-1*, MAN-1, red, .33" charac. 1-or-more segs gone $1.00
- ☐ 2-MONSANTO MAN-4, .19" charac. 1-or-more segs missing, red $1.00
- ☐ 5-MONSANTO MAN-3, (the claws) .12" charac, red, some segs gone $1.00

*Reflective bar segments, while Monsanto all LED segments.

NIXIE

☐ **$5.95** 3 for $16.00

COUNTING SYSTEM

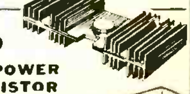
Includes SN7490, decade counter, SN7475 latch, SN7448 BCD decoder driver, 0-to-9 Nixie With socket.

☐ $1.49

HIGH POWER TRANSISTOR WITH HEAT SINK

3 for $3

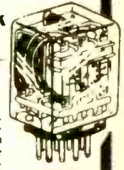
Removed from new equipment! Includes popular 2N174 'doorknob' transistor TO-36, germanium, PNP, 150 watts, VCBO 80V, 15 amps, 40 hfe. For ignition, high power transmitters, etc. Mounted on heat sink 5 x $2\frac{1}{2}$ x $1\frac{1}{4}$".



Potter & Brumfield KAP RELAYS

Your choice 3 for $7.50 **$2.98**

Excellent for "HAM" use as antenna switching, latching, transmit, receive, etc., and 100's of commercial or industrial uses. Includes plastic dust-cover with diagram and hookup info, 11-pin plug-in base. Contacts movable gold flashed silver, stationary overlay, with silver cadmium oxide movables. All contacts 10 amp 3PDT. Coil data,115VAC 2250 ohms, 17.5 ma. 12 VDC 21 mils 168 ohms. Size: $2\frac{1}{4}$" x 1 5/16". Wt. 4 ozs. Center pin missing. Comar Mfg. type equal too.



3PDT ☐ 12 VDC ☐ 115 VAC

SPERRY "ORANGE" TWIN DIGIT ARRAY

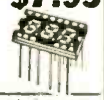
☐ **$5.95** 3 for $15.

Type SP332, each digit is individually controlled, operates off 180VDC, 100 ua, 200 mw. Color: ORANGE. 7-digits, glass protection over digits. Character height: 0.33. P.C. mounting. Size: ¾" x ¾", 9-pins per digit. Driver: SN7417.

3 LED DIGITS ON A DIP

☐ **$7.95**

Each digit is 7-segment LED (MAN-3 type) and internally "multiplexed" and driven by one SN7448. Similar to DL-33 by Litronix . . . . intended for calculators, clocks, test equipment, etc. Encapsulated in red transparent epoxy in 14-pin dip pak. With decimals. High brightness, character size .12 x .077. Requires 5V 10 mils. 3 for $21



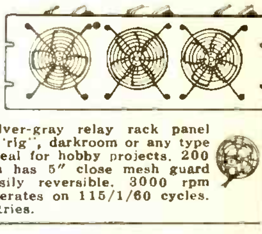
1-WATT FLANGELESS TOP HAT ZENERS

5 for $1

Type TK, Metal Case

Volts	Volts	
☐ 4.7	☐ 9.1	☐ 13.
☐ 6.3	☐ 10.	☐ 15.
☐ 8.2	☐ 12.	☐ 30.
		☐ 33.

3 'FANS ON A RACK'



☐ Only **$12.00** 2 for $20

Tri "prop" fans on a silver-gray relay rack panel (19"). Excellent for your "rig", darkroom or any type of electronic work. Even ideal for hobby projects. 200 CFM per 4" fan. Each fan has 5" close mesh guard on each side of fan. Easily reversible. 3000 rpm motor, has hp of 1/50. Operates on 115/1/60 cycles. Wt. 7 lbs. By Howard Industries.

MUX'D DIGITAL CLOCK PC BOARD

Your choice **$2.50**

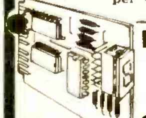
- ☐ MAN-1 ☐ Litronics 707 (MAN-1*)
- ☐ MAN-3 ☐ Litronics 704 (MAN-4**)
- ☐ MAN-4 ☐ Opcoa SLA-1 (MAN-1*)
- ☐ 6-MAN-3A's for above board. $9.50.

* Elec char. same as MAN-1 or 4.

Each board properly multiplexed for 6 digits, to hold MAN-1's, MAN-3's, MAN-4's. Litronics 707 (MAN-1) and 704 (MAN-4), and Opcoa's SLA-1 (MAN-1). Board $6\frac{7}{8}$" long with spec sheets.

LED MITY DIGIT "DCM'S"

*Your choice of 5 red LED readouts!



☐ Only **$9.99**

Buy 3 — Take 10%

Scientific Devices "Digital Counting Modules" outperform any other DCM on the market today. More features than ever before! Not gaseous, not incandescents, not nixie but the modern LED. Choose from such famous manufacturers as Monsanto's MAN-1, MAN-4, Litronics 707 and 704, Opcoa's SLA-1 (the last 4 having character heights of 0.33 at no extra charge). Each kit includes 3x2" p.c board with fingers for a FREE edge connector, side-mounting dip socket, LED readout of your choice, resistors, 3 IC's, and Molex connectors (this ELIMINATES SOLDERING YOUR IC's), and booklet. **INCLUDES P.C. EDGE CONNECTOR — FREE!**

READOUT	Char.	Maker
☐ MAN-1	.27 h.	Monsanto
☐ MAN-4	.19 h.	Monsanto
☐ 707*	.33 h.	Litronics
☐ 704**	.33 h.	Litronics
☐ SLA-1*	.33 h.	Opcoa

* Pin-for-pin MAN-1, ** Pin-for-pin MAN-4, elec. char. same

STUD 'TRIACS'

PRV	15 amp	25 amp
50	☐ $.65	☐ $.85
100	☐ .85	☐ 1.05
200	☐ 1.25	☐ 1.45
300	☐ 1.45	☐ 1.65
400	☐ 1.85	☐ 1.95
500	☐ 2.55	☐ 2.25
600	—	☐ 2.65

Terms: add postage **Rated:** net 30
Phone Orders: Wakefield, Mass. (617) 245-3829
Retail: 16-18 Del Carmine St., Wakefield, Mass. (off Water Street) C.O.D.'S MAY BE PHONED

☐ 15¢ CATALOG on Fiber Optics, 'ICs', Semi's, Parts

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Circle 86 on reader service card

MORE BARGAINS IN SURPLUS ELECTRONICS from B & F ENTERPRISES

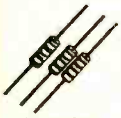
Just off the press our Best Catalog yet with 104 Illustrated pages of surplus Electronics, Optics, and Much More...

DIGITAL CLOCK CHIP

These large scale integrated (LSI) chips eliminate 14 to 20 MSI TTL chips in the design of an electronic clock. Features 12 or 24 hour operation, 6 digits, internal multiplexing, operated on 50 or 60 Hz input, or a schematic is provided for crystal control. Logic gates between the counter allow setting at the rate of one hour digit per second, or, one minute digit per second. A "hold" input allows stopping the chain. The multiplexer samples the outputs of the hours, minutes and seconds counters (in the six digit model), routing this data to a programmable read only memory (ROM), which is programmed to provide BCO and seven segment outputs. All outputs are compatible with bipolar devices, necessitating few external components for the display interface. Only one power supply is required for operation.

1. 5314 chip (24 pin plastic) used for 7 segment displays such as LED's, numitrons, minitrons and Sperry displays.
   Price $9.95
2. 5311 chip (28 pin ceramic) includes BCD output to above for interface to nixies, computer inputs, etc., in addition to 7 segment outputs.
   Price $14.95

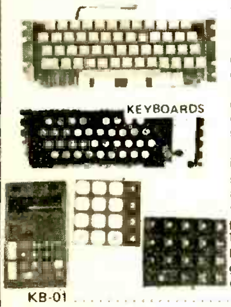
1/4-Watt RESISTOR ASSORTMENT!!



Brand-new 5% tolerance resistors, individually-bagged 5 to a bag, each bag marked with values. 70 different values, 10 ohms to 10 megohms in a 1 : 1.5 : 2.2 : 3.3 : 4.7 : 6.8 : 1 sequence. A complete laboratory supply of resistors at less than 5 cents apiece.

Sh.Wt. 2lbs.	¼WRA	$15.00
4 bags for $55.00	¼WRA	$55.00/4

KEYBOARDS:



Teletype format ASCII-coded keyboard, with parity check line (see fig. A). Coding is by means of a built in diode matrix, which can be modified from ASCII by inserting or removing diodes. Keys are 26 characters, all numbers, plus shift, ctrl, alt, line feed, car return, rept, brk, rub out, here is, and usual typewriter symbols. Mfr controls research and microswitch. Requires +5 volts, uses DTL circuitry, compatible with DTL or TTL. 52 keys, 3 integrated circuits, about 200 diodes. Brand new, guaranteed. 15 pin connector on 10" cable.

KB-01 .... $44.50

Non-decoded alphanumeric keyboard, Figure "C", single form, SPST contact on each key.

KB-3 .... $24.50

Figure "D", calculator keyboard in calculator case, pressure sensitive elastomer contacts, manufactured for Aries.

KB-4 .... $9.50

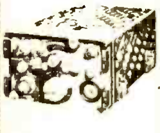
Touch-tone keyboard, Figure "E", manufactured by Chromerics. No electronics included.

KB-5 .... $9.00

Desk calculator keyboard, Figure "F", manufactured by Controls Research.

KB-6 .... $15.75

RT 270A/GRC TRANSCEIVER



This is a prime government surplus item, until recently in scarce supply and selling for hundreds of dollars. Consists of a double conversion FM superhetrodyne receiver and a FM transmitter linked thru a common antenna circuit. Range is 47 to 58.4 mHz continuous. Size is 7-3/8 x 4-3/16 x 12-15/16. Built-in calibrator and heat oscillators permit fast alignment.

RT 270A/GRC
New, including 1 mHz crystal $35.00

RT 2700A/GRC
Used, excellent, less crystal $20.00
*** 1 mHz crystal only $5.00

TRANSISTORIZED FLUORESCENT CAMPING/EMERGENCY LIGHT KIT!

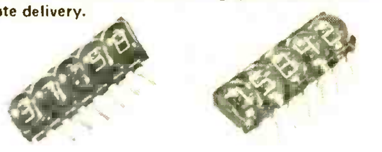
This transistor inverter powered camping and emergency light will provide a bright portable light from a 12-Volt D.C. battery. A cigarette lighter adapter is provided for automotive operation, or the unit may be run from other 12-Volt lantern batteries. The advantages of this unit over more conventional incandescent lamps is the vastly greater light output for equivalent power input and the superior distribution and color of the light.

The camping/emergency light is enclosed in a weather-tight plexiglas tube, with the electronics built into the tube. Completion time should be less than two hours, making it a nice evening's project, even for the beginner.

Sh.Wt. 3 lbs.	TFCELK	$12.50

ATTENTION MANUFACTURERS – LED RIOT!

B & F has bought over 500,000 7-segment LED numeric displays and over 1,000,000 LED lights. These are available in manufacturing quantities for immediate delivery.



5082 – 7400 SERIES DIGITS FROM HEWLETT PACKARD

Hewlett Packard, one of the world's largest manufacturers, has sold us his surplus of multiple digit clusters with one bad digit per cluster. They were for use in the HP35 calculator, 970A DVM, and other products. The remaining digits are guaranteed perfect in all respects and are intensity graded (marked on the back with letters A thru F) and matched, so that several strips can be combined and still result in a perfect match. These monolythic GaAsP displays require as little as 7 mW per digit, are highly readable at arm's length, and lend themselves well to hand-held portable applications.

Applications include hand-held calculators, digital thermometers, stopwatches, darkroom timers, DVM's, clocks and watches, or any other product requiring low cost, low power, long lifetime indicators.

The unit is common cathode, set up for multiplexed operation. Two decimal point styles are available; center decimal for PN 7804/05, and right decimal for PN 7814/15, as illustrated. The following configurations are available, where "8" represents a perfect digit, "X" a non-functioning digit:

X8888	7405-1 or 7415-1,	X888	7414-1
8X888	7405-2 or 7415-2,	8X88	7414-2
88X88	7405-3 or 7415-3,	88X8	7414-3
888X8	7405-4 or 7415-4,	888X	7414-4
8888X	7405-5 or 7415-5,	X88X	7556-1

All products are available at the following price rate:

1 – 24 digits . . .	$1.875/digit
25 – 99 digits . . .	$1.50/digit
100 – 499 digits . . .	$1.25/digit
500 – 999 digits . . .	$1.00/digit

Higher quantity price on request.

For the following applications we recommend the following configurations:

Pocket calculators: 7405-1 & 7405-5, which results in X88888888X, eight consecutive perfect digits @ $1.875 = $15.00.

Recommended Calculator chips:

Nortec 4204 @ $19.75 ($15.00 when ordered with displays).
Caltex 5005 @ $9.75 ($7.50 when ordered with displays).

Clocks: 7405-3 & 7556-1, which results in 88X88X88X, six perfect digits at $1.875 = $11.25.

Recommended clock chips:

National MM5314 @ $9.75 ($7.50 ordered with displays).
National MM5316 @ $19.75, includes alarm, ($15.00 ordered with displays).

For only hours and minutes, order 7405-3 only.

Digital thermometers, DVM's, stopwatches, darkroom timers, frequency counters, etc., order 7415-1 or 7415-5 for four digits ($7.50) or 7414-1 or 7414-4 for three digits ($5.60). Use Solitron CM 4102AE 3½ digit counter decoder @ $19.00, ($15.00 ordered with displays).

Schematics for calculators, clocks and counters using these components free with order.

LED SOLID STATE LAMPS

Plastic encapsulated gallium arsenide phosphide light emitting diodes. Designed for low power consumption, as low as 5 milliwatts. Red diffused lens.

10 pcs. . . . $2.00   100 pcs. . . . $15.00

1000 pcs. . . . $100.00

Higher volume prices on request.

SUPER QUALITY I.C. SOCKETS

Now available 24, 28, & 40 Pin sockets Only $1.00 ea.

Sockets made by T.I. and Cinch. All are low-profile, compact types.

14 Pin Dip Solder Tale Sockets
3 for $1.25 16 for $5.00
16 Pin Dip Solder Tale Sockets
2 for $1.00 13 for $5.00
14 Pin Dip Gold Wire Wrap Socket
2 for $1.25 10 for $5.00
16 Pin Dip Gold Wire Wrap Socket
2 for $1.50 8 for $5.00
10 Pin to 5 Gold Sockets (Cinch)
2 for $1.00 13 for $5.00

October 2, 1973

Dear Customers,

Due to a variety of circumstances in past months, some customer orders, refunds and exchanges have been lost or otherwise snafu'd. I would like to take this opportunity to point out that we have now solved our internal difficulties to the point where we can and will take immediate action on any such complaints. Any customer having any problem can be assured prompt action by writing to Ms. Lynn Chafey, Customer Relations Director, B & F Enterprises, 119 Foster St., Peabody, Massachusetts, 01960.

Without making excuses, I think some of you readers might be interested in the changing nature of the "surplus" business, which I believe we were instrumental in changing. In early 1970 electronic manufacturers were in the doldrums, due to the changeover from military to commercial business. Items (particularly TTL integrated circuits and other semiconductor items) were sold to original equipment manufacturers, (OEM's) at a fraction of catalog price, to stimulate business. This prompted us to negotiate directly with manufacturers for large quantities of items at low cost, and to offer these to hobbyists and electronic experimenters who buy in small quantities, at a fraction of catalog price. This was the experiment that revolutionized the surplus business, and we became more "cut-rate distributors" than "surplus dealers".

There were some problems, though. First, the commercial business took a wild upswing, and manufacturers who were begging us to accept products suddenly found they couldn't supply enough material, and deliveries became slow or nonexistent. Second, with slow deliveries, the amount of paperwork and handling to ship orders in two or three partial shipments became overwhelming. With a small mark-up on sales, it simply was impossible to devote much time to correspondence. Third, quite frankly, was that Pete and myself as engineers, were not used to the problems of inventory control, and shipping management. In a period of time when our sales were tripling every year, we had trouble keeping up with the greatly increased sales.

At the present time, I truly believe we have our problems solved, and can offer our customers both good service and low price. We have been shipping all stock items within 48 hours. We have refrained from advertising any items not in good inventory. And our rate of growth, while still good, is at a sufficiently slow pace now so that we can solve problems as we encounter them. As a parting word, I would like to say that we are interested in getting feedback from readers on other matters. What would you like to see us carry? We welcome any other comments that will help us improve service. Thank you in advance.

Very truly yours,

Franklin G. Fink, Partner
B & F Enterprises

NEW – COSMOS INTEGRATED CIRCUIT

Said to be the "New Wave" in integrated circuits of the future. Ultra low power drain (microwatts)

☐ 4000AE	Dual 3 Input Nor & Inv	$ .99
☐ 4001AE	Quad 2 Input Nor	$ .99
☐ 4002AE	Dual 4 Input Nor	$ .99
☐ 4006AE	18 Stage Static Shift Register	$4.99
☐ 4007AE	Dual Complementary Pair & Inv	$ .99
☐ 4009AE	Hex Buffer, Inverting	$2.19
☐ 4010AE	Hex Buffer, Non Inverting	$2.19
☐ 4011AE	Quad 2 Input Nand	$ .99
☐ 4012AE	Dual 4 Input Nand	$ .99
☐ 4014AE	8 Stage Static Shift Register	$5.99
☐ 4017AE	Decade Counter W/Decoder	$5.99
☐ 4020AE	14 Stage Binary Ripple Counter	$5.99

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Phone in charges to 617 531-5774 or 617 532-2323. BankAmericard – Mastercharge. $10.00 minimum. No C.O.D.'s please.

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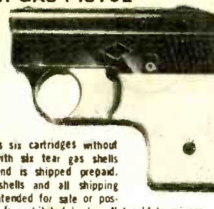
Phone (617) 531-5774
119 Foster Street
Peabody, Mass. 01960

Circle 87 on reader service card

World Famed BREVETTATA
TEAR GAS PISTOL



Appearance of this fine tear gas weapon is similar to real gun. It is ideal for people who work in lonely dark locations and require protection. Men give this gun to wives and daughers for night security. Many industrial applications. Shooting of gun stops aggressor without permanently injuring him. It fires six cartridges without reloading. Each gun comes with six tear gas shells and six blanks for practice and is shipped prepaid. Gun unit prices include 12 shells and all shipping costs. and this pistol is not intended for sale or possession in any locality where it is prohibited by law. Not sold to minors.

- ☐ 1 Gun-unit $15.00
- ☐ 2 Gun-units at $14.50 ea., total $29.00
- ☐ 3 Gun-units at $14 ea., total $42.00
- ☐ 6 Gun-units at $12 ea., total $72.00
- ☐ Extra Boxes of Ten Tear-Gas Shells $2 per box.
- ☐ Extra Boxes of Blanks, $1.25 per box
- ☐ Holsters $2 each. We prepay shipping costs on all of these items—when shipped with gun units.

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PHONE or WRITE for CATALOG...DIAL 402-987-3771

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SLA-3 7 segment LED readouts .77" numbers. 45 ma/seg. $7.95

MINIATURE TRIM POTS
5K, 10K, 20K, 25K, 50K, 100K, $.75 3/$2.00

MULTI-TURN TRIM POTS
Similar to Bourns 3010 style
3/16" x 5/8" x 1 1/4"
50, 100, 500, 2000, 5000, 10,000 and 20,000 ohms.
$1.50 ea. 3/$4.00

PRINTED CIRCUIT BOARD
4 1/2"x6 1/2" double sided fiberglass board, 1/16" thick, unetched $.60 ea. 5/$2.50

NIXIE TUBES
Similar to Raytheon 8754 tubes, with socket & data sheet $2.25 3/$6.00

TIS 73 N FET $.75
2N4891 UJT $.50
ER 900 TRIGGER DIODES 4/$1.00

VERIPAX PC BOARD
This board is a 1/16" single sided paper epoxy board, 4 1/2"x6 1/2" (standard veripax), DRILLED and ETCHED which will hold up to 21 single 14 pin IC's or 8, 16 or LSI DIP IC's with busses for power supply connections. It is also etched for a 22 pin connector $4.35

FLV 100 Visible LED ......$ .59
ME-4 IR LED ....$ .59
MV5026 Vis. LED ....$ .59
MT-2 PHOTO TRANS. .....$ .80
MCT-2 OPTO-ISOL. ......$ .90
MCD-2 OPTO-ISOL. ......$ .90
Green G_AP OSL-16 LED ....$ .90
Red G_AP OSL-3 LED ......$ .60
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MCA 2-30 photo darlington relay ....$ .90
14 PIN DIP SOCKETS ....3/$1.00

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PRV	1A	3A	12A	50A
100	.06	.11	.30	.90
200	.07	.16	.35	1.25
400	.09	.20	.50	1.50
600	.11	.25	.70	1.80
800	.15	.35	.90	2.30
000	.20	.45	1.10	2.75

Terms: FOB Cambridge, Mass. Send check or Money Order. Include Postage. Minimum Order $3.00

TRANSISTOR SPECIALS

2N3137	NPN	SI	TO-5	.6W	20V	.5A	70MHz	500HFE	4/$1.00
MPS3393	NPN	SI	TO-92	.3W	25V	.1A	190	.2	4/$1.00
2N3866	NPN	SI	TO-5	.5W	30V	RF	Power		$.75
2N1605	NPN	GE	TO-5	.15W	24V	.1A	14	125	5/$1.00
2N5324	PNP	GE	TO-3	60W	250V	10A	20	35	$1.50
2N404	PNP	GE	TO-5	25W	.2V	.15A	12	40	4/$1.00
2N3767	NPN	SI	TO-66	80W	4V	20A	10	80	$.70
2N2222	NPN	SI	TO-92	30W	.8V	.5A	250	80	5/$1.00
2N3055	NPN	SI	TO-3	115W	100V	15A	.01	50	$1.00
2N3772	NPN	SI	TO-3	150W	60V	30A	.2	30	$1.35
2N5296	NPN	SI	TO-220	36W	40V	4A	.8	60	$.50
2N6109	PNP	SI	TO-220	36W	40V	4A	.8	60	$.55
2N4898	PNP	SI	TO-66	25W	40V	4A	4	46	$.60
MJ2251	NPN	SI	TO-66	10W	225V	.5A	10	40	$.70
2N3638	PNP	SI	TO-5	.3W	25V	.5A	10	67	5/$1.00

CAPACITORS
6V 30 UF TANT. 5/$1
20V 4.7UF TANT. 5/$1
12V 10UF ELECT. 5/$1
50V 100UF ELECT $.40

DATA-LIT 707 LED readouts $2.75
MAN-3 LED READOUTS $1.75
MAN-4 LED READOUTS $2.50

Full Wave Bridges

PRV	2A	6A
200	.95	1.25
400	1.15	1.50
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1103 1024 bit RAM ..... $ 7.25
NEC 6003 2048 bit RAM $14.50
1101 256 bit RAM ......$ 3.25
8225 64 bit read-write RAM $ 3.50

5311—Clock Chip, 6 Digit BCD hold count, Output Strobe $11.95
5314—Clock Chip, 6 Digit hold count, Output Strobe $9.95

Conductive Elastometer low profile calculator keyboard. A 2 3/4" x 3 3/4" x 1/2" flex key. 19SK-6 keyboard having 0-9, •, +, —, ×, ÷, =, K+C buttons with off, on swich. $6.50

Injection laser—a single diode 6W, 25A G_AA_S unit similar to RCA 40859 $10.95

ASC II ENCODED TERMINAL KEY BOARDS $60.00

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74L00	.50	7472	.50
7400	.28	7473	.60
7401	.28	7474	.50
7402	.28	7475	1.00
7403	.28	7476	.75
7404	.33	7480	.70
7405	.30	7483	1.25
7406	.50	7486	.50
7408	.32	7490	1.50
7410	.28	7491	1.30
7411	.32	7492	1.30
7412	.40	7493	1.30
7413	.85	7495	1.30
7416	.50	74121	.70
7417	.50	74123	1.10
7420	.28	74125	1.50
7422	.32	74126	1.50
7426	.35	74151	1.25
7430	.28	74157	1.50
7437	.60	74164	2.20
7438	.55	74165	2.20
7440	.28	74176	1.95
7441	1.50	74177	1.95
7442	1.50	74192	1.75
7446	1.50	74193	1.75
7447	1.50	74195	1.25
7448	1.50	8211	1.50
7450	.28	8220	1.50

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PA234 1W audio ampl . $1.25
LM309K 5V 1A regulator $2.25
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709C operational Amp $ .47
723 Regulator .... $ .75
741 operational Amp $ .47
747 Dual 741 ...... $1.25
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741A oper amp . . $ .47
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TRIACS

PRV	1A	10A	15A	20A*
100	.40	.70	1.00	1.20
200	.70	1.10	1.50	1.60
300	.90	1.35	1.90	2.00
400	1.10	1.60	2.30	2.40
500	1.50	2.00	2.70	2.80

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PRV	1.5A	6A	10A	70A
100	.40	.50	.60	3.50
200	.60	.70	.80	6.50
400	1.00	1.20	1.30	9.50
600			1.70	11.00

Send 20¢ for our latest catalog featuring Transistors and Rectifiers; 325 Elm St., Cambridge, Mass.

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ADVERTISING INDEX

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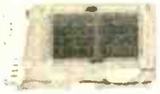
MORE BARGAINS IN SURPLUS ELECTRO-OPTICS from B & F ENTERPRISES

Just off the press our Best Catalog yet with 104 Illustrated pages of Surplus Electronics, Optics, and Much More...

NICKEL CADMIUM BATTERIES

- ☐ 0.5 ampere hour 1.25 volt sealed button cell . . . . 2 for $1.00
- ☐ Vented 4.0 ampere hour cell, plastic case $2.75
- ☐ 24 volt pack, sealed cells, mfg sonotone, size 12" x 1¼" x 1¼" capacity 0.6 ampere hours $11.75

CORE MEMORY STACKS



One of our most popular sellouts. Two types available are the 4096 words x 9 bits (36, 864 bits) easily organized as 4096 x 8 bits, and 8192 words x 4 bits (32,768 bits), manufactured by Litton Industries and RCA for Honeywell. Ideal for Minicomputors, some electronics, but no power supplies are included on the card.

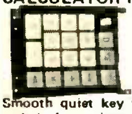
4096 x 9 Memory . . . $60.00
8192 x 4 Memory . . . $45.00

LED READOUTS

Popular OPCOA SLA-7, without decimal point. 0.27" numeral height, we formerly sold these at $4.25, and they sold extremely well. Because of a fortunate purchase we can offer them at a super-low price. Use for clocks, counters, calculators

SLA-7 Readouts $2.50

CALCULATOR KEYBOARD



This is a Flex-Key series SK keyboard made for pocket calculators. Only 2.36" x 3.76" x 0.45" thick; Switch matrix for Cal Tex 5001, 5002 or Mostek 5010 or 5012 chips. Smooth quiet key travel, double shot keys, completely sealed, impervious to dust, moisture and even direct liquid spills.

CK . . . $8.00
10 or more . . . $6.00

12 VOLT 0.750 AMPERE HOUR SEALED NICKEL CADMIUM BATTERIES

Brand new, manufactured by Gould National. Size: 1" dia. x 9-3/8" L. Manufacturer's list price is $24.50. Excellent for photo-flash, burglar alarms, etc. Fully guaranteed, available at a fraction of original cost—quantities are limited, won't last long, so order now!

12V 0.75 AHSNCB . . . $9.75

7-SEGMENT DIGITAL DISPLAY — $1.70 each

Bright blue-green display tube, with numerical display characters. Tube exhibits very fast display speed and easy-to-read characters of .57" H x .36" W, with decimal point. Complete with instructions to make a decade counting unit or a 6-digit clock. Tubes are brand new, bulk packed, and manufactured by Tung-Sol, no. 1705. Sh. Wt. 4 oz.

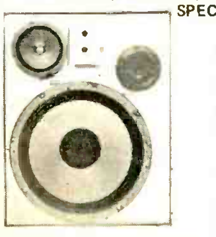
7SDD-1705 . . . $1.70 each; or 6 for $8.50, 10 for $14.00, 100 for $125.00, 1000 for $950.00

COLLINS CRYSTAL FILTERS

Anyone who is familiar with super high quality communications receivers is familiar with the Collins filter. 455 Kc center frequency 300 Hz bandwidth. Part number 526 7073 009, type X455-KF 300. Full technical information provided.

Collins Crystal Filter . . . $14.75

LOUDSPEAKER SYSTEM COMPONENT SPECIAL!



We have made an excellent purchase of an excess inventory of a local manufacturer's speaker systems, although we are not allowed to mention the mfg's. name, the specs should make it self-evident. The woofer is a 12" free-edge (acoustic suspension) unit, with 2" voice coil and a No. 2 magnet. The mid-range is a 5" sealed back speaker and 3-½" flare dome tweeter for best high frequency dispersion. Crossover between woofer & mid-range is by an R-L-C network, while high frequency crossover is by an R-C network. Balance controls are provided for both mid-range and tweeter. Plans for a suitable enclosure are provided. The level controls provide frequency response to suit room acoustics, with realism that will delight even the most critical listener. Response — 25 to 20K + Hz., Power — 40 watts RMS. Impedance — 8 ohms.

Sh.Wt.12 lbs.

- ☐ LSCS $36.00
- ☐ 2LSCS . . . . 2 for $65.00

TELSA COIL KIT

Here's a truly basic kit for those who like to "roll their own." All the parts for an exciting adventure into high-frequency, high voltage. Add your own metal housing — a small chassis or universal box is ideal.

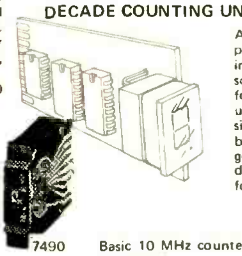
Tesla coils are patterned after the design of Nikola Tesla (1857-1943) an American electrical genius who built versions many feet tall. His dream was to light and power entire cities with energy radiated from such coils — but no luck!

Today's Tesla coils are popular with experimenters and students, and especially for science fair and educational demonstrations. Ours is a high-frequency push-pull oscillator coupled to a television flyback transformer, which steps up an external 12 VDC power supply to many thousand volts.

SPECIAL NOTE: Although current output is relatively low, some hazard is inherent in all high voltage devices. This kit is intended for the experimenter who is mature enough to observe reasonable precaution in its use.

TESLA COIL KIT $7.50

DECADE COUNTING UNITS WITH READOUTS



Always one of B & F's most popular items, now revised to include drilled boards, I.C. sockets, and right-angle socket for readout. Arranged so that units can be stacked side by side and straight pieces of wire bussed through for power, ground and reset. Several different units are available as follows:

- 7490 Basic 10 MHz counter. Used in frequency counters and events.
- 74196 Same as 7490 except presettable 50 MHz unit. Used where higher speed and/or presettability is required.
- 74192 Bi-Directional Counter, 32 MHz operation. Has two input lines, one that makes the unit count up, the other down. Uses include timers, where the counter is preset to a number and counts down to zero, monitoring a sequence of events, i.e., keeping track of people in a room by counting up for entries and down for departures.
- 7475 Adds latch capability. Used in counter so displays continue displaying frequency while new frequency is being counted for uninterrupted display.
- 7447 Basic decoder module. Drives basic seven segment display which is included for all modules.

NEWEST DCU!

This DCU combines all of the features of our other counting units, that is, high speed counting, up-down operation, storage, and preset. In addition it includes a comparator (7485) and a thumbwheel switch in order to provide comparison and preset capability. With this combination you can do the following:

1. Count up or down at speeds to 33 MegaHertz.
2. Store previous count during new count.
3. Preset to any number, count down (or up) and generate a logic level when count of zero is reached. Stack several units and generate logic level for any count greater than zero.
4. Preset to zero, count up (or down) and generate a logic level for any number greater or equal to the number preset in the thumbwheel switch. Stack several DCU's and generate a logic level showing whether number is greater than, equal to, or less than numbers preset on switches.

- ☐ 910 K 7490-7447 Counter $8.25
- ☐ 910 LK 7490-7475-7447 Counter $9.25
- ☐ 911 LK 74196-7475-7447 Counter $10.25
- ☐ 912 K 74192-7447 Counter $9.25
- ☐ 913 K 74192-7475-7447-7485 Universal DCU $14.50

I.B.M. POWER SUPPLY REGULATOR PARTS!

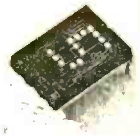
Like-new assembly surplus from the I.B.M. Company contains the following: (6) 150-Watt transistors, (6) heat sinks, (6) .1Ω 5W resistors, 12V, 20 Amp circuit breaker, a 16-ohm 10-Watt resistor, 50-Watt resistor, terminal strip, (2) 16-pin P.C. edge connectors for regular cards. An 8000 mfd, 15V computer grade capacitor is also provided. All in a nice mounting — looks as if it could be a neat unit to make a lab-type power supply. Unit is sold as an assembly, or in parts. Quantity is limited.

Sh.Wt. 20 lbs.	IBMPSRA	$7.50
3 for $20.00	IBMPSRA	$20.00/3
8 for $52.00	IBMPSRA	$52.00/8

Heat sinks capable of dissipating 150 watts of power

Price . . . . $1.00 ea.
Transistors, 2N441 or 2N442 type, TO-36 case . . . $1.00 ea.
Heat sink with transistor . . . . $1.50 ea.
4 for $5.00 . . . . $5.00/4
Connectors, 2 for $1.50 . . . . $1.50/2
Capacitor, $1.50 . . . . $1.50 ea.

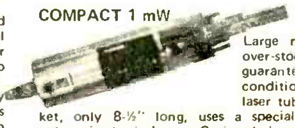
HEWLETT PACKARD SOLID STATE NUMERIC INDICATOR



These fantastic L.E.D indicators have built-in decoder/driver with memory. They use a 4 x 7 dot array for much better readability. They are packaged in a standard Dual-In-Line (DIP) package with built-in contrast filter. Completely DTL TTL compatible. HP part number 5082-7300 (right hand decimal)

HP 5082 . . . . $9.75

COMPACT 1 mW LASER TUBE



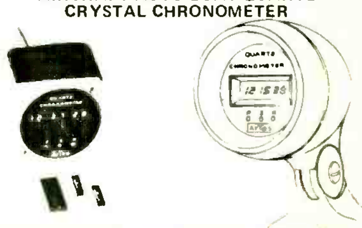
Large manufacturer sells his over-stock tubes to us, all guaranteed to be in perfect condition. Most compact 1mW laser tube (TEM.) on the market, only 8-½" long, uses a special tapered bore design, unique in the industry. Cavity design, internal hemispherical mirror system with co-axial mounting of all elements, maintain beam alignment and power stability under mechanical stress and changes in temperature. SPECIFICATIONS: red laser, 1mW power, TEM., 632.8mm wavelength, 1.10mm beam diameter. 0.85 mrad divergence, linear polarization, size: 8.5 x 1.75" diameter. These can be useful for alignment systems, measurement systems, and for illumination, etc., in equipment such as levels, transits, ranging, inspection displays, holography, etc. Operation life beyond 10,000 hours. This is not a toy tube, but a laser designed to meet rigid industry standards. List price is over $200.00 each.

Sh.Wt. 3 lbs.	C1mWLT	$97.50
2 for $180.00	C1mWLT	$180.00/2
10 for $850.00	C1mWLT	$850.00/10
100 for $7500	C1mWLT	$7500.00/100

Portable supply—operates from 12 vdc input. Useful for field experiments with laser. Available only with purchase of tube.

Price $25.00

AIRCRAFT AUTO BOAT QUARTZ CRYSTAL CHRONOMETER



Revolutionary!, was the reaction of our customers when they saw our latest kit. Measuring only 2½" x 2½" x 23/8", and accurate to 10 seconds a month, this chronometer promises to entirely replace mechanical clocks in cars, boats and airplanes.

Fits into a standard 2¼" instrument panel cutout. The displays are bright L.E.D. displays that should last a lifetime. Setting controls are recessed and operate from a pointed object such as a pencil point or paper clip, in order to keep non-authorized hands off. The clock should only have to be reset at very great intervals, or in the event of power loss (i.e., replacing battery in car). The clock is wired so that the timing circuits are always running, but the displays are only lit when the ignition is on, resulting in negligible power drain. The low price is only possible because of a new one chip MOS clock. Operates from 10-14 Volts D.C. An accessory unit which mounts on the back adapts the unit 59 20-28 volts for twin engine aircraft and larger boats using 24 Volts ignition. Know how disgusted you are with the usual car clock? Order this fine unit now for rallying, sports events, navigation, or just to have a fine chronometer that will give you a lifetime of superbly accurate time.

- ☐ Quartz Chronometer, Kit Form $69.50
- ☐ Quartz Chronometer, Wired $99.50
- ☐ 24 Volt Adapter $10.00

New-Style AUTO/BOAT/PLANE QUARTZ CRYSTAL CHRONOMETER

As you can see from the illustration, we have provided a new enclosure for our most popular kit, the ARIES Model AR-720K Quartz Crystal Chronometer. This enclosure can be mounted in many convenient variations, i.e., over or under the dashboard, over the center drive tunnel, or under the roof above the windshield.

- ☐ Automotive style quartz crystal chronometer $75.00
- ☐ Same assembled, calibrated, tested $99.00

Send in an order and get on our special custom customer Mailing List.

CATALOG: Check reader's card or write.

ALL ITEMS (WHERE WEIGHT IS NOT SPECIFIED) POSTAGE PAID IN THE U.S.A.

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Phone in charges to 617 531-5774 or 617 532-2323, BankAmericard — Mastercharge. $10.00 minimum. No C.O.D.'s please.

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Circle 87 on reader service card

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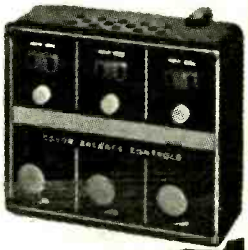
A BETTER LIFE STARTS HERE

(And our FREE CATALOG is packed with exciting and unusual ecological & physical science items—plus 4,500 finds for fun, study or profit . . . for every member of the family.) Great for unusual christmas gifts!

3-CHANNEL COLOR ORGAN KIT



Easy to build low-cost kit needs no technical knowledge. Completed unit has 3 bands of audio frequencies to modulate 3 independent strings of colored lamps (i.e. "lows"-reds, "middles"-greens, "highs"-blues. Just connect hi-fi, radio, power lamp etc. & plug ea. lamp string into own channel (max. 300w ea.). Kit features 3 neon indicators, color intensity controls, controlled individ SCR circuits; isolation transformer; custom plastic housing; instr.

Stock No. 41,831EH ....$17.50 Ppd.

ELECTRONIC CALCULATOR–$79.95!

Terrific buy, reduced from $199.50! Top quality American made with big machine capabilities. Adds, subtracts, multiplies, divides, does mixed calculations—silently in milliseconds! 8-digit entry, readout; floating decimal; +/— change key; zero suppression; automatic constant; error correction; recall key. Easily operated in home or office. 110-120v AC. 6-1/2X9X2". 3 lb. 6-month guarantee. Instructions.

Stock No. 78,006EH ....$79.95 Ppd.
No. 78,007EH ... (6-oz. PORTABLE) ....$89.95 Ppd.
No. 78,008EH (ECONOMY MODEL—NO MEMORY) ....$59.95 Ppd.

KNOW YOUR ALPHA FROM THETA!

For greater relaxation, concentration, listen to your Alpha-Theta brainwaves. Ultra-sensitive electrode headband slips on/off in seconds—eliminates need for messy creams, etc. Atch'd to amplifier, filters brainwaves, signals beep for ea. Alpha or Theta wave passed. Monitoring button simulates Alpha sound audio & visual (L.E.D.) feedback. Reliable, easy-to-use unit—comparable to costlier models. Completely safe. Comprehen. instr. bklt.

No. 1635EH (8x3x4"; 24 oz.) .. $124.50 Ppd.
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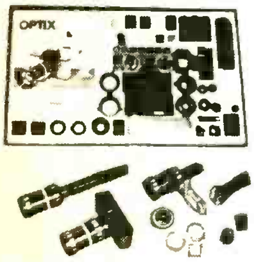

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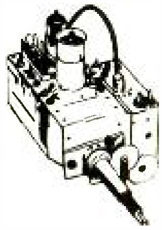
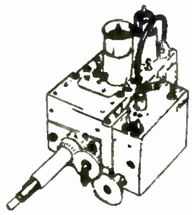

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These universal replacement tuners are all equipped with memory fine tuning and uhf position with plug input for uhf tuner. They come complete with hardware and component kit to adapt for use in thousands of popular TV receivers.

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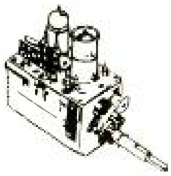
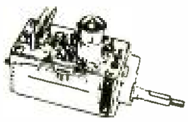
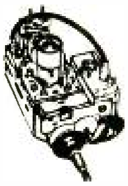
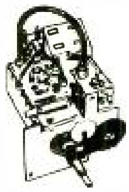
CR7XL	Series 600mA	2½″	12″	41.25	11.00
CR9XL	Series 450mA	2½″	12″	41.25	11.00

Castle Replacements $15.95

Castle custom replacements made to fit in place of original tuner. Purchase outright . . . no exchange needed. Write for current list of Castle replacements, or request the part number you require (use number on ORIGINAL TUNER ONLY; do not use service literature numbers). Available for many of the popular models of following manufacturers: Admiral, Curtis Mathes, Emerson, GE, Heathkit, Magnavox, Motorola, Muntz, Philco, RCA, Sears, Sylvania, Westinghouse, Zenith and many private labels.

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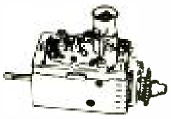
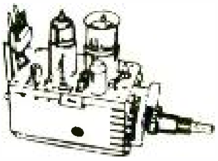



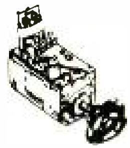
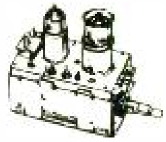
Overhaul Service $9.95

This is the service pioneered by Castle! We are now in our third decade of serving the TV Service Industry

Service on all makes and models, vhf or uhf, including transistor and color tuners . . . one price $9.95 (does not include tuners older than 10 years). Overhaul includes parts, except tubes and transistors.

Simply send us the defective tuner complete; include tubes, shield cover and any damaged parts with model number and complaint. Your tuner will be expertly overhauled and returned promptly, performance restored, aligned to original standards and warranted for 90 days.

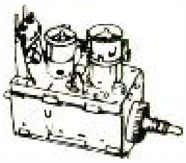
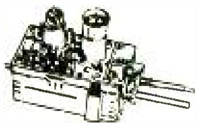
Dismantle tandem uhf and vhf tuners and send in defective unit only. Remove all accessories . . . or dismantling charge may apply.

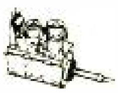
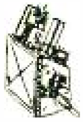
Custom Exchange Service $17.95

When our inspection reveals that original tuner is unfit for overhaul, and it is not available from our stock of outright replacements, we offer to make a custom replacement on exchange basis. Charge for this service is $15.95 for uhf tuner and $17.95 for vhf tuner.

If custom replacement cannot be made we will custom rebuild the original tuner at the exchange replacement price.

All replacements are new or rebuilt. All prices are f.o.b. our plant. Add shipping and handling of $1.25 on all prepaid orders. We will ship C.O.D.

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Instead of talking about a cassette deck with 3 heads we make one.

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The RS-279US also has many other desirable design and convenience features. Like a dual motor system. With a DC motor for the reel-table-drive and our exclusive direct drive DC motor for the capstan. Adjustable Dolby*. Switchable bias for CrO_2 tapes. Solenoid-operated function controls. Locking pause. Memory rewind. And Auto-Stop.

And the specs are just what you'd expect from a deck with those credentials. The signal-to-noise ratio is better than 59dB. Frequency response is from 20-16,000 Hz. And wow and flutter are less than 0.10%.

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