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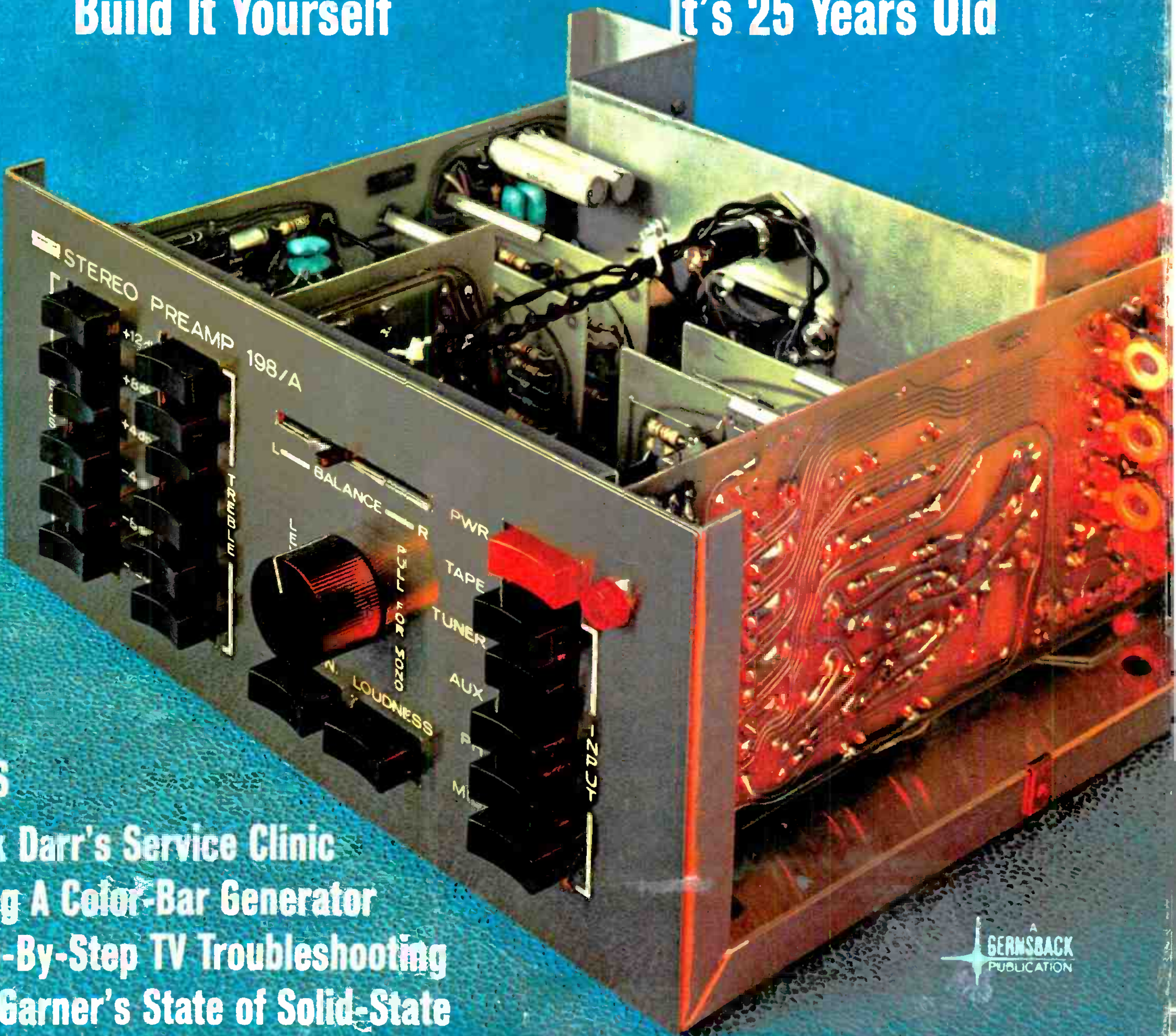

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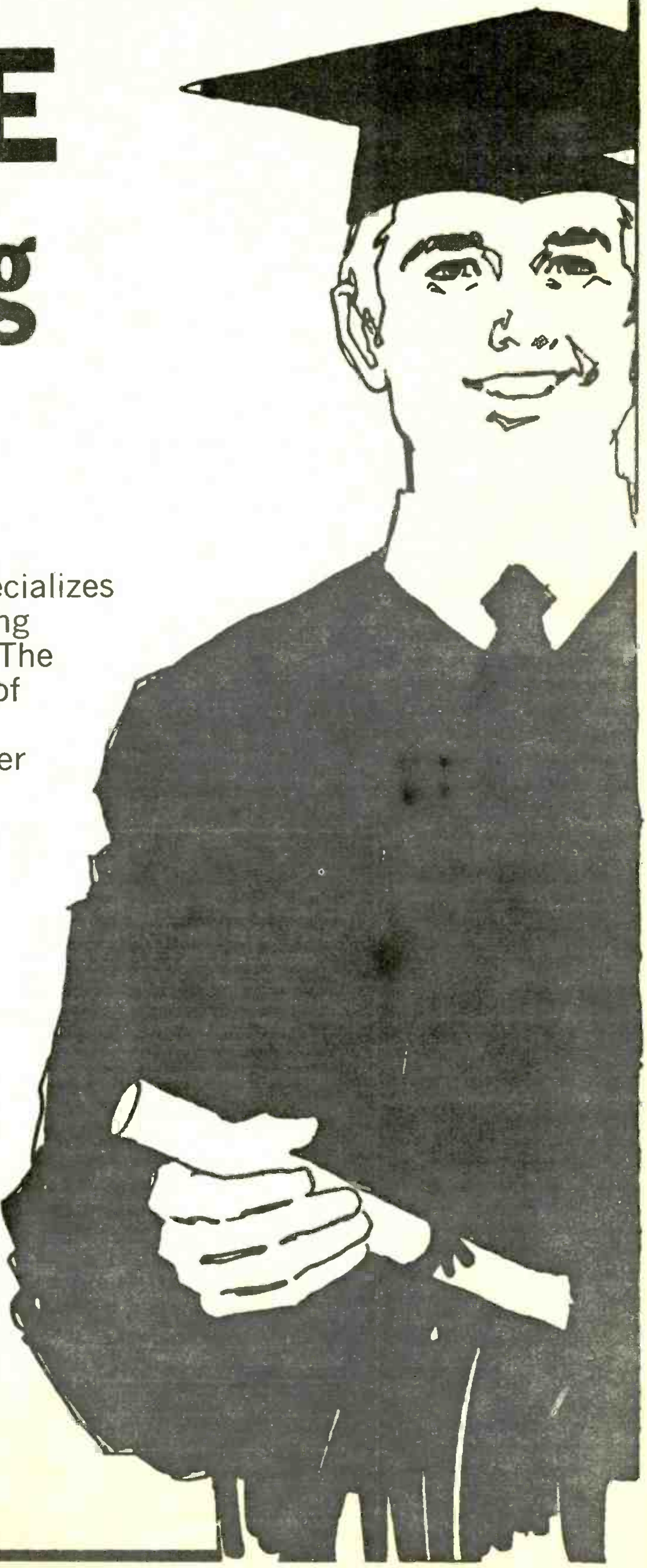

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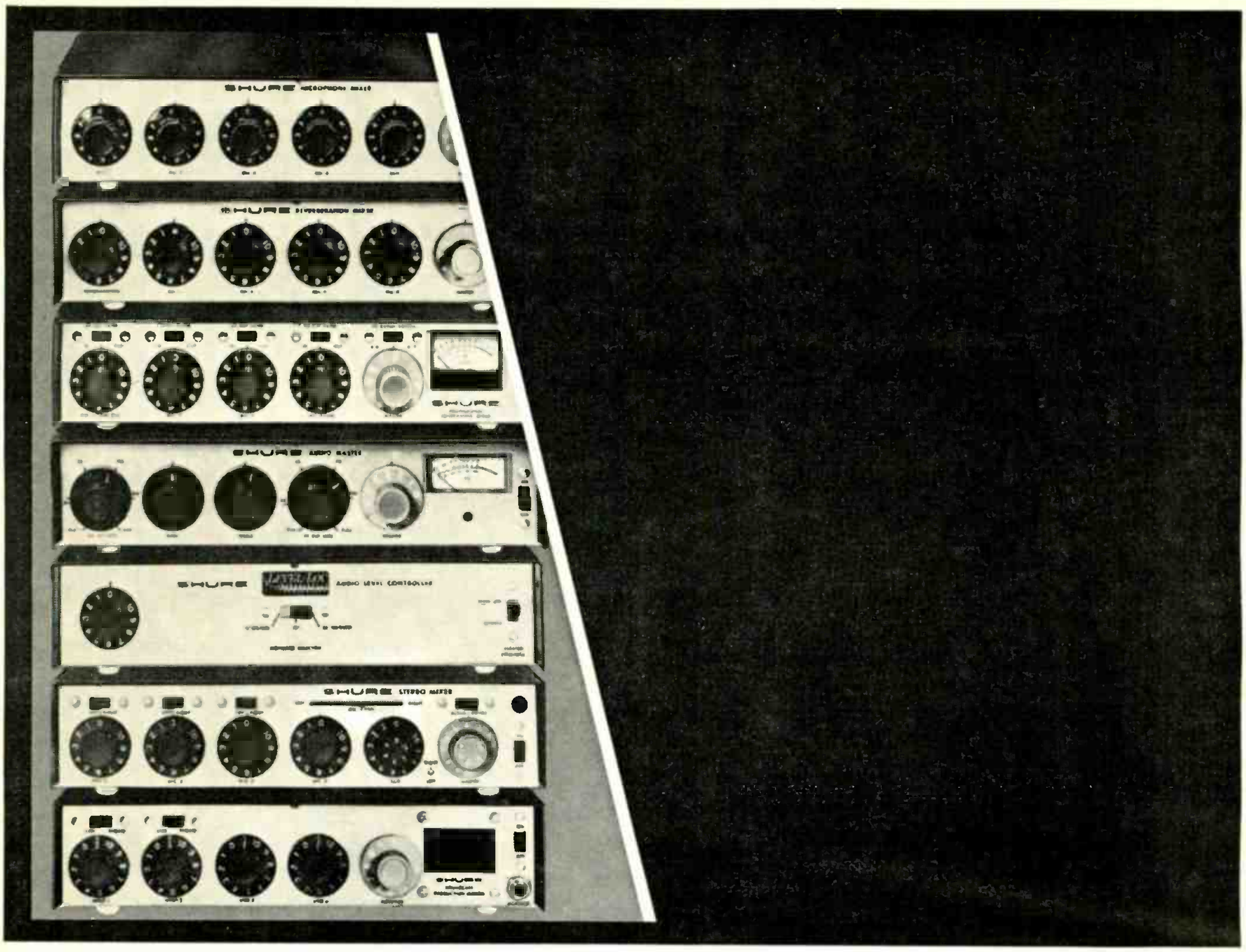

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Radio-Electronics

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December 1972

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SEASON'S GREETINGS

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

CALCULATORS ARE BIG NEWS. See how they evolved from counting on your fingers (the first "digital" computer) to the modern electronic marvels we are using today.

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looking ahead

Cable pay TV

Pay TV, which never succeeded over the air, appears to have much better chance via cable, and several tests of special-programming-for-a-fee are under way now or will start shortly. The standard argument against over-the-air pay TV was that it took programming away from free TV by blacking out a channel to non-payers. Proponents of cable pay TV say wired systems add rather than subtract, since they simply introduce new channels—mostly in the "mid-band" between Channels 6 and 7—for the new subscription services.

Home tests of at least eight different pay-TV systems in as many as 25 or 30 communities could be in progress within the next few months. The home pay-TV tests will literally be coast-to-coast, from Atlanta to San Diego. Some will involve signals scrambled for security, while others will merely use special converters without scrambling. Two systems will be tested simultaneously in 10 cities each. One, backed by Columbia Pictures, requires the CATV subscriber to call a special number on the telephone to get reception of the day's feature film. The other, developed by Warner Brothers' cable-TV subsidiary, provides a special channel for recent feature films at a monthly subscription fee of $4-$8, in addition to the regular CATV fee. Pay-TV subscribers are provided special converters for the mid-band pay channel.

Two of the systems involve a form of ticket. One requires a magnetically encoded ticket to be purchased in advance and inserted in a set-top receptacle to activate the circuit which unscrambles the picture. Another uses punched cards to activate a decoder permitting the viewer to see films, sports events and other special programs for a week.

Experiments with various methods of providing secure pay-as-you-see programming is widespread. It's unlikely that a single, standard system will emerge in the near future, since there's no particular need for one—CATV being closed-circuit hookups, generally one to a community. In all cases, the cable company provides the converter and/or decoder, so the consumer only pays for the programming—either on a per-program or a monthly basis.

Another video LP

Hot on the grooves of our report last month that RCA had developed a relatively low-cost color videodisc capable of playing 20 minutes per side, another system has emerged which promises 45 minutes of playing time on each side. This is enough playing time to provide a feature movie on one or two 12-inch discs.

The new system was developed by the European electronics giant, Philips of the Netherlands. Called VLP (for Video Long Play), the system is based on optical encoding. A unique feature is that, theoretically at least, neither the disc nor the pickup device is susceptible to any wear—since they don't touch each other. In place of grooves, the VLP disc has a series of oblong microscopic pits. Variations in the length of the pits and their distance from one another provides brightness, color, sync and sound. A low-powered (one-milliwatt) helium neon laser scans the disc from the bottom as it revolves at 1,500 rpm. The U.S. version will revolve at 1,800 rpm, to provide one full revolution of the disc for each television frame. A feature of the system is its ability to freeze any single frame as a still picture, to play backwards, in slow or fast motion.

The master disc is cut by a laser, and vinyl pressings are made in a manner similar to the manufacture of audio recordings. After pressing, a highly reflective microscopically thin aluminum coating is applied. Officials of Philips hope that the system will be on the market in 1974, with a price of about $625 quoted for the player, designed to be attached to the antenna terminals of any television receiver. The quality of the picture produced by the system is excellent, those who have seen it agree. The equipment is expected to be marketed in the United States by the North American Philips Co. (Norelco), and possibly by other manufacturers.

Color politics

Color television is still a sensitive political issue in many countries. Back in 1966 and earlier, most of the world chose up sides among the American NTSC color system, the German PAL system and the French SECAM. Although the decisions were couched in weighty engineering terms, they tended to be dominated, in actuality, by political considerations. The American bloc—including Japan, Mexico and the Philippines—had already selected NTSC. Canada chose NTSC because its citizens were receiving color from across the U.S. border. Most of Western Europe picked PAL. The French bloc—including France's former colonies in Africa, after many engineering studies, decided SECAM was the only way to go. This was at a time when France and the Communist countries were chummy, so the Soviet Union and other Eastern European countries conducted scientific tests which confirmed that SECAM had strong engineering advantages. Mainland China indicated her preference for SECAM, too.

Suddenly, a little repetition of the color TV war has erupted. One battle is being fought in Venezuela, where the U.S. State and Commerce Departments are fighting mightily for NTSC—to the point of helping to sponsor elaborate on-the-air demonstrations. Brazil has already chosen the PAL system, but there is a strong feeling that Venezuela will influence the Spanish-speaking South America.

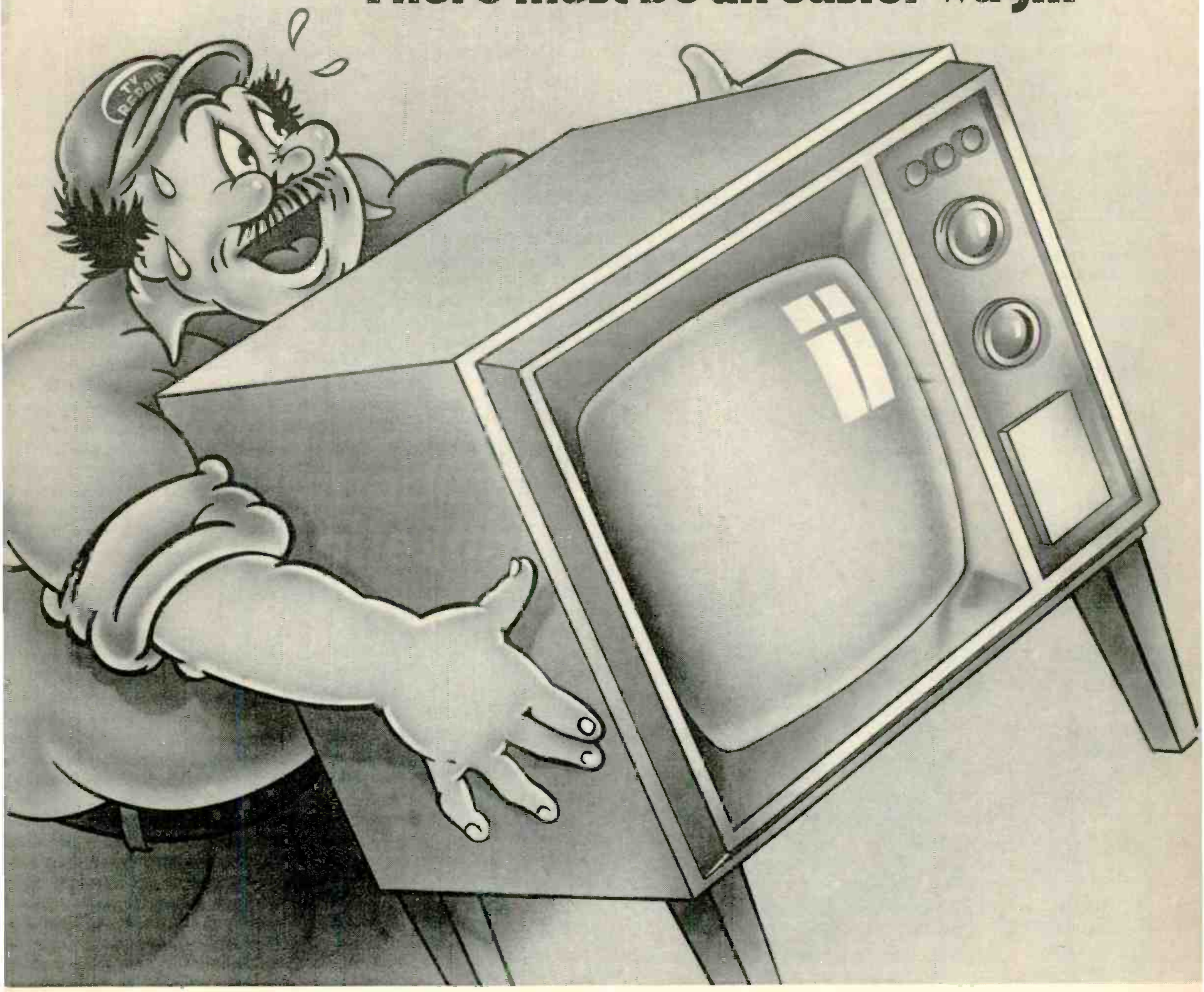
Meanwhile, Italy has become another battleground. It was long assumed that it would follow most of Europe in selecting the PAL system—but with increasingly close relations between Italy and France, Italy is now engaged in test broadcasting of the SECAM and PAL systems.

The next arena could be mainland China, where communications experts had their first exposure to the NTSC color system during President Nixon's visit. They apparently were impressed with it, because they are reported to be talking with various Japanese companies about the possibility of establishing color TV receiver plants there. As her relations with the Soviet Union have cooled, so has China's enthusiasm for the SECAM system.

But what about the Soviet Union? Color broadcasting there is in the SECAM system, but Russia's alliance with France has weakened, and some experts now predict the emergence of a fourth color system, invented in the Soviet Union.

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

There must be an easier way...



There is: Sylvania's Chek-A-Color test jig.

TV servicemen were never meant to be movingmen.

But, that was before antique, modern and French Provincial units that included hi-fi, tape decks and record players were built around a large-screen color TV set.

Getting those units to the shop can be a big job.

That's why we developed our two Chek-A-Color test jig units. One, our full-house model, gives everything you need to test a chassis. The other is a basic unit that practically lets you design your own test jig.

All you have to take back to the shop is the electronic guts of the TV monsters.

Regardless of the size of the original picture, Chek-A-Color lets you see it on a benchtop 14-inch (diagonal) screen. It adapts to both high and low focus voltage sets and a full line of adapters lets you test over 5,000 different models.

A front-panel switch controls a yoke programming system that gives you a range of impedances and/or deflection voltages to closely match both tube and solid-state systems.

For actual testing, a convenient meter lets you measure anode voltage and a speaker lets you check sound performance.

Since Chek-A-Color handles tube, hybrid and solid-state chassis, there won't be many complete cabinets to lug.

With a Chek-A-Color test jig all you have to take is the chassis. Get the picture? Sylvania Electronic Components, 100 First Avenue, Waltham, Mass. 02154

GTE SYLVANIA

guest editorial

the world of radio-tv

Radio was born a little more than three-quarters of a century ago. It was in May, 1895 that Alexander Popoff made what was possibly the first public demonstration of wireless telegraph equipment, which he did by combining the electromagnetic wave transmitter devised by Heinrich Hertz and the coherer, developed through experiments made by Branley in 1890.

Broadcasting started—in the principal countries of the world—a half century ago. Though its beginnings date back to before the second World War, regular television transmissions began about a quarter century ago.

Even though the development of radio and TV has been comparatively recent, those who have benefited from it have been numerous indeed. Today humanity has about a billion broadcast receivers and more than 160 million television sets. And each of these serves several persons—usually a whole family. Which is to say a prodigious number of people listen to the radio or view TV.

Technology has progressed very rapidly in this area. The receivers of sounds and images have been perfected in all points: sensitivity, sound and picture quality, and selectivity. No other technique has benefited from such impressive progress (no small part of which is due to the fundamental revolution initiated by the invention of the transistor in 1947).

If we admire the rapid evolution of our technique, we are also profoundly moved in noting what an influence it has exercised on the life of humanity. No invention has so affected the evolution of the world as has radio and television!

During the second World War, the populations of occupied countries were kept abreast of the true course of events by listening to the broadcasts from the free countries, and thereby their morale was sustained.

The Resistance profited notably by radiophone communications. We can state that with all the more certainty, as at the time we were able to erect, at Annecy, a shortwave transmitter for the courageous Resistance groups assembled in the mountains near Lake Geneva.

In our days, radio and television reach all the people of the world. Because of the reflection of short waves from the Heaviside layer and—more recently—the action of artificial satellites receiving and retransmitting signals, sounds and images can be transmitted to any part of the earth.

Thus the Olympic Games, played in Japan and Germany, were viewed directly—and even in color—in all countries. Several hundreds of millions viewed the same scenes at the same time.

And radio communication is not limited by the dimensions of our planet. When the people of Earth went walking on the Moon, we viewed them direct over the 240,000 miles that separated us.

This enormous distance is far from being the limit of our communications range. In the near future we will be able to see the surfaces of other planets of the solar system on our television screens. And in the more distant future, our descendants will be able to view other stars of our galaxy and their planets. The term "direct view" or "live" will cease to have meaning, for the waves will spend months or years traversing the distance that separates their transmitters from the Earth.

* * *

The liaison that our technique makes possible between all peoples must eventually have as its happy result the unification of humanity.

Certainly, for a better understanding between the inhabitants of different countries, it will be useful to employ that international auxiliary language, Esperanto. Easy to learn because its grammar consists of 16 simple rules; because by using a rational system of prefixes and suffixes one can form a large number of words from a small number of roots, that language, created in 1887 by Dr. Zameshof, should be taught simultaneously in all the schools of the world.

The use of Esperanto in relations with the people of other countries would also preserve better the quality of the national languages.

But—even in its present state—the liaison that radio and television has already established between the peoples of our planet has already brought them closer together. Knowing each other better, they will have a greater feeling of solidarity.

We hope therefore that, thanks to the worldwide expansion of our technique, there may be no more war, that a spirit of cooperation may develop between the various countries and that humanity may be able to carry out the precept of Jesus Christ: "Love one another!" ***—E. Aisberg****

**See page 82 for a word about our guest editorialist.*

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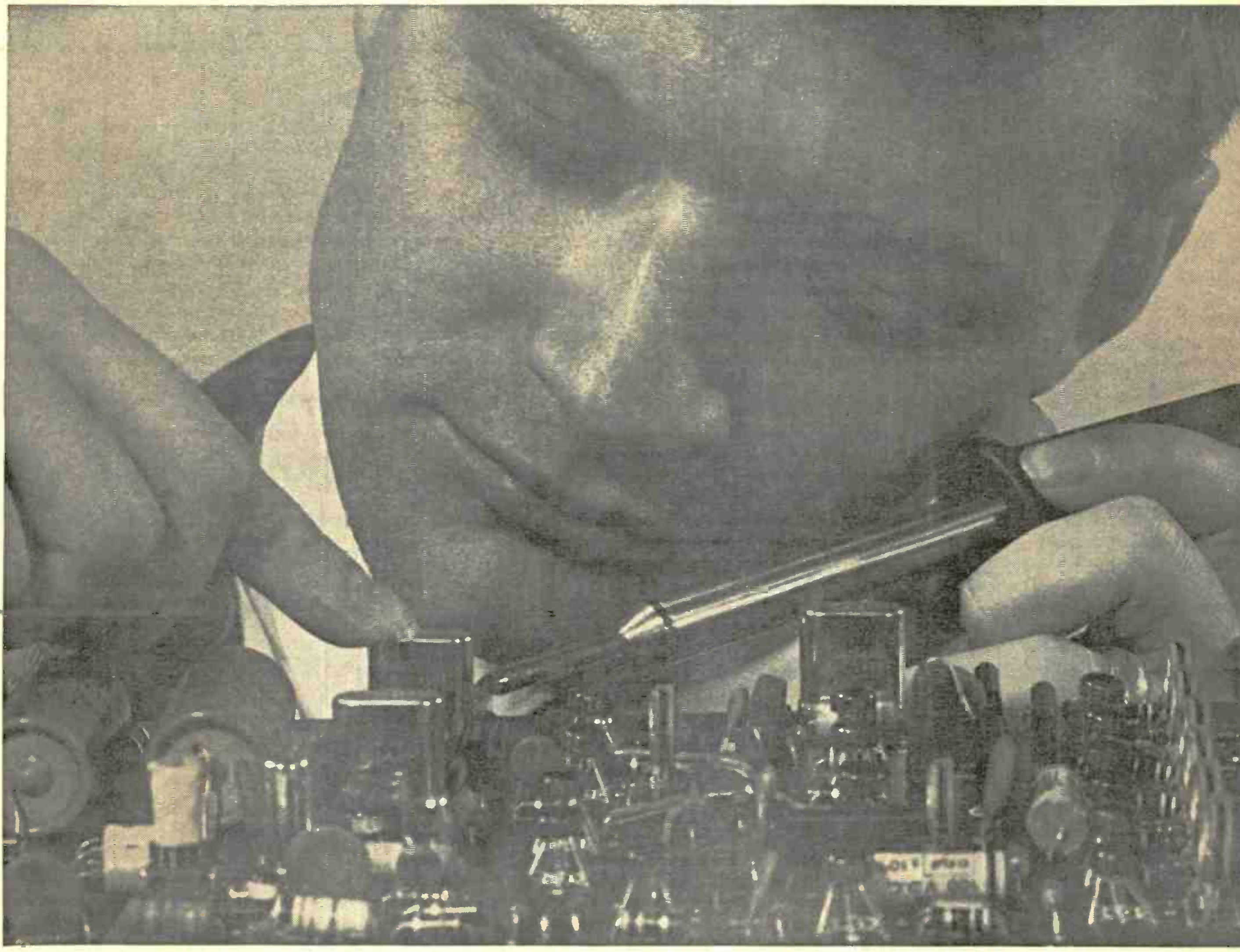

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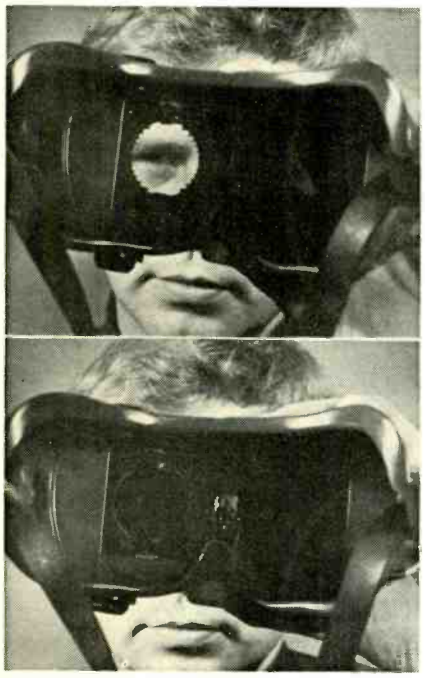
new & timely

Electronic goggles "blink" for flashes of bright light

Electronic safety goggle lenses that switch from transparent to practically opaque (0.01% transmission) in less than 50 microseconds have been developed by researchers at Sandia Laboratories (New Mexico).



THE FLASHPROOF GOGGLES. Above, full "on." Below, completely opaque (one lens in top photo is shadowed by inventor's hand.)

Designed primarily to protect workers from flashblindness due to nuclear flashes, the goggles are equally useful in industrial jobs like arc welding. The lenses may also be used to protect sensitive light detectors (image intensifiers, vidicon tubes, etc.), as an optical shutter for high-speed photography or an optical switch or light gate. (Had the moon television camera that was put out of action by being pointed at the sun been protected by one of these lenses, it would not have been damaged.)

The variable-density lens is a sandwich—two polarizers oriented at 90° to each other, with a ceramic layer of lanthanum-modified lead zirconate-lead titanate (PLZT) between them. Transparent electrodes of sputtered copper or gold, 2 mils wide and 40 mils apart, are supplied with 90 volts (maximum) from a 5.5-volt battery in a pocket-size power pack. Current is a fraction of a microampere.

The power supply is controlled by an array of five photodiodes—pointed in different directions—mounted above the nosepiece of the goggles. The light threshold, at which the glasses start to darken, can be adjusted by changing the resistors in the circuit. In the "on" state the goggles are more transparent than ordinary sunglasses, with a light transmission of 21% (U.S. Air Force sunglasses transmit 15%). Transmission may be set at any level between this 21% and complete opacity with a simple resistance control.

New York technician reports absolutely new TV trouble

The TV-radio technician has become familiar with the set that can't be turned off, as well as the TV that "makes the room cold when it's turned on," but the type of trouble recently reported by Belin Radio and Television of New York City has apparently never before been noted in the literature.

According to Mel Ressler, proprietor, a woman whose set had just been repaired called back hysterically: "I can't turn it off!" Mel suspected a shorted switch and advised her to pull the plug. Then he says, the lady called back a few minutes later, really hysterial this time: "Everything is off but the dial. It's still lit! And I can't get it to go out!"

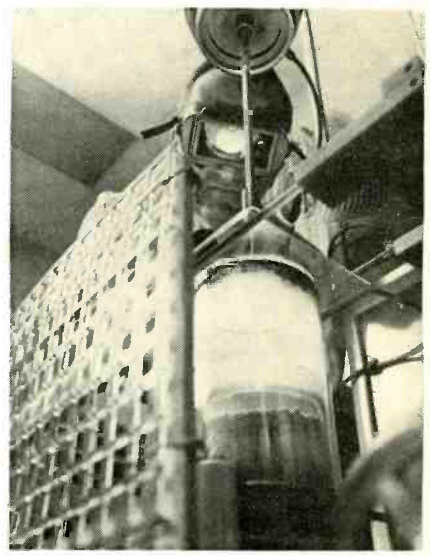
"This," thought Mel, "I've gotta see!" So he went over. "And," he says, "she took me to the set. There was this light inside, all right. The guy had left his flashlight in there and left it on with the light shining through the numbers."

Computer improves quality of man-made crystal

Automatic control of the growth process and diameter of crystals grown for communications systems improves the quality of the crystal and reduces the cost of producing it, Bell Laboratories scientists report. Crystals are grown by pulling a crystal "seed" slowly out of melted crystal material. The time required—in the case of the crystals grown in this experiment—is 20 to 30 hours.

If the crystal is pulled too rapidly it becomes skinny—if too slowly, its diameter increases. To keep defects to a minimum, the diameter of the crystal must be kept as near uniform as possible. This previously required that a skilled technician watch over the crystal throughout the whole 20 to 30 hours.

In the automatic method a digital scale takes a continuous series of measurements of the weight of the molten material. The computer uses these to calculate the crystal's rate of growth, and feeds back information that lowers or raises the temperature of the melt, according to whether the crystal is growing too fast or too slow. Thus not only does constant human surveillance become unnecessary, but the crystal is more uniform than even a skilled technician could make it.



AUTOMATIC CRYSTAL GROWER about to go into action. The rod with which the crystal is "pulled" can be seen clearly. The wearer of the goggles is Ralph C. Joseph of the Materials Development Dept., Bell Labs, Allentown, Pa.

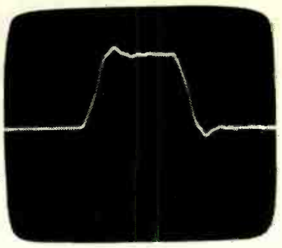
The new system has been used to grow crystals of gadolnium gallium garnet, a substrate material for the magnetic "bubbles" developed by Bell with the prospect of using them in automatic switching systems and computers. Similar control systems will probably be used for growing other types of communications crystals.

Radio warning beacons to prevent auto accidents?

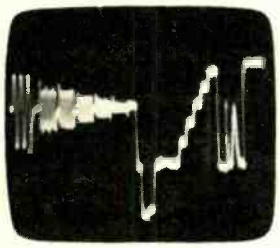
The French Ministry of Transport is experimenting with a new technique for cutting down the number of automobile accidents that occurs regularly in dangerous places, those "black spots" that pile up large totals of damage and fatalities. [In some foreign countries, roadside signs bearing a large black circle (black

(continued on page 14)

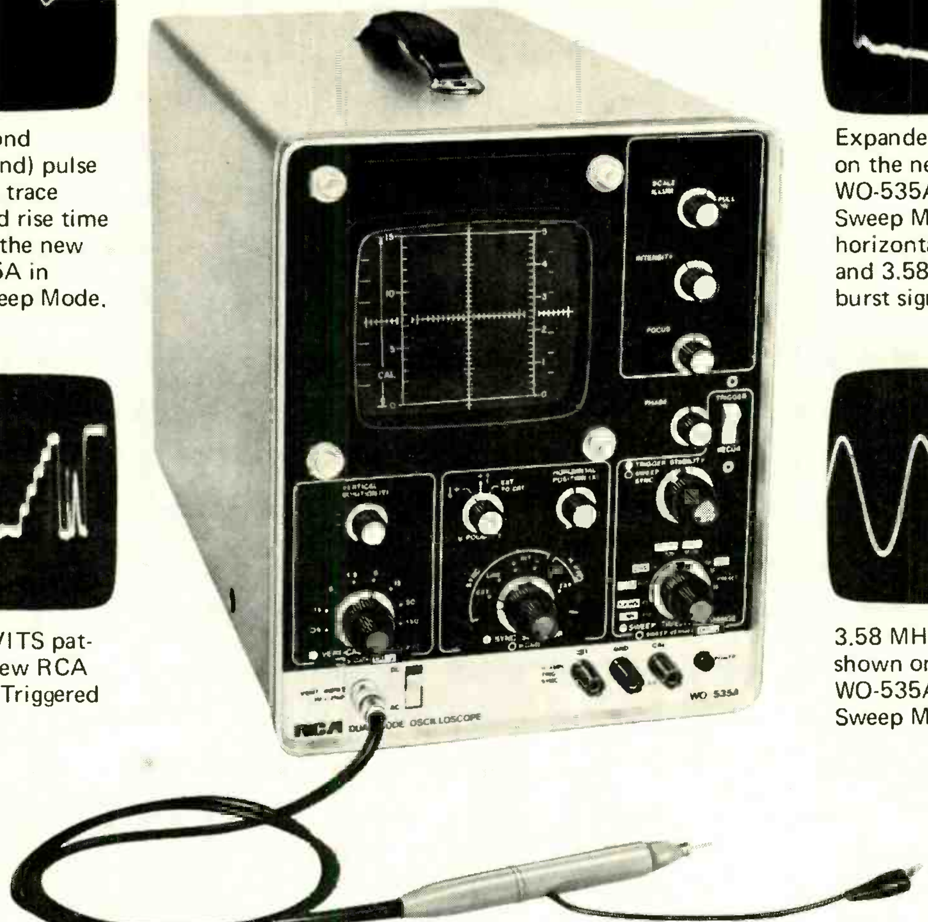
TRIGGERED SWEEP



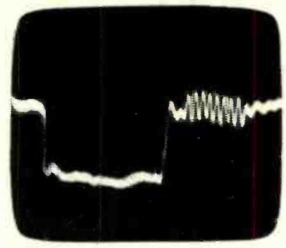
250-nanosecond (¼-microsecond) pulse demonstrates trace expansion and rise time capability of the new RCA WO-535A in Triggered Sweep Mode.



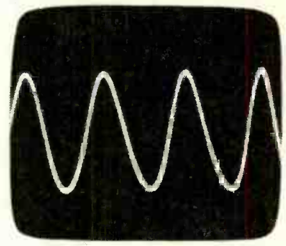
Typical TV VITS pattern on the new RCA WO-535A in Triggered Sweep Mode.



RECURRENT SWEEP



Expanded video signal on the new RCA WO-535A in Recurrent Sweep Mode shows the horizontal sync pulse and 3.58 MHz color-burst signal.



3.58 MHz sine-wave as shown on new RCA WO-535A in Recurrent Sweep Mode.

Now...a 5-inch triggered/recurrent sweep oscilloscope for only $329*

It's the all solid-state RCA WO-535A featuring one-step calibration for simplified voltage measurements and usable frequency response to 10 MHz.

In the Triggered Sweep Mode, you can lock in waveforms and patterns that cannot be viewed easily using recurrent sweep. Triggered sweep with wide, variable trace expansion permits you to view small segments of complex waveforms, such as vertical-interval test signals (VITS). In the Recurrent Sweep Mode, you get all the advantages of a conventional continuous-sweep oscilloscope.

There are many other features of the WO-535A you'll like – and your RCA Distributor will be glad to supply complete information about this general-purpose oscilloscope that provides high performance in such applications as radio and TV servicing, industrial maintenance, troubleshooting, and general waveform analysis.

Also ask your RCA Distributor for the full story on the RCA WO-505A, priced at $299*, and the RCA WO-33A, priced at $180*. Or write RCA Test Equipment Headquarters, Harrison, N.J. 07029.

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Circle 5 on reader service card

new & timely

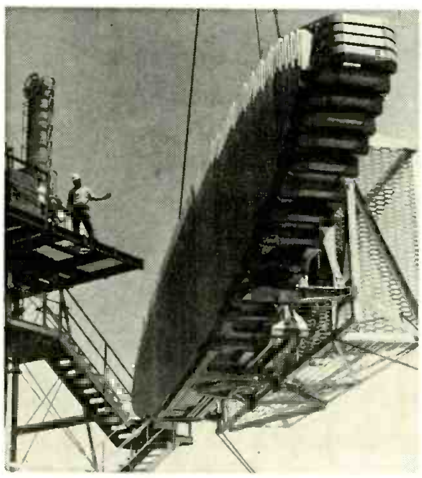
(continued from page 12)

spot) are used to mark locations where vehicular accidents occur regularly, resulting in death and property damage.]

The Ministry is installing small transmitters in a number of these "black spots" and placing receivers tuned to the transmitters in a number of cars. As the car approaches a "black spot" the driver hears a bleep-bleep that warns him of present dangers.

If the technique seems effective, the Ministry may move to have all French motor cars equipped with inexpensive receivers permanently tuned to the beacon frequency.

According to a spokesman for the Ministry of Transport: "It has been proved that accident warning signs are not very effective, but we feel that a sudden unexpected sound inside the car might persuade drivers to be cautious."

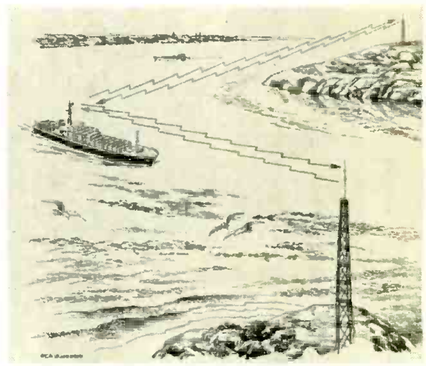


TWENTY SEVEN FEET LONG, WEIGHING 1,500 pounds, this Hughes Aircraft Co. radar antenna is being installed in the radome assembly of a Boeing 707-320 aircraft. It is intended for use in the Air Force Airborne Warning and Control System (AWACS). Boeing is also testing a competing radar by Westinghouse, and will recommend one of them to the Air Force.

Electron device detects human cancerous cells

The principle of nuclear magnetic resonance used in magnetometers may be useful in detecting cancer, says Dr. Raymond Damadian, Brooklyn physician-biophysicist. In a nuclear-resonance device (RADIO-ELECTRONICS, April, 1960, page 38) hydrogen atoms are aligned with an external magnetic field. The magnetic field is suddenly cut off and the atoms drop back to random alignment or alignment with the earth's magnetic field, giving off electromagnetic energy (radio signals) as they do so.

Dr. Damadian has discovered that it is possible to distinguish between the signals given off by atoms in cancerous tissue and those from atoms in healthy tissue. Up to the present his researches have been confined to small tumors, but he hopes within the next couple of years to construct a cancer-detecting nuclear magnetic resonance device large enough to enclose the entire human body.



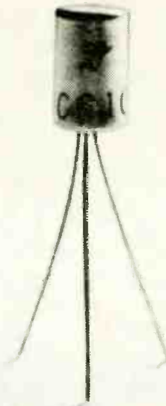
A NEW NAVIGATION AID has been proposed by RCA for the U.S. Coast Guard's River and Harbor Aid to Navigation System. It is based on a transponding technique. Shore stations with transponders reply to signals transmitted by interrogators aboard ship. Thus the ships will be able to identify the stations and calculate their distance from them. A ship, if also equipped with anti-collision radar, could enter a harbor in densest fog. The system would be near ideal for ferries, which could operate in any weather.

Cool conductors increase carrying capacity 7-fold

A 40-foot section of aluminum underground power cable—chilled to −320°F (77°K)—has stood up for several days under voltages comparable to those now handled by commercial oil-filled underground power cables. Voltages up to 435,000 were applied to it. At the low temperature of the tests, conductor resistance is greatly reduced and fantastic currents can be carried. The test was carried out in the General Electric Research and Development Center, Schenectady, NY, in a project designed to find means of carrying larger amounts of power from the outskirts of a city to its center.

The success of the tests indicates to General Electric engineers that such cryogenic (low-temperature) cables could carry more than 3,500 megavolt-amperes

(continued on page 16)



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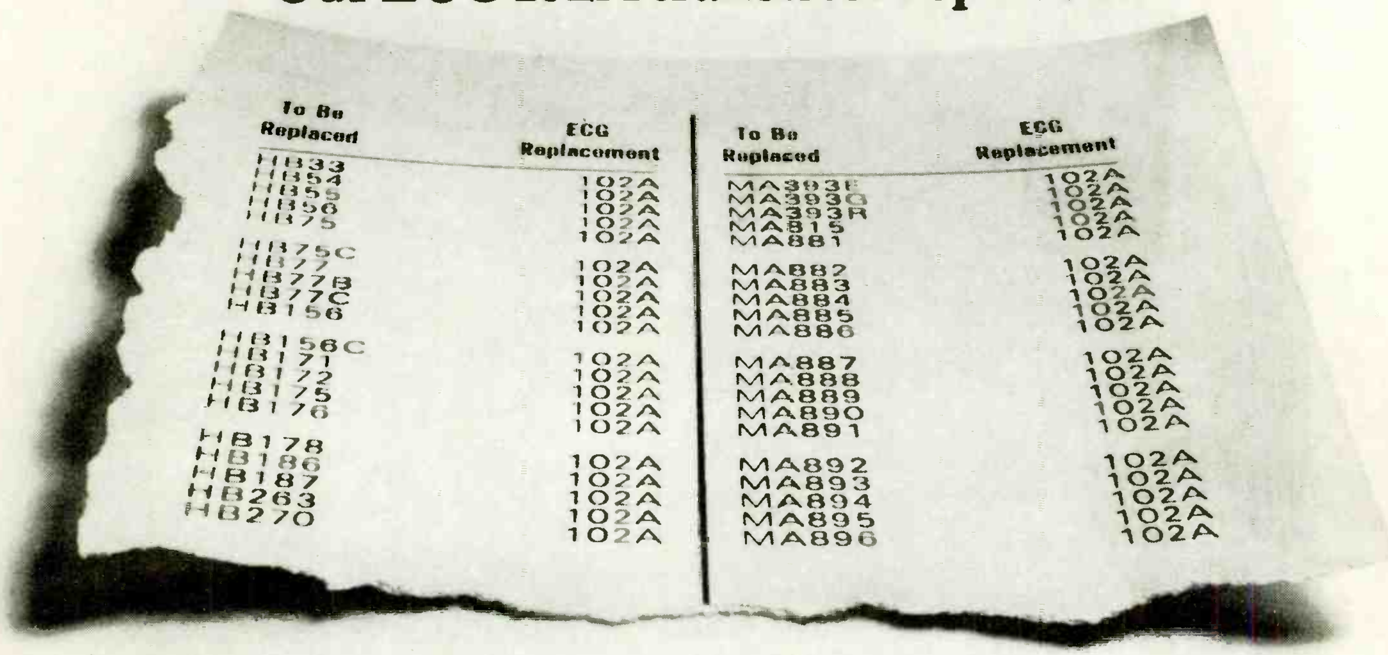

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HB54	102A	MA393G	102A
HB55	102A	MA393R	102A
HB56	102A	MA815	102A
HB75	102A	MA881	102A
HB75C	102A	MA882	102A
HB77	102A	MA883	102A
HB77B	102A	MA884	102A
HB77C	102A	MA885	102A
HB156	102A	MA886	102A
HB156C	102A	MA887	102A
HB171	102A	MA888	102A
HB172	102A	MA889	102A
HB175	102A	MA890	102A
HB176	102A	MA891	102A
HB178	102A	MA892	102A
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GTE SYLVANIA

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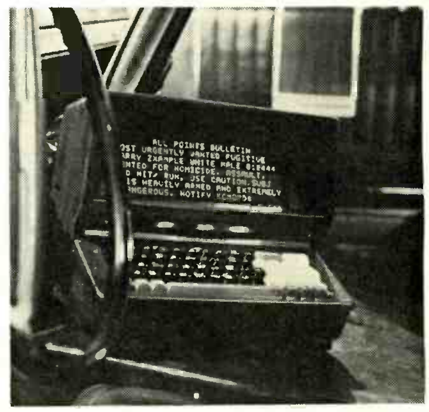
(continued from page 14)

(MVA). By contrast, a 500 MVA rating would be considered high for present metropolitan-area cables.

The cable was insulated by a winding of paper about 1 inch thick. Liquid nitrogen was used as the coolant, and the whole enclosed in a steel pipe 20 inches in diameter.

The engineers look forward to some years of further research and development before the system is ready for regular use.

CHECKING THE COOL CABLE after several days of testing. In a commercial three-phase system, three conductors would be used instead of the single conductor employed in the tests.



MOBILE DIGITAL RADIO TERMINAL is mounted in a patrol car of the Kansas City, Mo., Police Department. It can transmit messages in 1.5 seconds and receive its computer answer in about 5 seconds, as well as display broadcasts from the police control. The unit is a Kustom MCT-10, made by Kustom Electronics, Chanute, Kan. R-E

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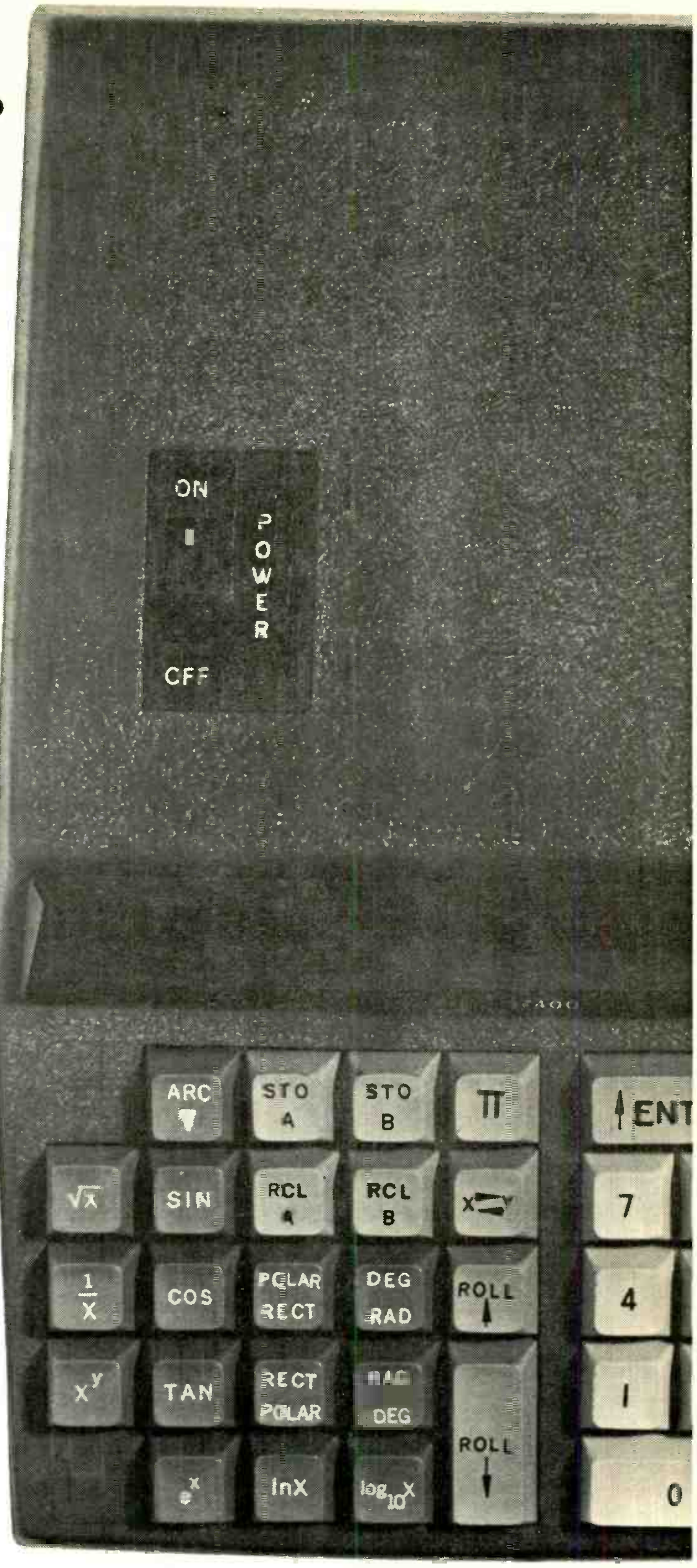

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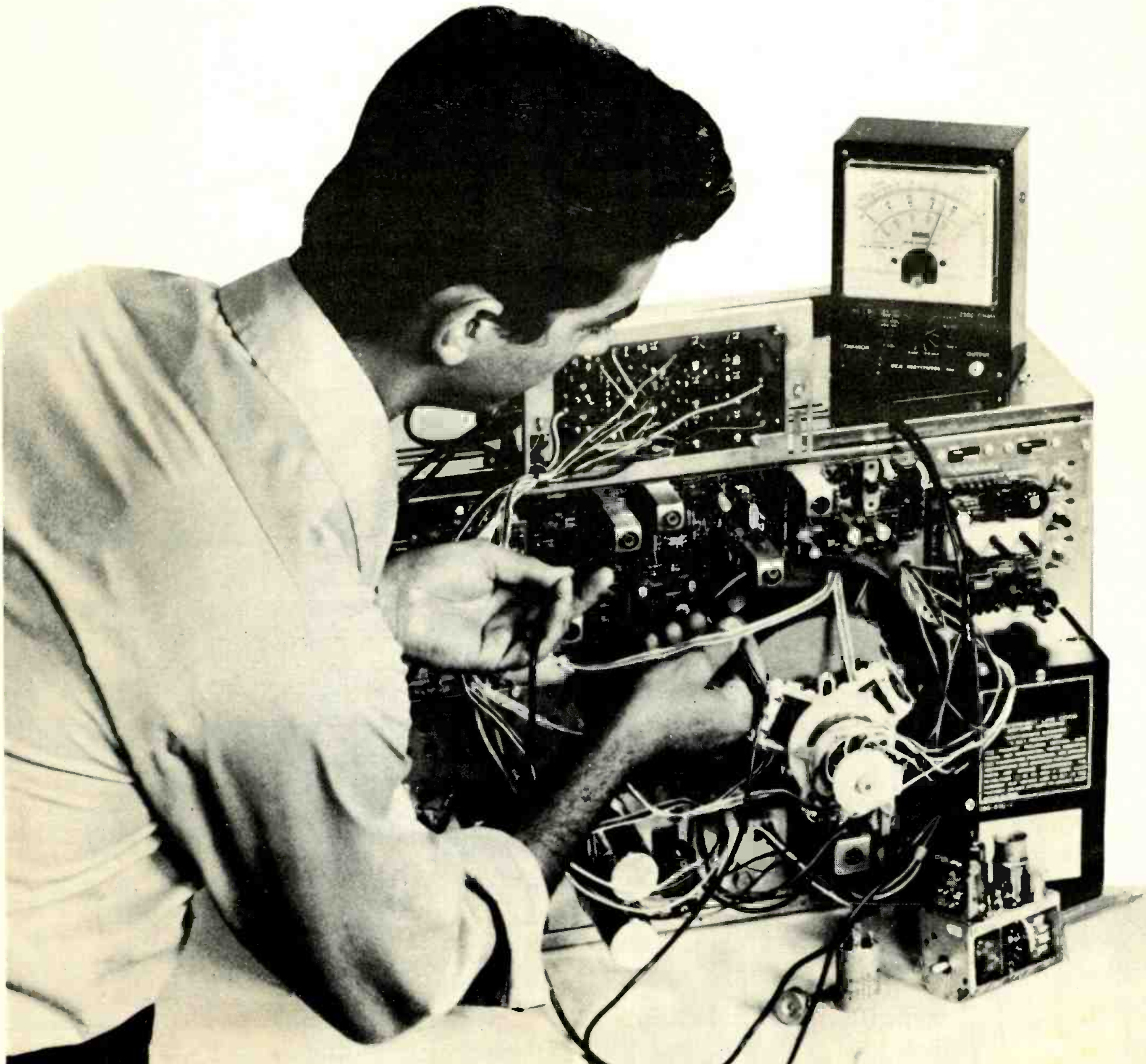

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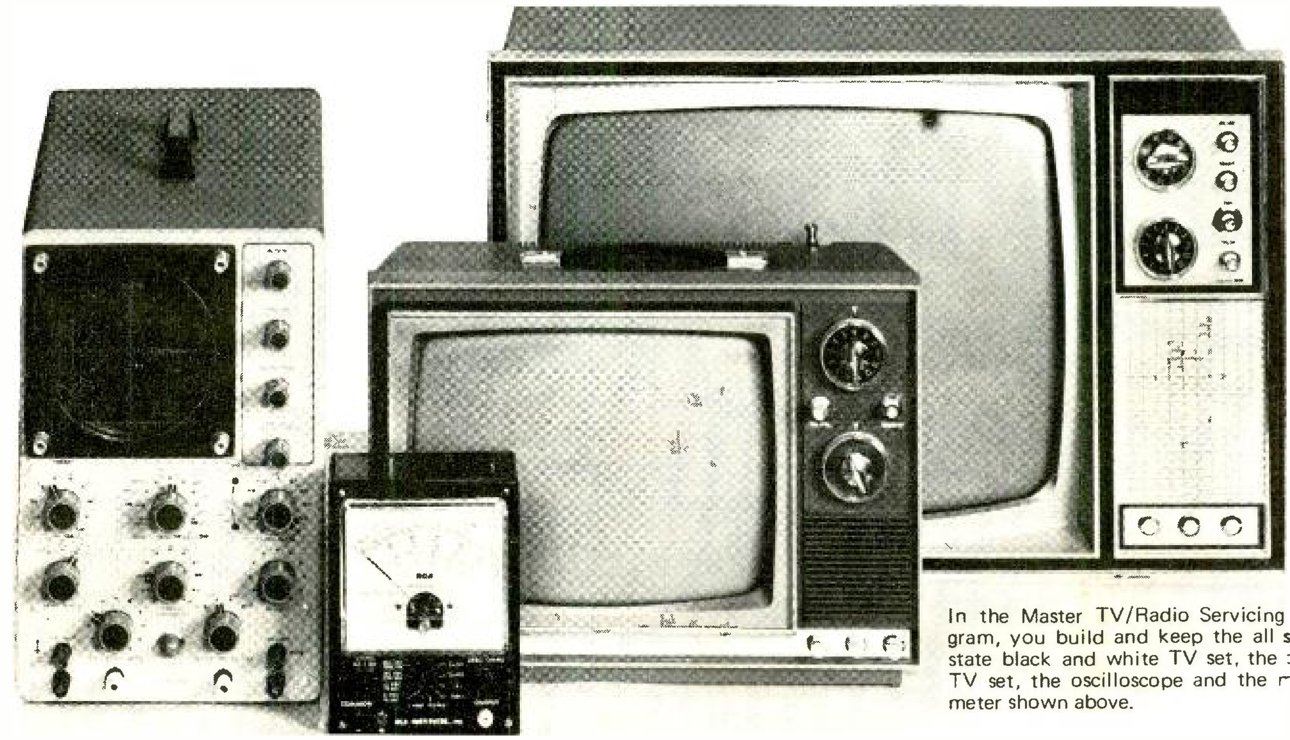

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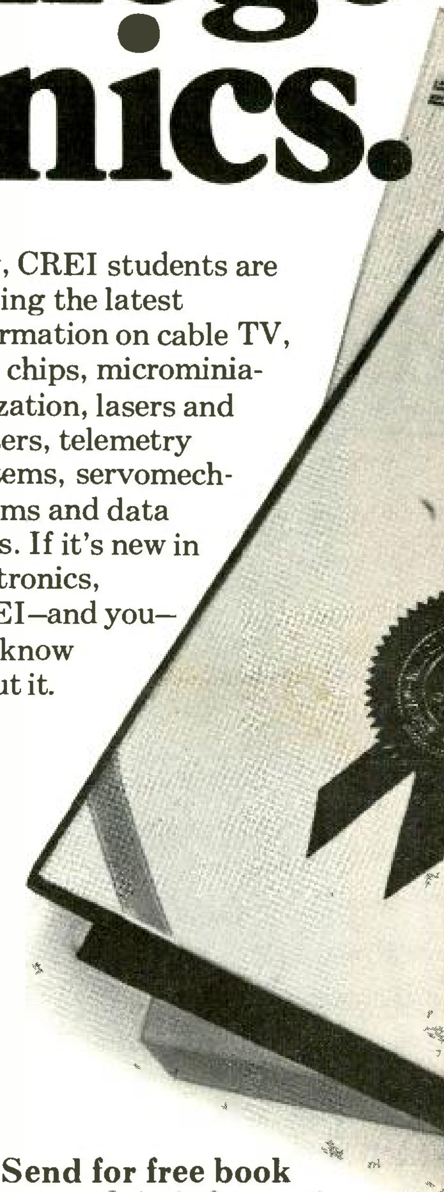

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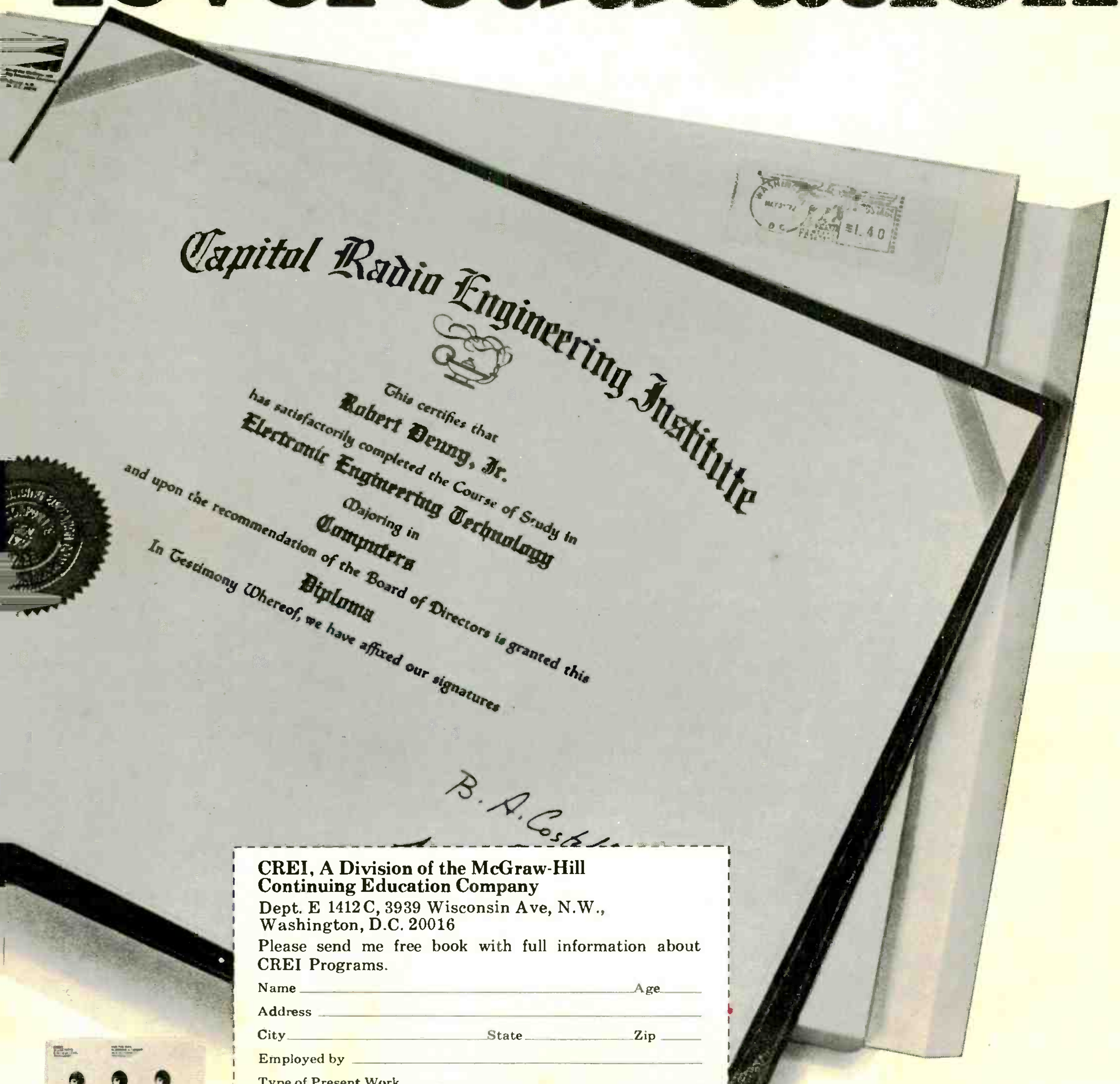

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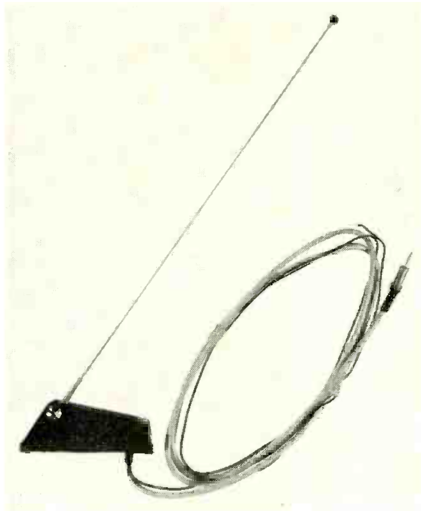

Circle 20 on reader service card

IN THE MAY 1972 ISSUE WE FEATURED AN article describing car radio combination antenna-preamplifier systems. When optimally designed there can be an improvement in receiver performance because of an increase in the signal to noise ratio at the receiver's antenna terminals. The advantage is not due to negating the effect of cable loss and thermal noise pickup as in analogous television preamp systems, but is due to a reduction in the influence of ignition interference on the antenna lead-in wire. In many situations where signal strength is generally good this improvement may not be significant. However, the principle may still prove attractive if a physically smaller antenna is desired. Preamplifier gain compensates for the lower induced voltage and S/N is maintained. One of the models described in the May issue is disguised as a side view mirror.

Hans Kolbe and Co. produce the Beta 3 Electronic Antenna which is designed for operation on both the AM and FM bands. A short 15 inch whip extends with an adjustable angle from the amplifier base. An optional extension cable permits the antenna to be mounted virtually anywhere on the vehicle. The 6 or 12 volt supply is connected with a single wire, ground return being made through the car body. We measured a current drain of 10 mA at 12 volts. The amplifier gain drops off by about 1 dB at the lower supply voltage.

The preamplifier is built on two miniature printed circuit boards which together contain some 3 transistors and 25 other components. The two boards apparently split the AM and FM functions and are electrically coupled at input and output. Impedance and gain were carefully measured across the two bands and the results graphed and explained below.

AM measurements

Figure 1 shows both input and output impedance falling with increasing

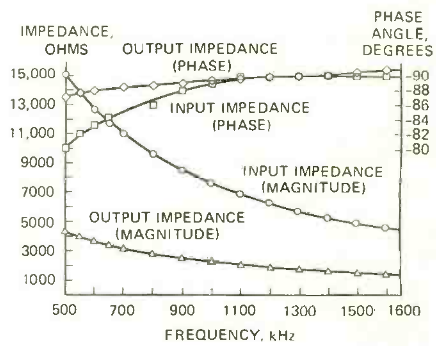

Figure 1

frequency. Both impedances are essentially reactive as indicated by the nearly -90 degree phase angle of the impedances. In fact these curves suggest that the input and output impedances can be closely approximated by 22 and 80-pF capacitors respectively. Since the auto antenna is electrically much shorter than a wavelength on the AM band it

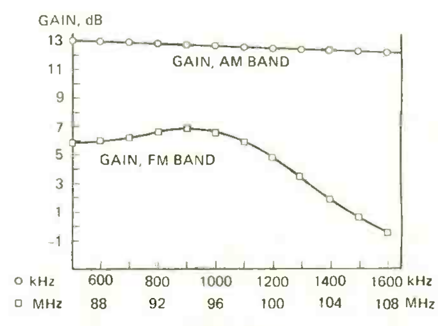

Figure 2

can be accurately represented by a 30-pF capacitor driven by the induced voltage on the antenna. The car radio conventionally sees this capacitance shunted with the lead-in cable capaci-

equipment report

tance resulting in a source impedance on the order of 100 pF. The rf input circuitry is tuned to be inductive for maximum power transfer from the antenna at midband. The 80-pF capacitance includes the lead-in cable attached to the preamp and can be tuned for good match by the radio's antenna trimmer. The gain measurements plotted in Fig. 2 are flat across the band at about 12.5 dB. Measured open-circuit with a low-impedance signal source this figure must be corrected by about 6 dB due to input matching losses. So before entering the antenna cable the signal from the whip is amplified by a net 6 dB or 4 times in power.

FM measurements

Considerable variations in both impedance and gain were measured across the FM band. Figure 3 plots the magnitude and phase of the FM impedances. Midband input impedance is 330 ohms at 60 degrees. This impedance nearly doubles near the high end of the band. The impedance of a car antenna varies depending on antenna location and the ground plane effect of the car body, but will be in the neighborhood of 300 ohms at a small angle with a 0.4 wavelength whip. The match at midband to the Beta 3 is fairly good. As the frequency increases the antenna looks longer and its radiation resistance lowers. A poorer match therefore exists at the high end of the band. Unfortunately this measurement coincides with a gain drop off as shown in Fig. 2. The output impedance looks almost purely resistive midband at 75 ohms and 15 degrees rising slightly above 100 ohms at both band edges. The weak point of this amplified antenna system is seen to be the high end of the FM band where the signal to noise will be degraded. **R-E**

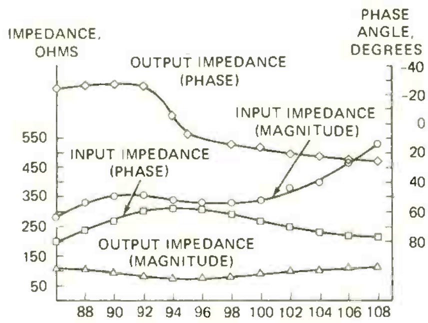

Figure 3

COLOR TV ISSUE

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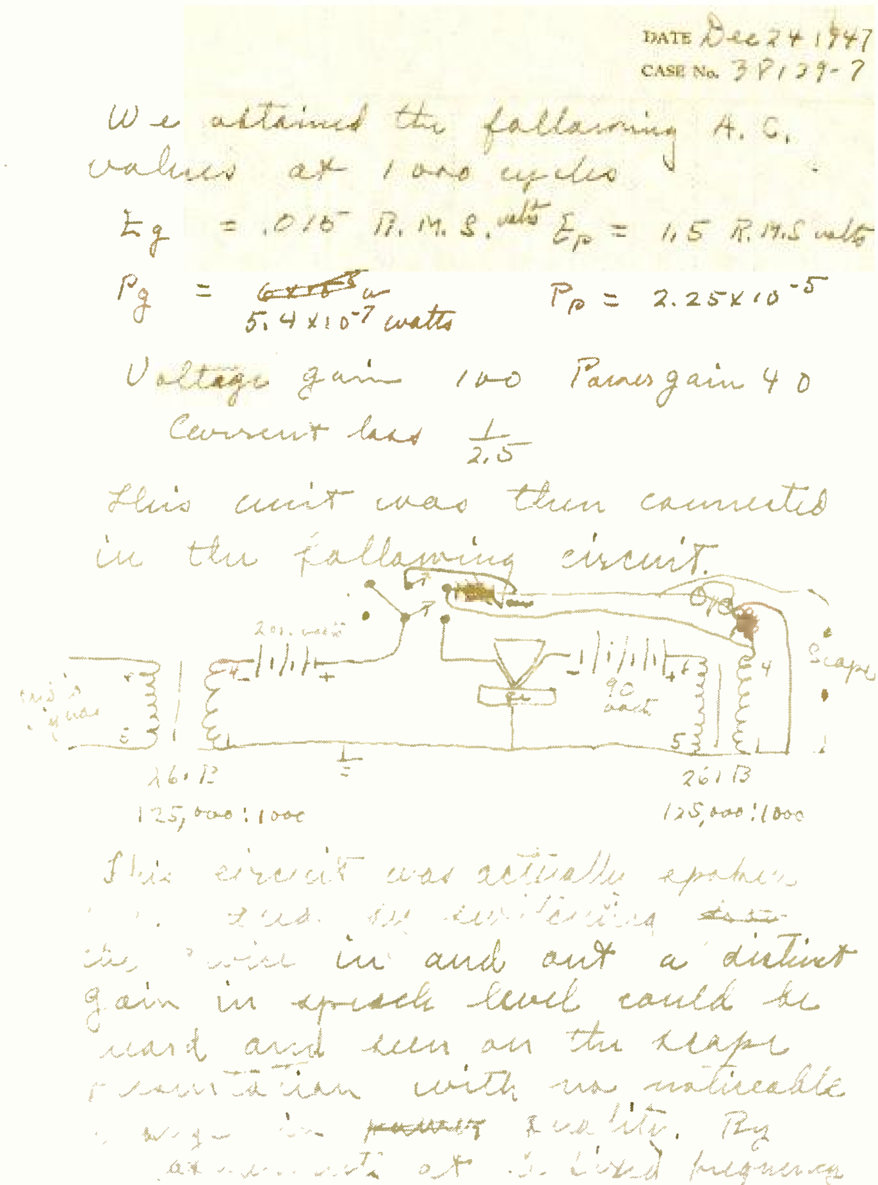


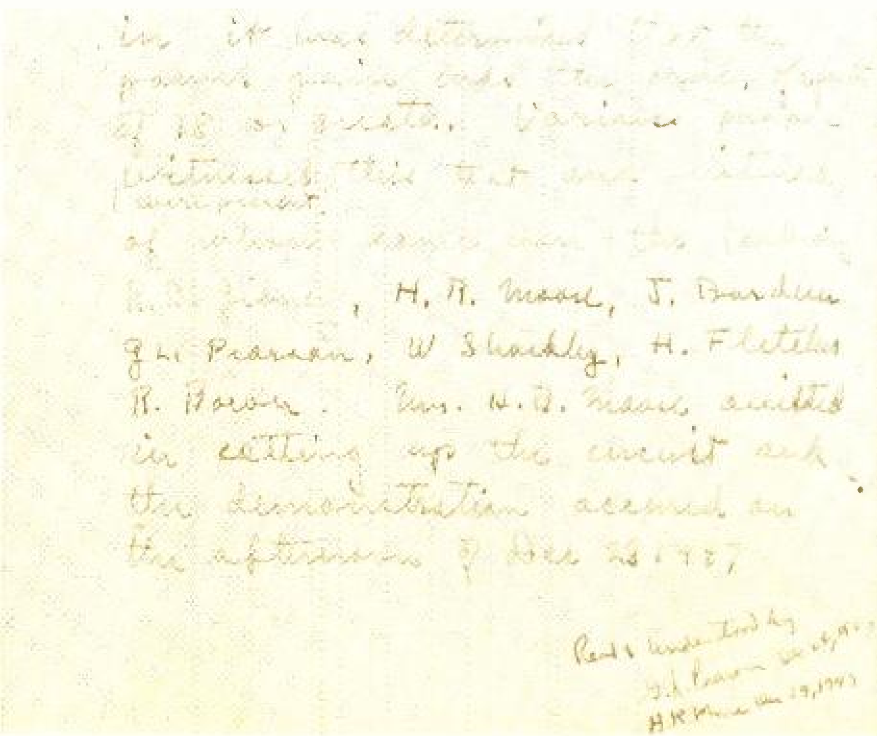
THE TRANSISTOR DID NOT QUITE SPRING on a startled world like a bolt from the blue. It was discovered (on December 23, 1947) by a team of Bell Laboratories scientists—Shockley, Bardeen and Brattain—who were engaged in a project to find just some such thing. Shockley had already worked out in theory and sketched a semiconductor device that might amplify, and it was while testing and modifying that device (which surfaced some years afterward as a field-effect transistor) that the point-contact transistor (Fig. 1) was born.

But "coming events cast their shadows before," and there had been hints of amplification in semiconductor devices in the past. Earliest was possibly the "oscillating crystal" of zincite announced in 1924 by Lossev. It was described in U.S. magazines*, but apparently nobody but Lossev could make it work. Since the effect of impurities in a crystal structure was then unknown, nobody realized that Lossev succeeded because he happened to have a particular sample of zincite, and the "oscillating crystal" was passed over and forgotten.

In 1930, Dr. Julius Lilienfeld actually patented a solid-state amplifier (U.S. Patent 1,745,175) based on a semiconductor. Though probably his own experimental amplifier worked, Dr. Lilienfeld's invention was never "reduced to practice," probably also due to the general ignorance of the action of semiconductors and impurities.

(turn page)

THE TRANSISTOR—25 YEARS OLD



On the left are the original lab notebook pages outlining the discovery of the transistor. From such humble beginnings we now have devices that threaten the continued need for vacuum tubes. Here's a short 25-year history of how it happened

by FRED SHUNAMAN

*Radio News, September, 1924.

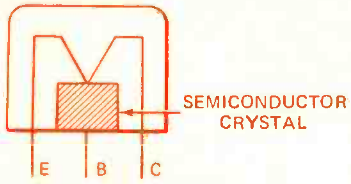


FIG. 1—A POINT CONTACT TRANSISTOR.

Only about a year before the actual invention of the transistor, Hugo Gernsback described in one of his April Fool stories, a remarkable "crystal amplifier" which he called the Crystron. As Fig. 2 shows, this was a forecast of the FET (field-effect transistor).

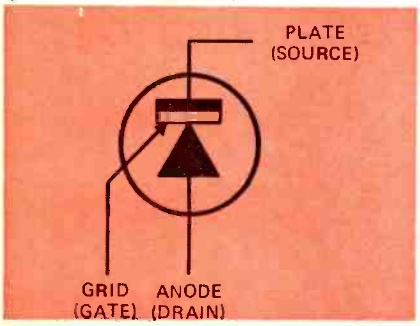


FIG. 2—THE CRYSTRON, the imaginary crystal amplifier dreamed up by Hugo Gernsback.

In an editorial in the May 1928 issue of **Radio-News** Hugo Gernsback had speculated, "Then, too, there is always the chance that a totally new discovery will come along that, in itself, will obliterate the vacuum tube in one way or another; and it is even within the bounds of possibility that there will be invented some new device that will require so little power that a small dry-cell battery will operate it for a considerable length of time. This, in turn, would again make the radio set independent of the lighting current and make it more transportable. But all these things are yet in the future." (Perhaps he knew!—*Editor*)

The first transistors

Less than a year after the transistor was invented, Western Electric put a few on the market for experimental purposes. These first crude devices (sold at $15 each) fell far short of what scientists predicted for the transistor. They were short-lived for the most part, though it had been suggested that their life might be indefinitely long. They were noisy. Their characteristics often varied with time. Gain was far below what was said to be theoretically possible. The frequency range was limited, and for a time it seemed that the transistor would be entirely an audio device.

And no two transistors were alike! A tube manufacturer could tool up to make a run of, say, 6L6's, and be reasonably sure of the output. The early way to make transistors was to make a run, test the units, and decide what to call them as a result of the tests. Raytheon, for example, put out a CK-series. Those that most closely approximated what the design engineers had in mind were called CK721's and were sold commercially. Those that fell short or varied too widely from the specs, but seemed still usable, were called CK722's and sold to the hobby market. And those that were least noisy became CK227's and were dedicated to hi-fi audio use.

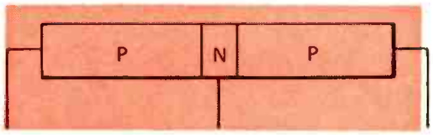


FIG. 3—THE JUNCTION TRANSISTOR overcame many earlier problems and disadvantages.

But improvement came fast. The junction transistor (invented by Shockley) was more reliable than the point-contact type. The emitter and collector of this transistor, instead of being fine wires contacting the base, became part of the same crystal, making a perfect contact with the base from each side (Fig. 3).

Zone refining

Shortly afterward—about 1954—control of impurities in the crystal made a great leap forward. W. G. Pfann, of Bell Labs, discovered that if a rod of crystal material (invariably germanium at that time) was melted, and then part of it solidified, it tended to leave any impurities in the melted portion, concentrating them in the last bit of metal to harden. Using a process he called zone refining, he melted a portion of a germanium rod by putting an inductive heating coil around it, then by moving the coil (or the crystal) gradually moved the melted portion down the rod, melting new material ahead and allowing the rod to solidify behind (Fig. 4). Since the impurities tended to remain in the melt, it was possible to "sweep" them down the rod, leaving behind material of hitherto-unheard-of purity.

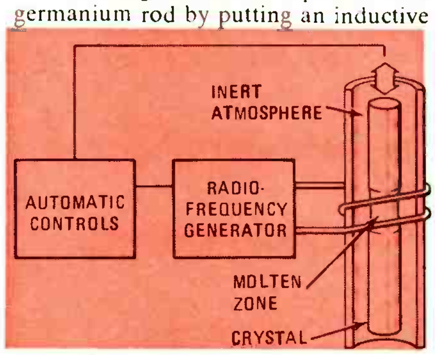


FIG.4—ZONE REFINING, an important step ahead in the development of the transistor.

The same theory was applied in making junction transistors. Using a melt that contained both n and p-type impurities, it was found that if the crystal was grown slowly, there was a tendency to take up the n-type impurities in the growing crystal, making it an n-type. Now, if the process were speeded up, the p-type impurities that had collected just below the crystal would be swept up into it, creating a p-type zone. By alternately speeding up and slowing down the growth, sections of the right width for bases could be grown in the crystal. All that was necessary was to saw it up into pieces of the right length, with the base in the center.

This type of junction transistor was considered an improvement on the point-contact transistor, but had weaknesses. Control of impurities was inexact. Frequncy range was limited. Methods were found to overcome these weaknesses, and the grown-junction transistor faded into the background. It never became obsolete, however, and a few types are still on the market.

The next step was the alloy transistor. A thin slab of material, destined to be the base, was etched from both sides

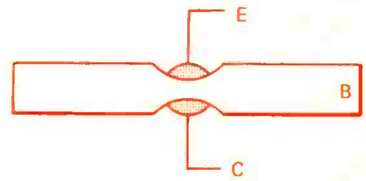


FIG. 5—THE ALLOY TRANSISTOR increased reliability, raised frequency limits.

until it became very thin. The collector and emitter "buttons" were then alloyed into the base, as shown in Fig. 5. For the first time, transistors that would operate at frequencies in the megahertz region were produced. In Philco's famous "surface-barrier" transistors, a thin stream of etching fluid was directed on opposite sides of the strip, making a sort of pit on each side. When the partition between the two pits became thin enough, the composition of the fluid was changed to one containing a saturated solution of indium, which was "plated" on the base material.

A great step forward

The next step in the development of better and faster transistors was *diffusion*. Instead of alloying material with the desired impurities onto the substrate, the impurities were introduced directly into it by exposing it to a gas containing the desired impurities. This is done in an oven at high temperatures. The impurities penetrate the surface of the substrate material, and may change it from p to n or vice versa. The concentration and depth of penetration can be controlled by diffusion better than by any method developed before it.

Diffusion brought with it another important technical advance, the *masking* technique. To control the boundaries of the diffused area, an insulating layer of silicon dioxide (quartz, roughly) is laid down over the surface of the crystal. This is covered with a *photoresist*, a layer that resists etching acids if exposed to light. A *mask* with the desired pattern is placed over the surface and light projected onto it, to activate the photoresist. The unexposed areas are then etched away, making "windows" to the surface below, into which impurities can be diffused over sharply bounded areas.

Masking, incidentally, not only led to more varieties of transistors, but to other devices, the ultimate of which is our present large-scale integrated circuitry. A large number of maskings, etchings and diffusions are used to make an integrated circuit.

Diffusion also led to *drift* transistor, in which the base material is heavily doped near the emitter, and gradually more lightly doped as the collector is approached. The resultant electric field across the base speeds up carrier flow, and the possibility of doping the area near the emitter heavily and that near collector more lightly reduces capacitive charging time, again increasing the upper frequency limit.

The mesa transistor

The base area may now be diffused into the collector material. Early transistors of this type had a diffused gold stripe contacting the base as a non-rectifying (ohmic) contact. A diffused aluminum stripe, forming a rectifying contact, became the emitter. The area around the base was etched away to reduce collector-base capacitance. (Fig. 6), leaving the region sitting on top of

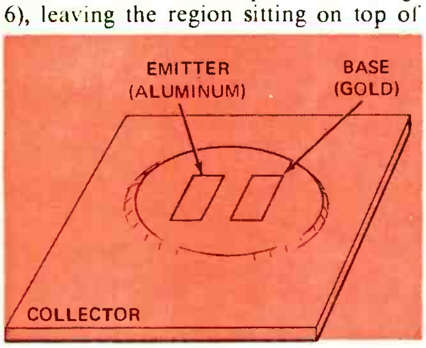


FIG. 6—THE MESA, a diffused transistor.

the collector in a way that caused it to be called a *mesa* transistor.

The next step was to diffuse the emitter as well as the base into the crystal. Once the base was laid down, the emitter was diffused into it. A standard formation was a ring-shaped base around a smaller center emitter, with the collector as the substrate. Note in Fig. 7 that the base not only surrounds the emitter, but extends under it, forming a base region between the emitter above and the collector below. This *planar* transistor, which appeared in the early '60's, reached an upper frequency limit above 800 MHz by 1964.

The *epitaxial* transistor (Greek: epi

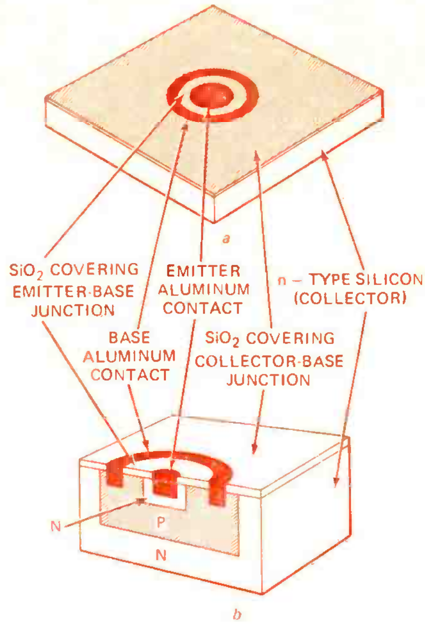


FIG. 7—THE PLANAR TRANSISTOR was an early use of silicon as a transistor material.

= upon; taxis = arrangement, structure) was next. Like the ordinary diffused type, this transistor is made in a heated chamber, Base atoms are deposited on the collector material atom by atom, in such a way that the added material continues the original crystal structure. This reduces the resistance. In some transistors, a thin epitaxial collector layer is grown on top of the original collector, the epitaxial layer being more lightly doped than the rest of the collector material. The base is then grown on the epitaxial collector layer. Transistors made this way have a higher breakdown voltage.

New approaches

Note that about this time we find the base taking shapes other than that of the "dot" or "button" used to describe emitter and collector and base areas up to that time. The reason for irregular shapes is that it is desirable to have the boundary between the two regions (the junction) as large as possible in comparison to the total area of the section. In late designs, this approach

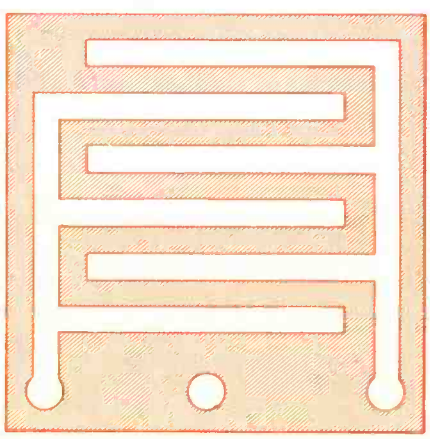


FIG. 8—INTERDIGITAL TRANSISTOR.

has been carried out to the point where the emitter and base regions look like the teeth of two combs pushed together (Fig. 8). The engineers call this *interdigitation* (fingers between each other).

This technique has become important in both increasing the frequency limits and greatly increasing the power handling capacity of the transistor. In some high-power transistors, emitters are counted by the hundreds. They are bonded together with aluminum strips, which overlay the rows of emitter buttons (giving the unit its name of *overlay transistor*). In microwave transistors, the width of the "digits" and the spacing between them has been reduced to a thousandth of an inch or so.

Another kind of transistor

Experiments with field-effect transistors had been underway, and began to bear fruit in the early 1960's. The FET is actually older than the ordinary transistor. Lilienfeld's device was a kind of FET, as well as Gernsback's imaginary Crystron, and also the device designed on paper by Shockley that set engineers on the trail of the first transistor in 1947.

The first FET's were junction types, the earliest being the Tecnetron, invented in France. It was a cylindrical device of n-type semiconductor (Fig. 9-a). It resembled a resistor, which in fact

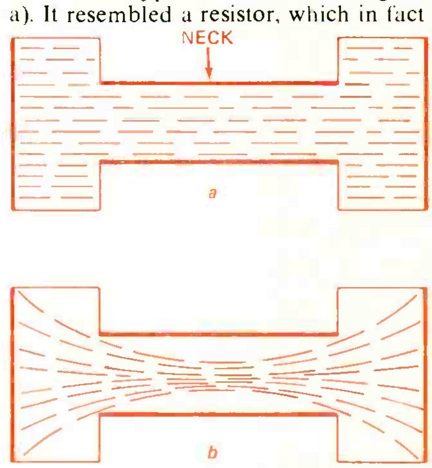


FIG. 9—THE TECNETRON, an early field effect transistor, was of the junction type.

it was. A ring or "neck" of indium around the center was the control element. With no voltage on the neck, the unit had a certain resistance. If now the neck were given a negative bias, its electrons would drive away the electrons immediately below it (Fig. 9-b) creating a *depletion region* and reducing the current through the cylinder, the conductive area of which had now been reduced. With enough negative bias, the field, or depletion region, could extend to the center of the material, *pinching off* the current entirely.

The modern metal-oxide-semiconductor FET has largely superseded the earlier junction (J-FET) type. It consists of *channels* of either n or p material, with a control element placed above, and insulated from, the channels. (Fig. 10). Charges applied to this *gate* can produce a depletion effect like that of

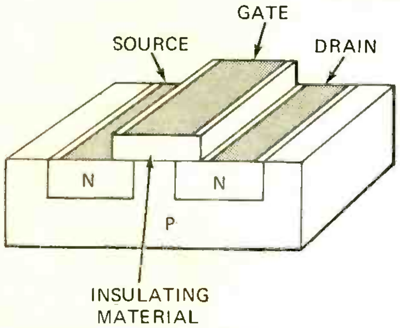


FIG. 10—MOSFET, the metal oxide semiconductor field effect transistor, has a high input impedance, like a vacuum tube. This leads to its use in rf amplifiers at high frequencies.

the Tecnetron. This is a *depletion-type* FET. In an *enhancement* type, the process is opposite. If the channels are n-type, a positive voltage applied to the gate attracts electrons into the p-type area beneath it, changing the p-area in effect into an n-region. The resistance between the channels is decreased and current flows. If the channels are p-type, the region beneath the gate is of n-type material, and the gate is forward-biased by a negative voltage. Metal-oxide-semiconductor (MOS) FET's are often used in complementary circuits, an n-p-n and a p-n-p in parallel to produce a push-pull output.

Silicon enters the field

Up to about 1960, germanium transistors dominated, despite the fact that there are dozens of materials that can be classed as semiconductors. A silicon transistor was announced in the late '50's. Its gain was low and it was expensive to manufacture, but it had a breakdown voltage of 300, much higher than that of germanium devices. Within the next half-dozen years or so the silicon transistor became more important than its germanium opposite number, and today silicon transistors with an upper frequency limit of over 4 gigahertz at low power levels and a power dissipation of more than 300 watts are in common use. Larger transistors have been built for specialized purposes. Silicon n-p-n transistors with a current rating of 250 amperes have been produced, as well as units with a breakdown rating of 1500 volts.

Transistors and near-transistors

Several variants fall just outside the definition of transistor, though very close to it in function. One of these is even called the "unijunction transistor," though its other name, double-based diode, would seem more exact. In its simplest form, it is a rod of semiconductor material, which acts as a resistor when a voltage is placed across the ends. An emitter is placed part-way down the rod, and when forward-biased, injects electrons or "holes" into it, lowering the original resistance. Thus the emitter controls the current much as the charge on the neck of a Tecnetron controls the current through it.

The silicon controlled rectifier is usually compared to two transistors hooked up in a feedback circuit. Other variants include the hook and the intrinsic-layer transistors, which follow transistor principles, though they have more elements than the conventional transistor. Still others are the spacistor and trinistor.

Transistors of the future

The *optical transistor* is a true transistor that is activated by light instead of current or voltage on its control element. It and its transmitting counterpart, the light-emitting diode, form the base of a whole new division of the art, *opto-electronics*. Applications of the optical transistor include detection of infrared and visible light transmissions, spectroscopy, surveillance in space and a host of others.

But probably the most important transistors of today (and of the future) are the tiny ones imbedded in integrated circuits. Made by masking and diffusion, as previously described, they are replacing discrete components in all branches of the industry. As an example, a complete integrated circuit chroma system for color TV receivers is now available in the form of three dual in-line IC's (Fig . 11). One of them is

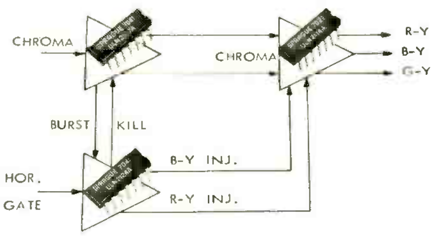
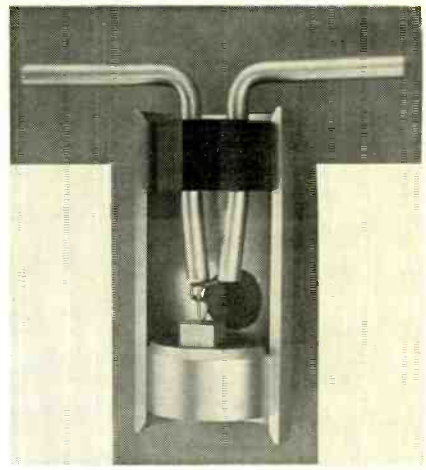


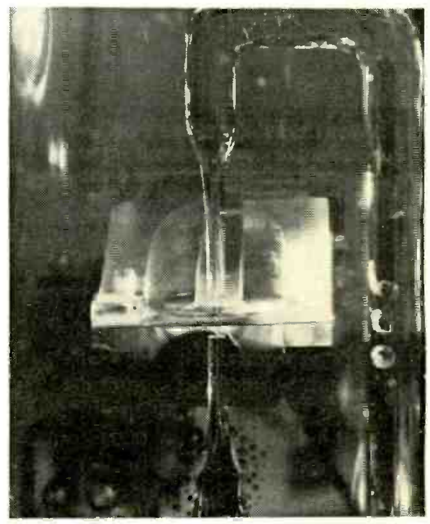
FIG. 11—THREE TINY UNITS make up the whole color section of a television receiver.

the chroma amplifier, supplying a burst signal to the second IC, the combined oscillator, acc and apc circuits and the color killer, which returns a signal to the color amplifier. The third unit is a balanced product detector and matrix that receives the chroma signal and outputs the R – Y, B – Y, G – Y signals to the picture tube. And this is just the first step in integration of common electronic circuitry. Not only may we expect to see all the color circuitry in a TV receiver in *one* integrated circuit—we will probably see other circuits combined with it, the limits of integration being controlled only by economic, not electronic factors. In that direction lies the future of the transistor. **R-E**

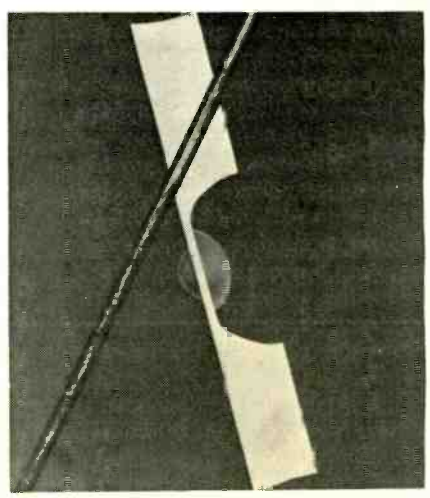
early transistors



ONE OF THE EARLIEST TRANSISTORS, this point-contact type was mounted in a case like that of the diodes in use at the period.



AN ALLOY TRANSISTOR in the making. A thin stream of etching fluid is directed at each side of the base material, wearing it thin. Then "buttons" of indium are alloyed into each side.

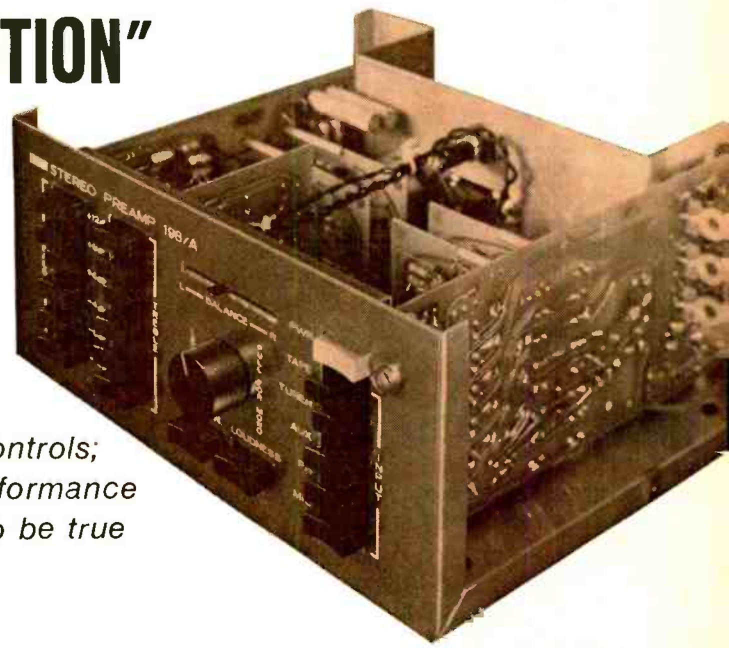


BASE OF THIS ALLOY TRANSISTOR is thinner than the human hair in front of it. The "bumps" are emitter and transistor buttons.

BUILD A "ZERO DISTORTION" STEREO PREAMP

by GARY KAY

Stereo preamp has push-button tone controls; printed-circuit board construction and performance specifications that are almost too good to be true



INTERESTED IN BUILDING A HIGH-quality stereo preamplifier for a price well under the cost of commercial units having comparable features? It's not just an ordinary preamp, but an attractive, easy to build unit based on state-of-the-art circuit design techniques that deliver noticeable advantages over conventional preamps.

Most preamps use a series of capacitor-coupled class-A amplifier stages using local feedback for equalization and to control the gain of the individual stages. The distortion and frequency response characteristics of this type of construction are not the best, and some designers are using operational amplifier integrated circuits. The operational amplifier technique works very well (see article on page 58 of this issue). The idea is to use feedback on an active device with a very high open-loop gain. The feedback controls the closed-loop gain, and greatly enhances the distortion, noise and frequency response characteristics of the device. Unfortunately, inexpensive IC's are inherently noisy and although the feedback helps, the noise is still at a level that makes it undesirable for use in high-quality audio equipment. The key to this preamp's operation is a unique gain module recently described in a British periodical ("Audio Preamplifier using Operational Amplifier Techniques" by Daniel Meyer, *Wireless World* magazine, July 1972). This gain module is actually a high-gain amplifier built using operational amplifier techniques but constructed from discrete components. It provides all of the advantages of high open-loop gain devices with the added bonus of low noise.

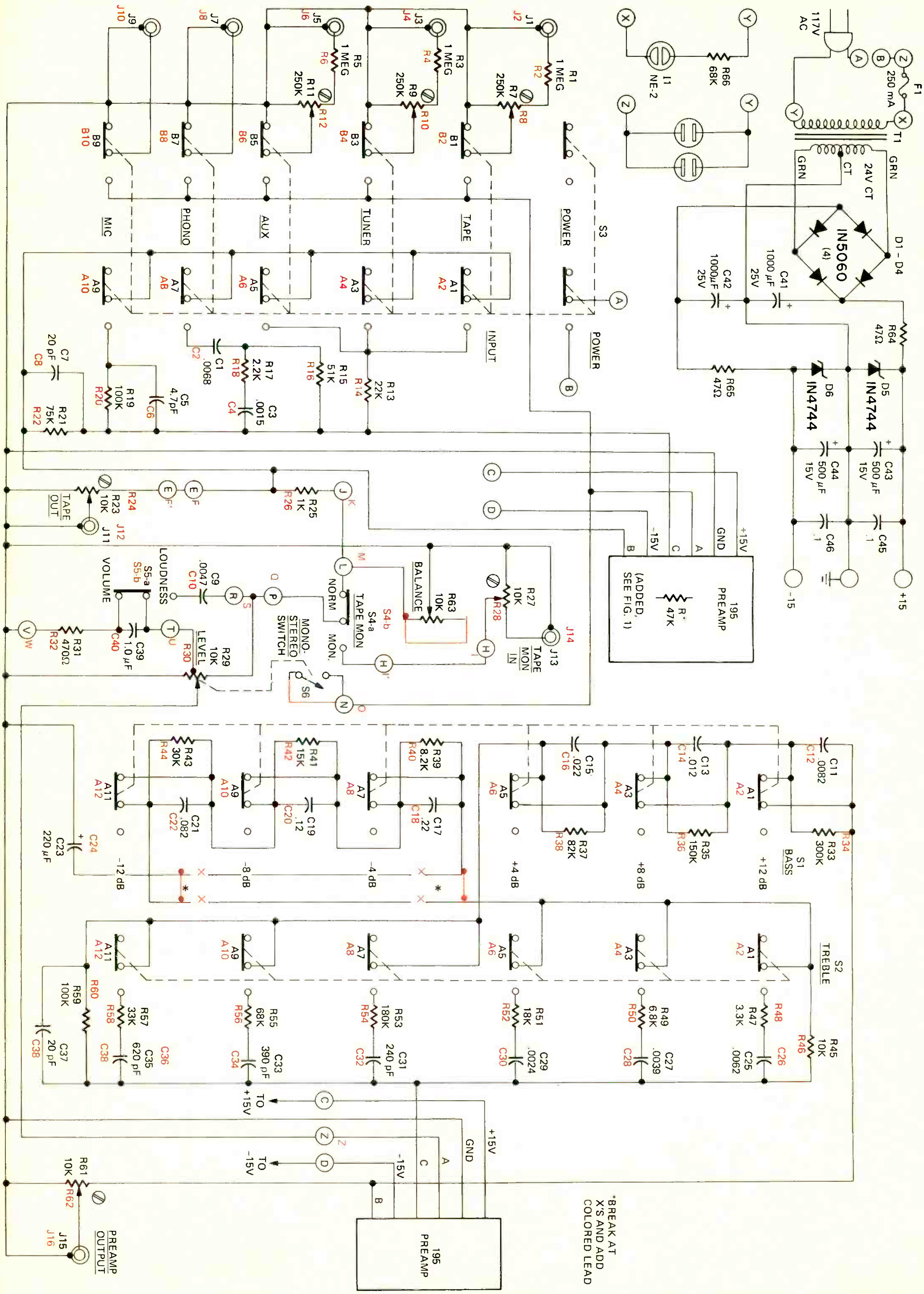
Each channel of this preamp uses two of these gain modules, which plug on to mother boards. In addition, all of the pushbutton switches as well as all of the input and output connectors are soldered directly to the circuit boards, reducing wiring to a minimum.

Functionally, the preamp has an internal power supply, pushbutton BASS and TREBLE switches, external BALANCE control, internal LEVEL controls on the TAPE, TUNER, AUX, and TAPE MONITOR inputs and the TAPE and PREAMP outputs. Switches are provided for POWER-OFF, TAPE MONITOR-NORMAL, LOUDNESS-VOLUME, and MONAURAL-STEREO modes. The power switch controls power for the preamp as well as for two ac receptacles on the rear panel. All input-output jacks are the RCA-phono type and are orientated so the unit can be nearly flush mounted against the back panel of a bookshelf if desired.

How it works

The amplifier module circuitry was designed for high gain, minimum distortion, low noise, and maximum power supply isolation among other things. Transistors Q1 and Q2 (Fig. 1) form a differential pair with a current source feeding the emitters. This provides good power-supply isolation and operates the transistors in their optimum low-noise region. Active load current source Q3 provides power supply isolation and is a high-impedance load for transistor Q1, thus insuring high gain. Transistor Q4 operates as an emitter follower to reduce loading on Q1 while Q5 acts as a class-A amplifier operating into active load current source Q6, for maximum gain and improved linearity. The closed loop gain of the circuit is set, as on other operational amplifier circuits, by the use of feedback. One of the feedback resistors, R13 is already provided on the board. Capacitor C3 in series with R13 decreases the gain to unity at dc no matter what the ac gain has been chosen to be. The other feedback component(s) X_{cb}, is inserted between points C and B. The ratio X_{cb} + R13/R13 sets the ac gain of the amplifier. If X_{cb} is composed of reactive components the gain can be made to vary as a function of frequency to provide equalization or tone control.

The overall circuit operation can best be understood from the block diagram, Fig. 2 and the schematic in Fig. 3. Amplifier module 1 boosts the audio level from either a magnetic phono cartridge, mike, or high-level input to a level compatible with the input of the second amplifier module. The input-selector-pushbutton-switch channels the desired input into the amplifier module 1 and simultaneously connects the appropriate feedback network to provide equalization. All high-level inputs are fed into the amplifier through a 1-megohm resistor and trimmer resistor. This guarantees a minimum input impedance of 1 megohm and enables the user to set each individual level control for a uniform audio level whenever changing inputs. The output of amplifier module 1 then passes through a balance control, tape monitor switch and a



117V AC
F1 250 mA
T1
24V CT
GRN
CT
D1 - D4
IN5060 (4)
C41 1000 µF 25V
C42 1000µF 25V
R64 47Ω
R65 47Ω
D5 IN4744
D6 IN4744
C43 500 µF 15V
C44 500 µF 15V
C45 .1
C46 .1
+15
-15
R66 68K
I1 NE-2
J1 J2
J3 J4
J5 J6
J7 J8
J9 J10
R1 1 MEG
R3 1 MEG
R5 1 MEG
R7 250K
R9 250K
R11 250K
S3
MIC
PHONO
AUX
TUNER
TAPE
POWER
INPUT
C1 .0068
C3 .0015
C5 4.7pF
C7 20 pF
R13 22K
R15 51K
R17 2.2K
R19 100K
R21 75K
R23 10K
TAPE OUT
J11 J12
R25 1K
C9 .0047
LOUDNESS S5-a S5-b
VOLUME
C39 1.0 µF
R31 470Ω
R29 10K LEVEL
NORM
TAPE MON S4-a S4-b
MONO STEREO SWITCH
MON.
S6
BALANCE
R63 10K
R27 10K
J13 J14 TAPE MON IN
195 PREAMP
R* 47K
(ADDED, SEE FIG. 1)
GND
+15V
-15V
R43 30K
R41 15K
R39 8.2K
C21 .082
C19 .12
C17 .22
C23 220 µF
C15 .022
C13 .012
C11 .0082
R37 82K
R35 150K
R33 300K
S1 BASS
-12 dB
-8 dB
-4 dB
+4 dB
+8 dB
+12 dB
S2 TREBLE
R59 100K
R57 33K
R55 68K
R53 180K
R51 18K
R49 6.8K
R47 3.3K
R45 10K
C37 20 pF
C35 620 pF
C33 390 pF
C31 240 pF
C29 .0024
C27 .0039
C25 .0062
TO +15V
TO -15V
R61 10K
J15 J16 PREAMP OUTPUT
195 PREAMP
*BREAK AT X'S AND ADD COLORED LEAD

PARTS LIST

R1 thru R6—1 megohm ¼-W 10%
R7 thru R12—250,000-ohm trimmer
R13, R14—22,000-ohm ½-W 5%
R15, R16—51,000-ohm ½-W 5%
R17, R18—2,200-ohm ½-W 5%
R19, R20, R59, R60—100,000-ohm ½-W 5%
R21, R22—750,000-ohm ½-W 5%
R23, R24, R27, R28, R61, R62—10,000-ohm trimmer
R25, R26—1,000-ohm ½-W 10%
R29, R30—10,000-ohm audio taper pot with 5,000-ohm tap with pull switch
R31, R32—470-ohm, ½-W 10%
R33, R34—300,000-ohm ½-W 5%
R35, R36—150,000-ohm ½-W 5%
R37, R38—82,000-ohm ½-W 5%
R39, R40—8,200-ohm ½-W 5%
R41, R42—15,000-ohm ½-W 5%
R43, R44—30,000-ohm ½-W 5%
R45, R46—10,000-ohm ½-W 5%
R47, R48—3,300-ohm ½-W 5%
R49, R50—6,800-ohm ½-W 5%
R51, R52—18,000-ohm ½-W 5%
R53, R54—180,000-ohm ½-W 5%
R55, R56—68,000-ohm ½-W 5%
R57, R58—33,000-ohm ½-W 5%
R63—10,000-ohm linear taper slide pot
R64, R65—47-ohm ½-W 10%
R66—68,000-ohm ½-W 10%
R*, R*—47,000-ohm ¼-W 10%
C1, C2—.0068-μF polystyrene
C3, C4—.0015-μF polystyrene
C5, C6—4.7-pF disc
C7, C8, C37, C38—20-pF disc
C9, C10—.0047-μF polystyrene
C11, C12—.0082-μF polystyrene
C13, C14—0.012-μF metalized polycarbonate
C15, C16—0.022-μF metalized polycarbonate
C17, C18—0.22-μF metalized polycarbonate
C19, C20—0.12-μF metalized polycarbonate
C21, C22—0.082-μF metalized polycarbonate
C23, C24—220-μF @ 6.3V electrolytic
C25, C26—.0062-μF polystyrene
C27, C28—.0039-μF polystyrene
C29, C30—.0024-μF polystyrene
C31, C32—240-pF polystyrene
C33, C34—390-pF polystyrene
C35, C36—620-pF polystyrene
C39, C40—1-μF 15 volt electrolytic
C41, C42—1000-μF 25 Vdc electrolytic
C43, C44—500-μF 15 Vdc electrolytic
C45, C46—0.1-μF
D1 thru D4—1N5060 silicon diode or equal
D5, D6—15-V 1-W Zener diode, Motorola 1N4744 or equal
*S3—5-station dpdt tandem plus 1 station push-to-lock pushbutton switch
*S1, S2—6-station dpdt pushbutton switch
*S4, S5—dpdt pushbutton switch
S6—spst pull switch mounted on the rear of level control
F1—¼-amp fuse
T1—24-volt 80 mA ct transformer 117 Vac primary
LM1—neon lamp NE-2

*S1 thru S5 are being custom made for Southwest Technical and no substitutes are available.

Parts List No. 195 Preamp Module

Q1, Q2, Q6, Q7—2N5210 Motorola
Q3, Q4, Q5—2N5087 Motorola
D1—4.7-V 400mw Zener diode Motorola MZ-70-4.7 or equal
D2, D3—1N914 diode or equal
C1—4.7-μF tantalum electrolytic
C2—5-pF disc
C3—33-μF @ 6-V electrolytic
R1, R3, R9, R10, R11, R13—1000-ohm ½-W 10%
R2—47,000-ohm ½-W 10%
R4, R5—22,000-ohm ½-W 10%
R6—15,000-ohm ½-W 10%
R7—8200-ohm ½-W 10%
R8—10,000-ohm ½-W 10%
R12—4700-ohm ½-W 10%

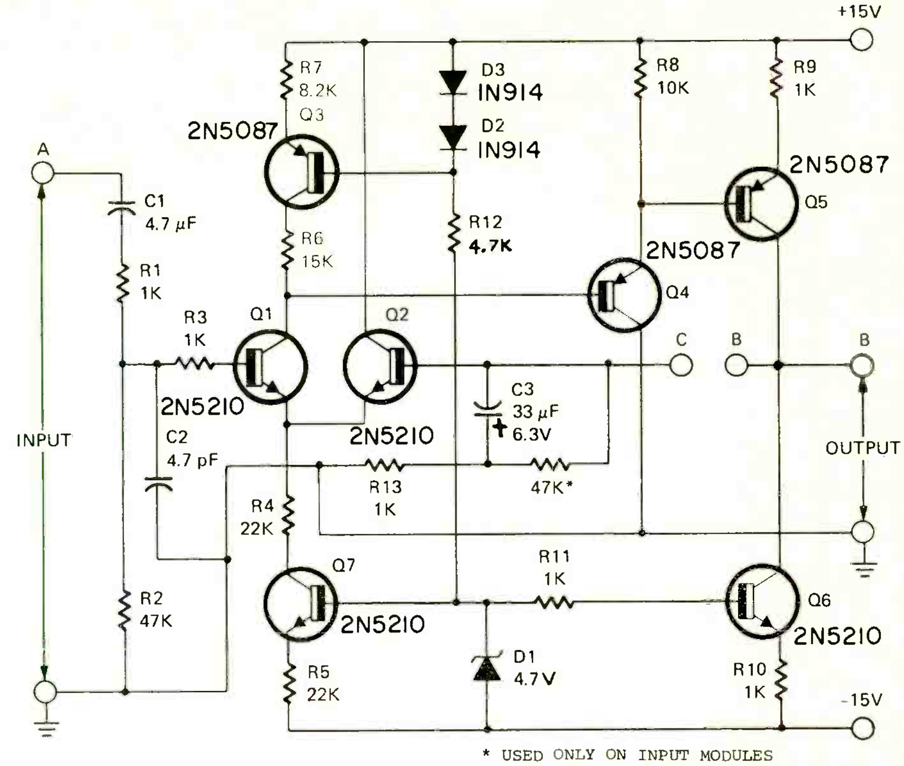


FIG. 1—AMPLIFIER MODULE CIRCUITRY. Four of these modules are needed; two for each channel. Note that pne 47,000-ohm resistor is used only in the input modules; it is not needed in the output modules.

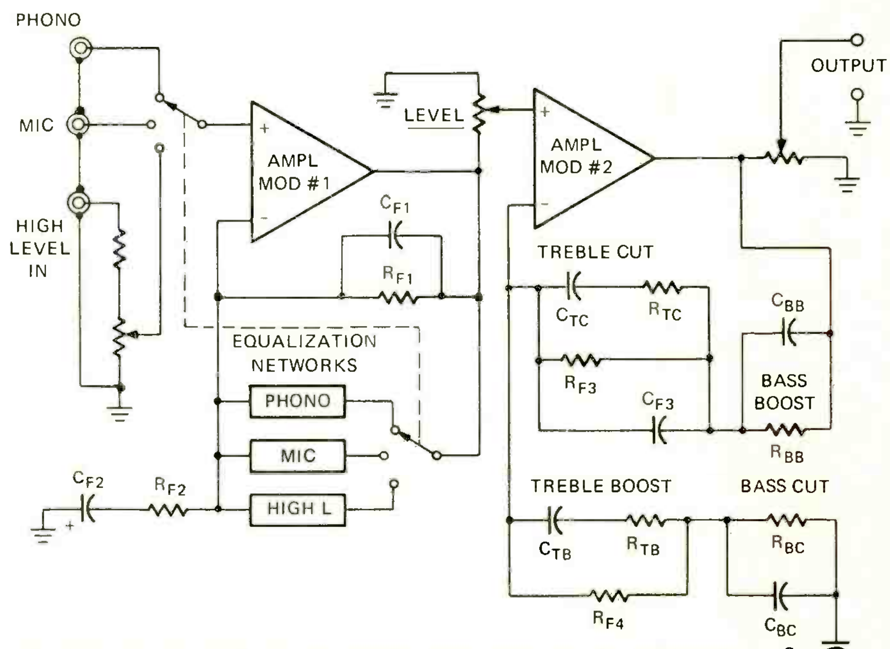


FIG. 2—BLOCK DIAGRAM OF THE PREAMP helps explain how the unit operates. Only one channel is shown.

level control. The LEVEL control normally operates as a volume control unless the LOUDNESS switch is depressed. The loudness circuit introduces a slight bass and treble boost on the lower end of the level control which is contoured to compensate for the low- and high-frequency deficiencies of the human ear at low sound pressure levels.

The output of the level control is then fed into amplifier module 2 which provides more gain and also introduces the desired bass and treble compensation. By switching different resistor-capacitor combinations into the feedback loop, the gain of amplifier module 2 is made vary with frequency thus providing a convenient means of introducing bass and treble boost or cut. Tonal increments are 4 dB with a maximum boost and cut of +12 dB and -12 dB respectively. A complete tone control response curve is shown in Fig. 3. Operating the unit with all switches out will provide flat response making the unit ideal for situations where no boost or cut can be

SPECIFICATIONS

Sensitivity:	Phono—2.0 mV at 1-kHz for 1.0 V rms out Mic—1.0-mV for 1.0-V rms out Aux, Tape, Tuner—200-mV for 1.0-V rms out maximum sensitivity—adjustable for less
Frequency Response:	Down 3 dB at 5 Hz and 80 kHz
Total Harmonic Distortion:	At 1.5 V rms out, less than 0.02% on all inputs
Max Input:	70 mV (phono)
Hum and Noise:	65 dB below one volt on phono 75 dB below 1 V on all other inputs
Input Impedance:	Phono—47,000 ohms Mic—47,000 ohms Aux, Tape, Tuner—1 megohm
Output Impedance:	10,000 ohms or less
Power Required:	117 Vac, 0.5 A
Dimensions:	10" W x 5" H x 10" D

The right and left channels are identical electrically. Codes, terminal markings and wiring shown in solid black are for the left channel. Codes shown in color are for the right channel. Constructors using the PC board patterns supplied will note minor differences in the right- and left-channel signal paths through the tone controls. In the left channel, the signal goes from the arm of the +4 dB TREBLE switch to the arm of the −12 dB BASS switch. In the right-channel wiring, the signal from the arm of the +4 dB switch goes to the normally closed terminal on the −4 dB BASS switch. These and other wiring differences between the two channels are indicated by "X" break points and colored circuit lines. For example BALANCE control R63 is connected between terminal L in the left channel and terminal M in the right channel. Similarly, S6 is connected between terminals N and O.

tolerated such as in professional audio work.

The output level control is provided at the output of amplifier module 2 to allow the user to set the maximum output level of the preamp to match the maximum input requirements of the power amplifier with which the preamp is being used.

Construction tips

The prototype was built using 0.050" aluminum for the three main chassis panels and subpanels. The cover is from a vinyl covered piece of wood with an aluminum foil shield cemented to the inside. The front panel of the unit is made from a piece of 0.025" plated brushed steel which was lettered and cemented to the aluminum panel.

There are eight circuit boards in the unit. Four for the preamp switching circuitry, the other four are identical and are the gain modules.

Assemble all eight boards making sure to orientate all diodes, transistors, and electrolytic capacitors correctly. All trimmer resistors on the boards as well as resistor R66 and lamp LM1 are attached and soldered from the foil side of the board. Insert jumper wires on the boards where indicated by a solid line connecting pads printed on the component side of the board. On two of the four high-gain amplifier boards omit the jumper connecting pad C to ground. On the other two boards attach and solder a 47,000 ohm ¼-watt 10% resistor across electrolytic capacitor C3. The two boards without the jumpers are used on the left side of the unit when viewed from the front while those with the resistor added are used on the right side. All chassis members are held together by 6-32 hardware while the circuit boards with the pushbutton switches are secured with 4-40 hardware.

All chassis hardware should be orientated and attached as shown in the photos. All wiring is No. 24 or No. 26. The only exceptions are the wires going to the power switch terminals A and B. These should be No. 18. The two pairs of wires running to the LEVEL control should be shielded cable, and the wires connected to the terminals of the ac receptacles, should also be No. 18. Use twisted pairs where shown in the photos and route the twisted pairs along the top plane of the chassis. All other wires are routed along the lower chassis surface.

Using the preamp

Insert the four gain modules into the mounting slides and orient the boards so the component sides are toward the front of the chassis. Set all trimmer resistors so the tab on the knurl of the controls is about halfway between its two end points. Set all tone control switches so the response is flat and be sure LOUDNESS and TAPE MONITOR switches are not depressed. Press the LEVEL control switch in so the unit operates in a stereo mode and set the control in the fully counterclockwise position. Set the BALANCE control to its midway position and depress the PHONO input selector. Attach the patch cords of your turntable to the phono inputs of the preamp. Plug in the line cord and depress the power switch. Using a vom or scope, check the dc voltage level at the preamp output on both the left and right channels. This voltage should be well under 0.1 volt dc. If it is not, unplug the unit and recheck all construction steps. If this measurement is correct, put a record on the turntable and monitor the ac voltage. As the LEVEL control is advanced the meter should show a fluctuating reading of around 0.25 volts rms. If you are using a

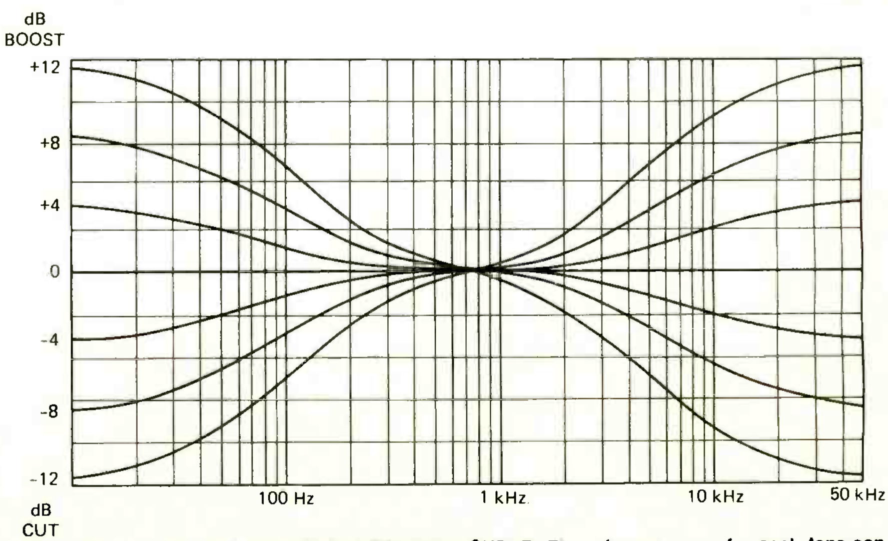
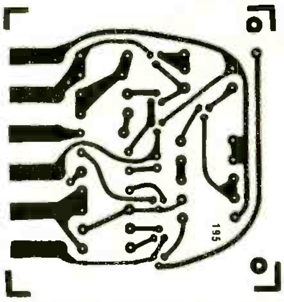
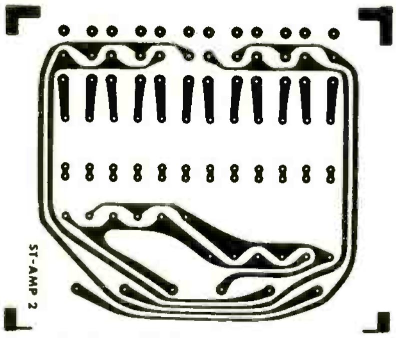


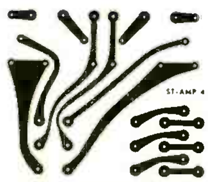
FIG. 3—COMPLETE TONE-CONTROL RESPONSE CURVE. There is one curve for each tone-control push-button selector position.



CIRCUIT BOARD B. Four are needed.



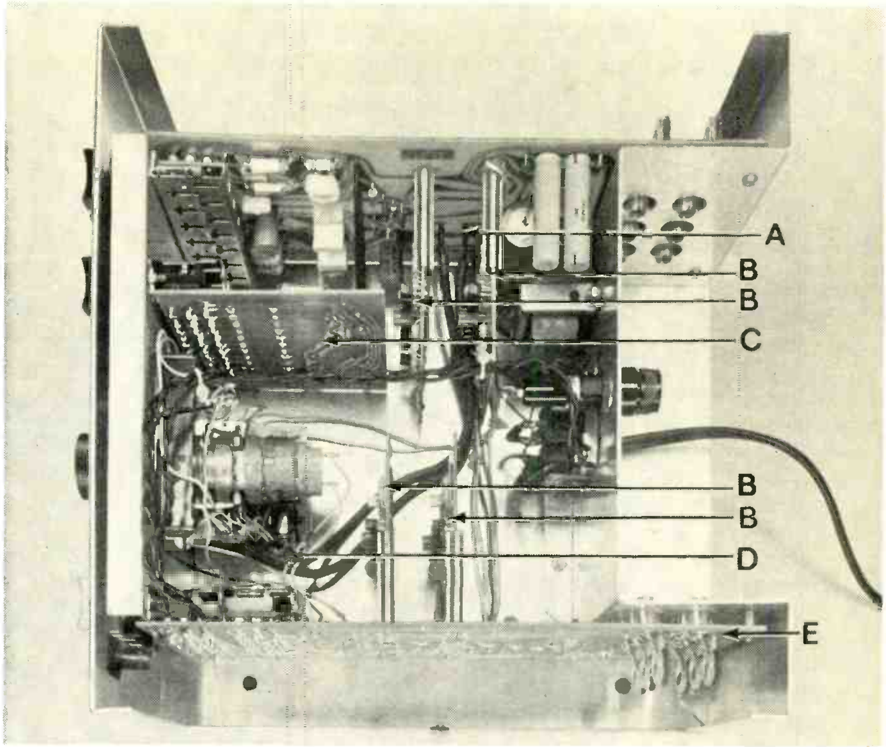
CIRCUIT BOARD C. One is required.



CIRCUIT BOARD D.

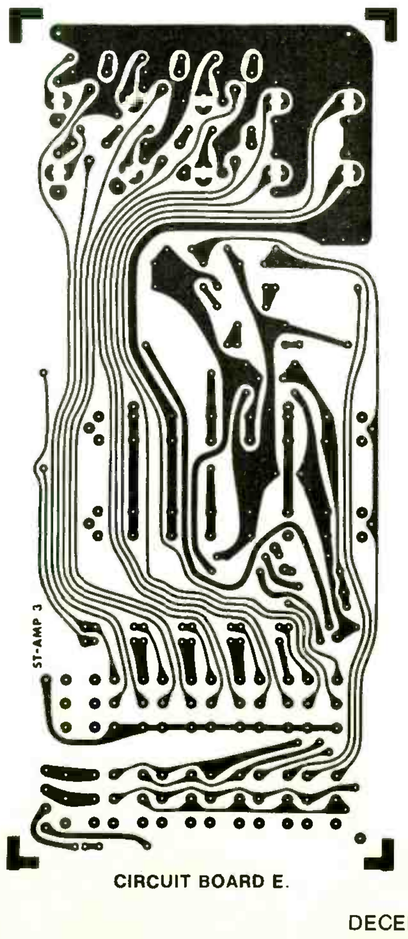
All boards shown one-half actual size.

CIRCUIT BOARD A.



INTERIOR PHOTO OF FINISHED PREAMPLIFIER. Each circuit board is identified by letter. These letters match the circuit boards shown on this page. All circuit board patterns are shown exactly half size.

The following parts for this preamp are available from Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio Texas 78216. Complete set of 9 printed-circuits, drilled, with socket clips. No. 198-cb — $17.50
Set of 9 circuit boards, socket clips, 3 pushbutton switches, and volume control (dual control with push-pull switch). No. 198-SW — $34.50
Complete kit of all parts including cabinet and front panel. No. 198-k — $69.50



CIRCUIT BOARD E.

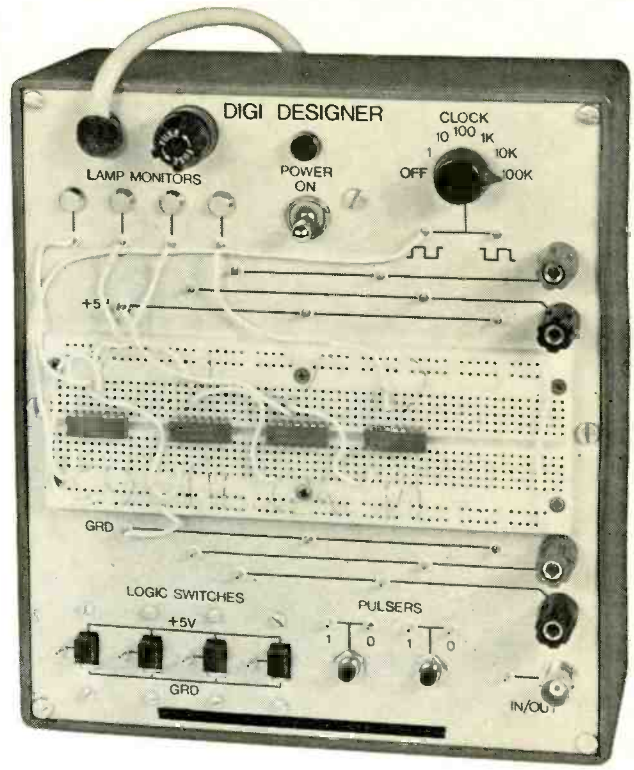
scope, you should see a normal audio trace. If everything still looks OK, remove power, and connect the output of the preamp to the input of your power amplifier. Turn the LEVEL control down near low volume, apply power, set the trimmer resistors to give the desired amount of preamp gain. Connect all other input devices to the preamp and set the appropriate input level controls to give the desired amount of gain. After setting all trimmer resistors, secure the cover. The only precautions to be noted are to 1.) Be careful of 117-volt power wires when adjusting the trimmer resistors 2.) Do not repeatedly turn the unit off and on 3.) Keep the unit away from components generating strong magnetic fields such as power transformers, line cords, etc. **R-E**

Space limitations did not permit us to include, in this issue, some additional photographs of the assembled tuner. We also omitted parts placement diagrams that show where to position the various component parts on the printed-circuit boards. All of this information will be presented in the January 1973 issue. The information presented here will permit you to get started.

DIGITAL IC BREADBOARD
Build It Yourself

For fast breadboarding of digital IC circuits you need more than just a breadboard. You also need a power supply; a clock generator; and some logic switches. Here's a single unit that has it all

by JACK CAZES



HOW OFTEN HAVE YOU BREADBOARDED AN IDEA AND WISHED you had a fast, solderless way to do it so you could spend more time testing your circuit than wiring it? Have you ever ruined heat-sensitive components such as transistors and IC's because of repeated soldering and unsoldering? Do your breadboarding attempts sometimes end up as a cumbersome maze of boxes—experimental circuit in one box, power supply in another, logic indicators in still another?

The DIGI-DESIGNER incorporates many circuits that the serious digital hobbyist uses to design relatively complex digital circuits, all in a single, compact unit, and . . . it uses two unique new breadboarding components that enable you to make solderless connections by simply pushing wires into holes. Connections to and from circuits *within* the Digi-Designer are made by inserting the stripped ends of pieces of No. 22 solid wire into small holes in the tops of *breading pins*; these are miniature, feedthrough, Teflon-insulated terminals that serve as low-resistance solderless connecting points.

Integrated circuits, transistors, capacitors, resistors, etc., plug into solderless terminals of a unique breadboarding socket. It has 128 sets of five electrically connected terminals each, at the center; and 8 sets of 25 electrically connected terminals each along each edge. The terminals in the center are spaced 0.1-inch apart to accommodate the pins of a DIP (Dual Inline Package) integrated circuit. When an IC is plugged into the breading socket, four connections can be made to each of its pins without soldering or additional jumpers. The groups of terminals at the edges of the socket are handy where numerous connections must be made to common circuit points, such as ground, V_{co}, and reset bus.

Circuits that are built into the DIGI-DESIGNER include

- A transistor-regulated 5-volt power supply, that can deliver up to several hundred milliamperes,
- A six-decade 1 Hz to 100 kHz digital clock generator, with complementary outputs,
- Two manual bounceless (digitally conditioned) pulsing buttons, also with complementary outputs,
- Four logic-level lamp monitors, each with its own Darlington transistor driver circuit, and,
- Four logic switches.

Building the Digi-Designer

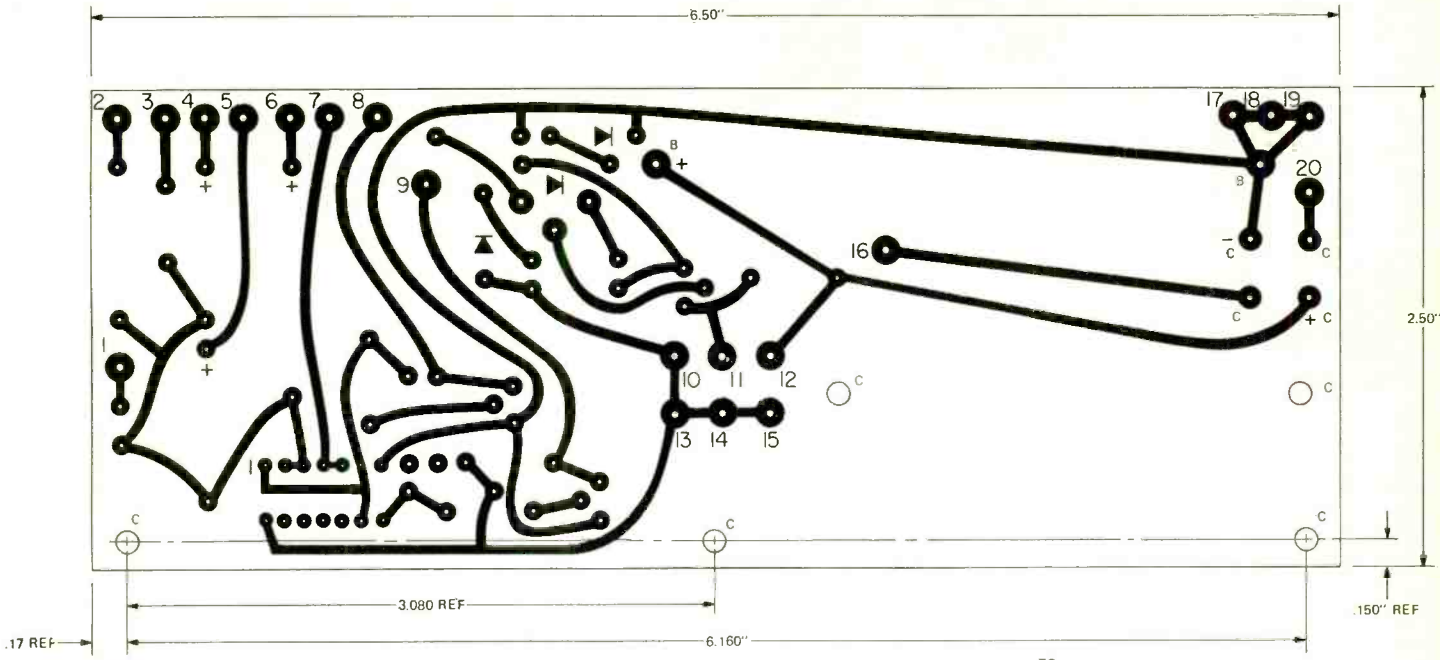
Wiring and component layout are not critical, but should be kept neat to make debugging (if necessary) easy. The front-panel layout shown is a convenient arrangement that minimizes the number of crossed and tangled leads. Make the front panel first. This includes drilling, painting, and marking. Dry-transfer lettering is handy here. Next, install all front-panel mounted components; lamps, switches, breading pins and socket. Also install four insulated 5-way binding posts and a BNC connector along the right edge of the case. These were selected to mate with a variety of commonly used pieces of test equipment. It might be a good idea to check your own test gear and select connectors that match them.

Install breading pins by first slipping their insulators into No. 29 holes drilled in the front panel, and then pushing the metal posts through the insulators with the flat side of a heavy pair of pliers. Be sure to push the metal post straight in, with little or no lateral wobbling. Careful insertion results in even expansion of the insulator at the rear of the panel, with a solid fit.

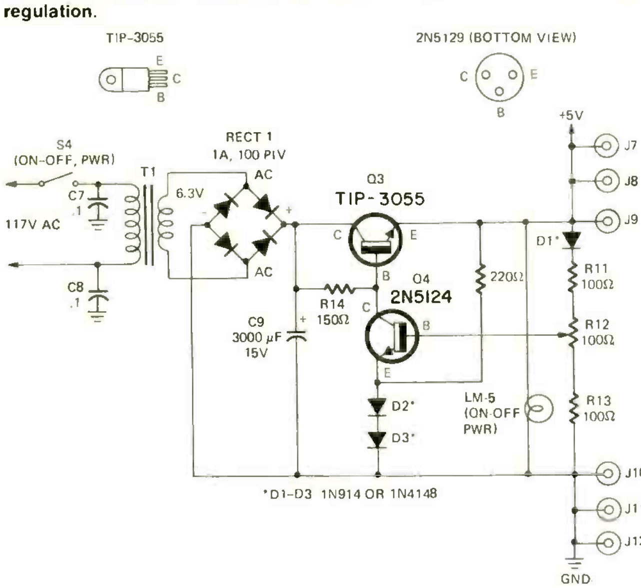
Fasten the breading socket to the case with the six countersunk screws provided. No permanent electrical connections are made between the socket and the rest of the Digi-Designer. Be sure, when fastening the socket, that the self-stick insulating backing is between the socket and the case to prevent any of its metal terminals from shorting to the case.

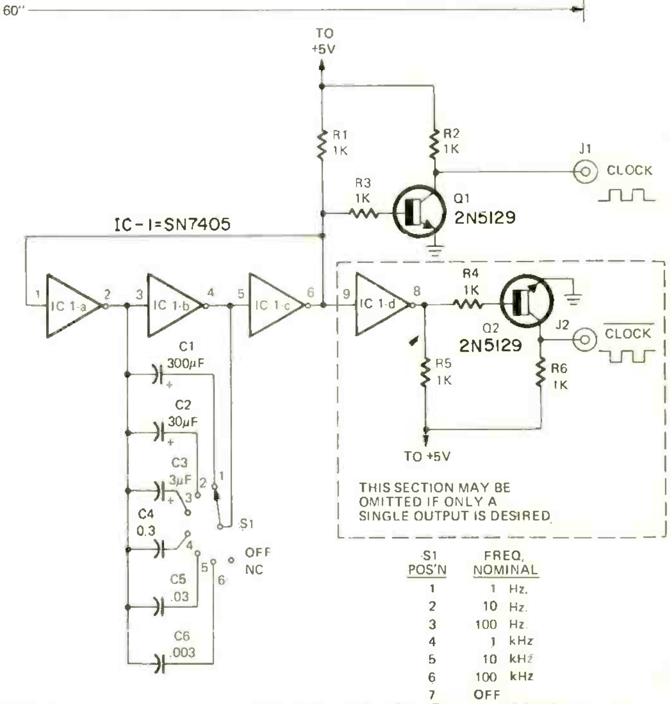
The power supply, pulser button conditioning circuits, clock circuits, and the lamp drivers are all on printed circuit boards. The power supply and clock circuit are on one board, the pulser circuits are on another board, and the lamp driver circuits are on a third. Insert components in their respective locations on the boards according to the drawings. Be sure to use a temporary heat sink, such as a pair of long-nose pliers, when soldering transistor and IC leads to the copper foils on the boards, since they can be easily damaged by overheating. DIP sockets are not required, but are convenient for mounting the IC's.

Now connect all panel-mounted ground points together with a piece of bare wire. These include J10, J11, J12, one side of S5 thru S8, J26, J30, the outside of J28, and the com-



MAIN PRINTED CIRCUIT BOARD (above) is used for both the clock generator and power supply. CLOCK-GENERATOR CIRCUIT (right) is simple and easy to build. POWER-SUPPLY CIRCUIT (below) uses Zener-diode regulation.



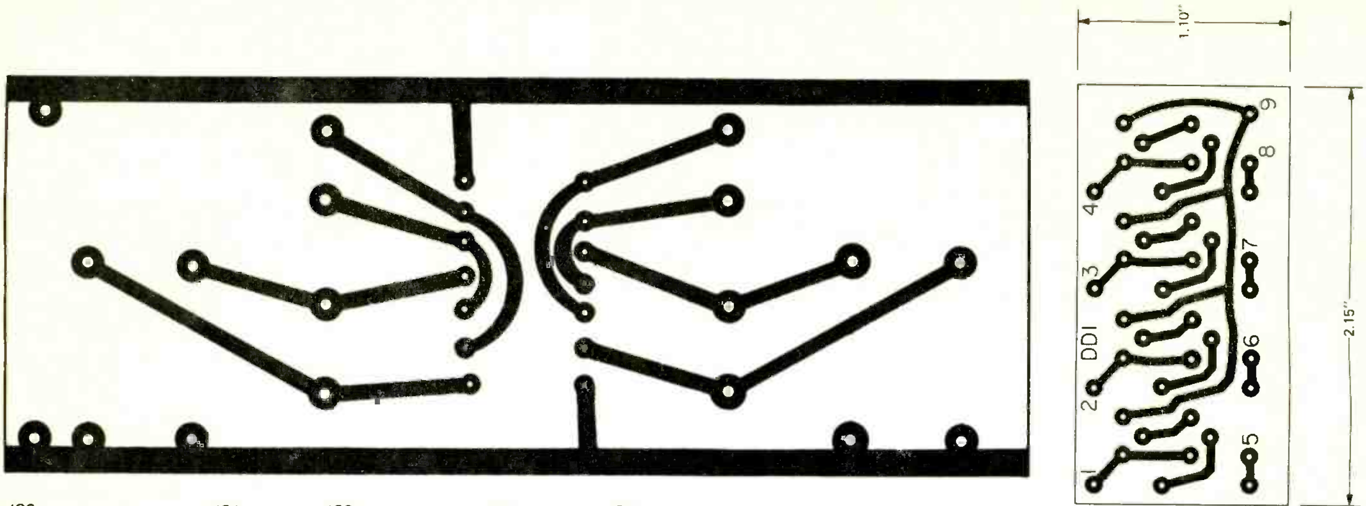


All resistors ¼ watt 10% unless noted
R1 thru R10—1000 ohms
R11, R13—100 ohms
R12—100 ohms, trimmer
R14—150 ohms
R15—220 ohms
R16 thru R19—22,000 ohms
All capacitors 15V ceramic unless noted
C1—300-μF electrolytic
C2—30-μF electrolytic
C3—3-μF electrolytic
C4—0.3 μF
C5—0.03 μF
C6—0.003 μF
C7, C8—0.1-μF 400V
C9—3000-μF electrolytic
Q1, Q2, Q4 thru Q12—2N5129
Q3—TIP3055 or 2N3055
IC1—SN7405
IC2—SN7400
D1, D2, D3—1N914 or 1N4148
RECT—Full-wave bridge rectifier, 1 amp, 100 piv
T1—117 Vac primary, 6.3V secondary, 1.2A (Stancor No. P6134 or equal)
S1—single pole, 7-position, non-shorting selector switch
S2, S3—spdt monetary pushbutton
S4—spst toggle
S5 thru S8—spdt toggle
LM1 thru LM5—5V, 50mA lamps
SOCKET—EL breadboarding socket SK-10
J1 thru J29—EL breading pins
J30, J31, J33, J34—Five-way binding posts
J32—BNC panel connector
Misc:—PC boards, DIP sockets, case, etc.
A complete kit of all parts needed to build the Digi-Designer, including a case, is available for $49.95 including postage. An SK-10 socket and 29 breading pins are available for $24.95, postpaid. E. L. Instruments, Inc., 61 First Street, Derby, Conn. 06418.
Kit DES-1, consisting of the IC's needed to perform the experiments described in this article (3-SN7400, 4-SN7490, and 1-SN74181 selected for the computer circuit described is available for $17.95, postpaid, from Electronetics Co., Inc., P.O. Box 278, Cranbury, N.J. 08512.

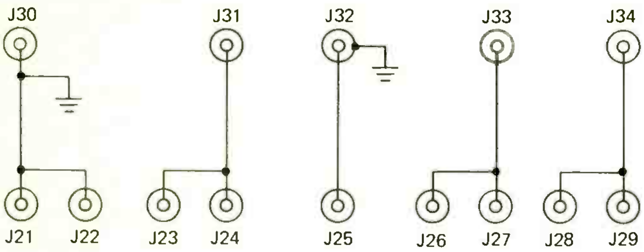
mon terminals of S2 and S3. Similarly, use a length of insulated wire to connect all panel-mounted 5-volt points together, including J7, J8, J9, and the other side of S5 thru S8. Also install the jumpers between the output connectors and their respective breading pins.

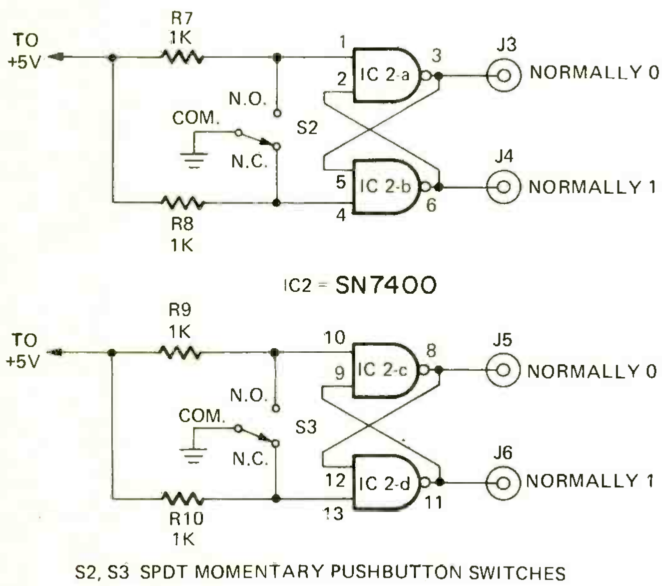
The power supply/clock board is mounted on the rear of the panel after making connections between it and other panel-mounted components. Mount the lamp driver board directly onto the lamp terminals with stiff connecting leads that are sturdy enough to support it. Similarly, mount the pulser board onto the pulser switches. Next, tie all ground points together and all 5-volt points together on boards and other components. Finally, wire the transformer primary circuit and connect a line cord to it.

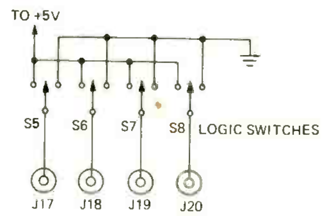
Set R12 for an output voltage of less than 5 volts at any convenient tie point (at J7, for instance). Plug IC1 and IC2 into their respective sockets, making certain that pin 1 of each IC is in socket position 1. Adjust R12 so that the output volt-

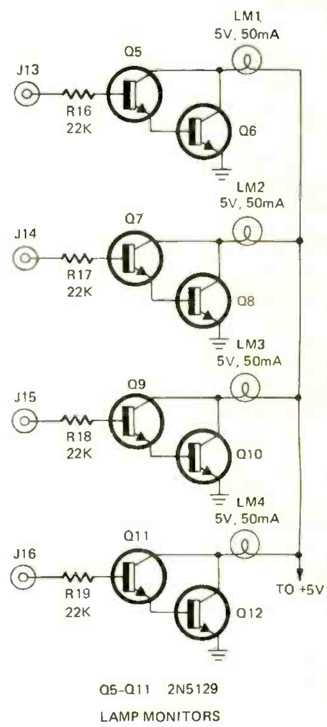


TWO CIRCUIT BOARDS used in the digital breadboard. The one at the top left is for the pulsers. The one at the top right is for the lamp-driver circuit.









OUTPUT JACK connections (top left) for the Digi-Designer.
PULSER SWITCH circuits are shown at the left.

age is exactly 5.0 volts.

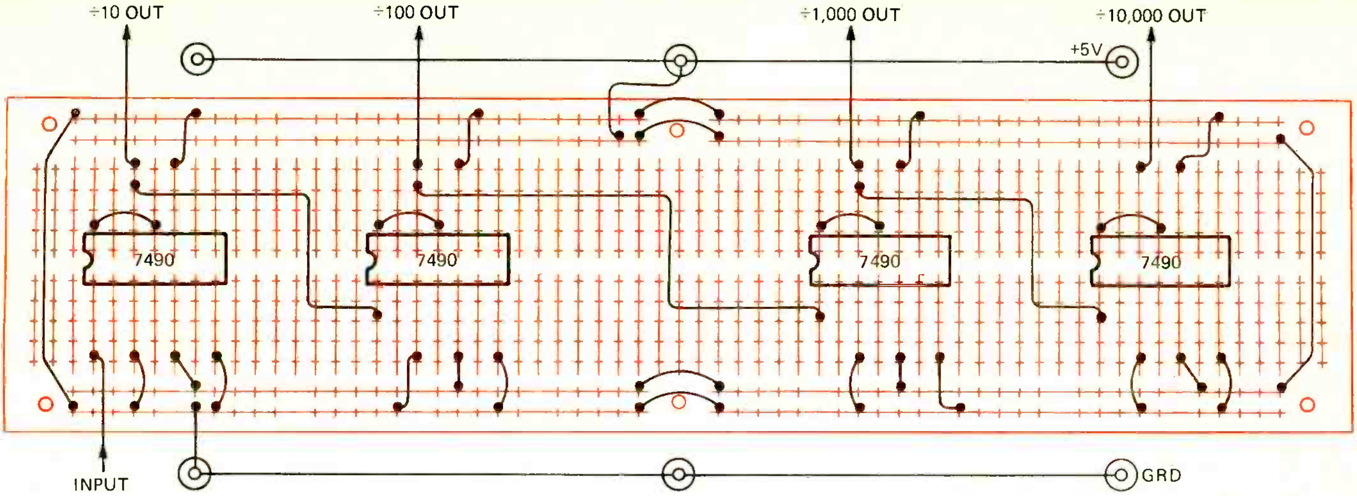
Measure the voltage between each of the 5-volt pins (J7-J9) and ground (J10-J12) to see that 5-volts is present at each of these locations. Connect jumpers from each of the lamp-monitor pins to 5 volts. They should light. If they do not, and you're sure that all your wiring is correct, then check the lamps with an ohmmeter. Also, check or replace the driver transistors in those circuits that are inoperative, since it is easy to damage these by careless soldering. If all lamps are operating properly (off when grounded, and on when connected to 5 volts), they can now be used to check other circuits in the Digi-Designer. Connect jumpers from each of the logic switch common pins (J17 thru J20) to lamp monitors. With the switches in their grounded positions, all lamps should be off; in the 5-volt positions, lamps should be on.

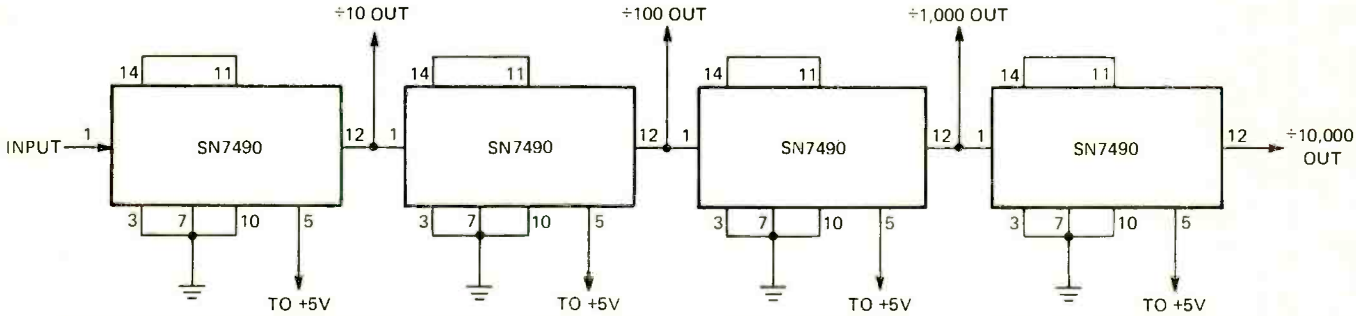
Move the jumpers to connect the pulser button output pins (J3 thru J6) to the lamp monitors. A logic "1" output should turn on a lamp, whereas a logic "0" output should turn a lamp off. Now connect the complementary clock generator outputs (J1 and J2) to two of the lamp monitors. Set the clock selector switch (S1) to the 1 Hz position. The lamps should turn alternately on and off at a rate of about once per second. With the selector switch in the 10 Hz position, the on-off flashing should be barely discernible. Higher frequency settings should cause both lamps to appear to be on continuously, at about half-normal brilliance. If a scope or frequency counter is available, measure the actual frequencies and record them for future reference. The capacitor tolerances are generally so broad that actual frequencies obtained will probably be quite different from the nominal values. In my prototype, the following frequencies were measured:

NOMINAL SETTING	ACTUALLY MEASURED
1 Hz	1 Hz
10 Hz	12.5 Hz
100 Hz	122 Hz
1 kHz	1.4 kHz
10 kHz	13.6 kHz
100 kHz	143 kHz

Using the Digi-Designer

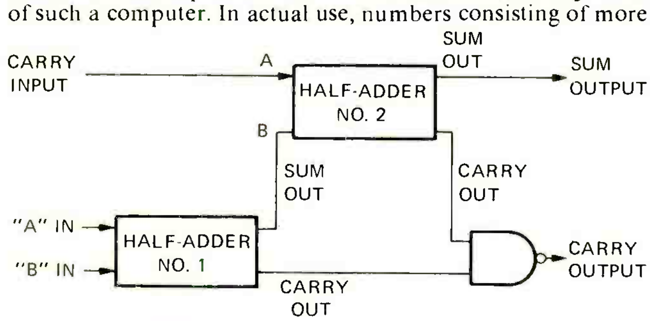
Let's look at a few examples of how to use the Digi-Designer to breadboard and operate digital circuits. Remember, all you have to do to make a connection is to push the stripped ends of wires, or the bare ends of component leads into the holes in the breading socket and breading pins. External pieces of equipment (scope, meter, power supplies, etc.,) are plugged into a mating *external connector,* with breading pins serving as breadboarding tie points.





Four-Decade Scaler—Plug four SN7490 integrated circuits into the breading socket as shown above. Here, as in most cases, several 5-volt and ground connections are involved. It's convenient to set up long strips of tie points for this. It should take only a few minutes to hook up the scaler circuit shown in the schematic; one possible physical arrangement is shown. Connections to the input and the four outputs are determined by the end use to which the scaler will be applied. You might try connecting the input to the CLOCK or to the PULSER button, and the outputs to lamp monitors or to a scope to observe the various input/output relationships for the four scaler stages. Thus, we have built, in a few minutes, an extremely accurate frequency scaler for use in digital division applications, such as digital clocks, calculators, digital measuring instruments, etc. Additional decade stages can be included by moving the IC's closer together.

Digital Binary Adder Circuit—In many computers, addition and subtraction are the only functions performed. Multiplication, division, exponentiation; are carried out by multiple additions and/or subtractions. The binary adder described here represents the basic arithmetic building block of such a computer. In actual use, numbers consisting of more

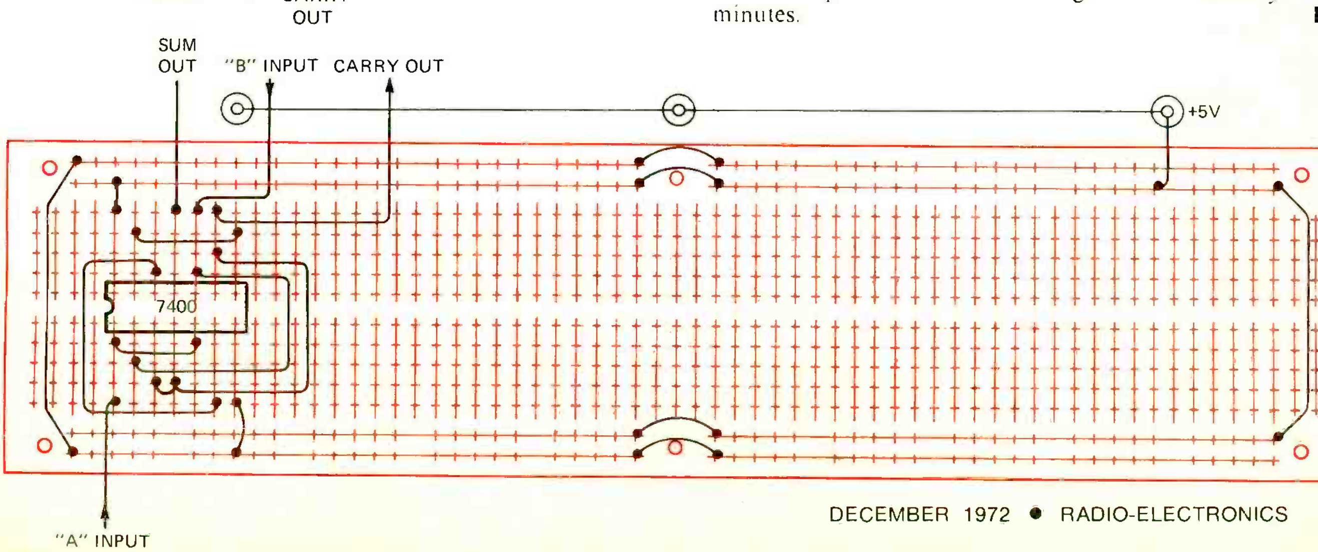


than a single bit (as is generally the case) are handled in either of two ways:

1. Have a *full adder* to handle each bit simultaneously,
2. Feed the bits, one at a time, to a single, high-speed full-adder.

Wire the half-adder as shown below and note the states of the SUM and CARRY outputs that result from various combinations of A and B inputs. Now, build two half-adders and connect them together as shown in the schematic, to form a single-bit full-adder. Again compare input/output relationships. This time, a CARRY INPUT is provided. This input accepts the CARRY OUTPUT from a previous stage.

I think that these examples have shown you how you can make use of your Digi-Designer to conveniently design, assemble, and test relatively complex digital circuits, even a small computer, without soldering . . . and in only a few minutes. **R-E**



step-by-step

TV TROUBLE

Power supplies with
state color TV. Here's

by ART MARGOLIS

IT IS BECOMING COMMON TO FIND transistors in the power supply in solid-state color TV sets. They are identified by such terms as active power filter, filter driver, voltage regulator, regulator driver, capacitance multiplier and error amplifier.

Component failure in this circuit makes the TV exhibit the old familiar "hum in the video." It is usually 120-Hz hum since most modern TV power supplies have full-wave rectifiers.

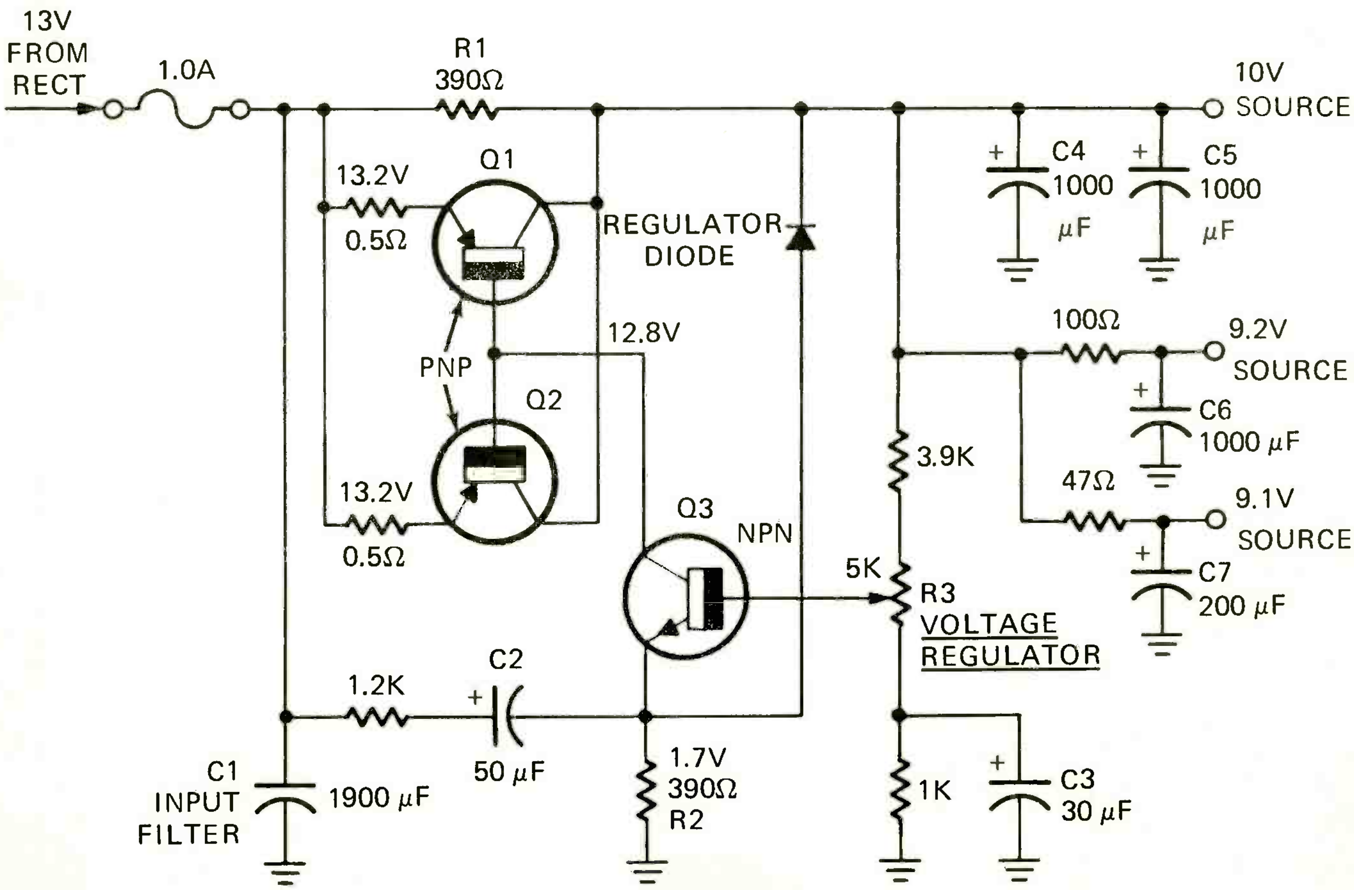
A typical circuit has the transistors somewhere between the rectifiers and the B-plus output, among the filter capacitors. They take the place of the choke in a pi-type filter network. In a typical circuit, see schematic, a pair of pnp transistors are in parallel as series regulators (Q1 and Q2) with their collectors attached to the B-plus output. The emitters are both tied to the rectifier output, while the bases are tied to the collector of Q3, an npn transistor. The base of Q3 is attached through the arm of the pot to a voltage divider on the B-plus line.

Voltage regulation

When the TV is turned on, electrons flow from all the circuits into the B-plus source point (the junction of the three B-plus lines). At that junction the electrons find two paths. One, a direct line through a 390-ohm resistor (R1) to the rectifiers. Two, through the forward-biased series regulator transistors (Q1 and Q2) from collector, to emitter and then on to the rectifiers.

The power supply has a bleeder resistance made up of potentiometer R3 and its two series resistors. The pot's arm permits a varying voltage to be picked off and fed to Q3's base as operating bias.

By varying the pot, electron flow from Q3's emitter to base is made heavier or lighter. This varies the bias on Q1 and Q2 and controls their col-



SOLID-STATE REGULATED POWER SUPPLIES are common in transistor color TV sets and in some high-power hi-fi equipment. This is a typical circuit arrangement. Some may have one high-current transistor in place of Q1 and Q2. In some circuits Q1 and Q2 are connected as emitter followers.

SHOOTER'S GUIDE

electronic regulation are common in solid-
how they work and how to troubleshoot 'em.

lector current. When they conduct heavily, their collector current causes a greater drop in the B-plus. If they have a light electron flow, the B-plus rises with the lower collector load. It is seen, the pot sets the TV's B-plus level.

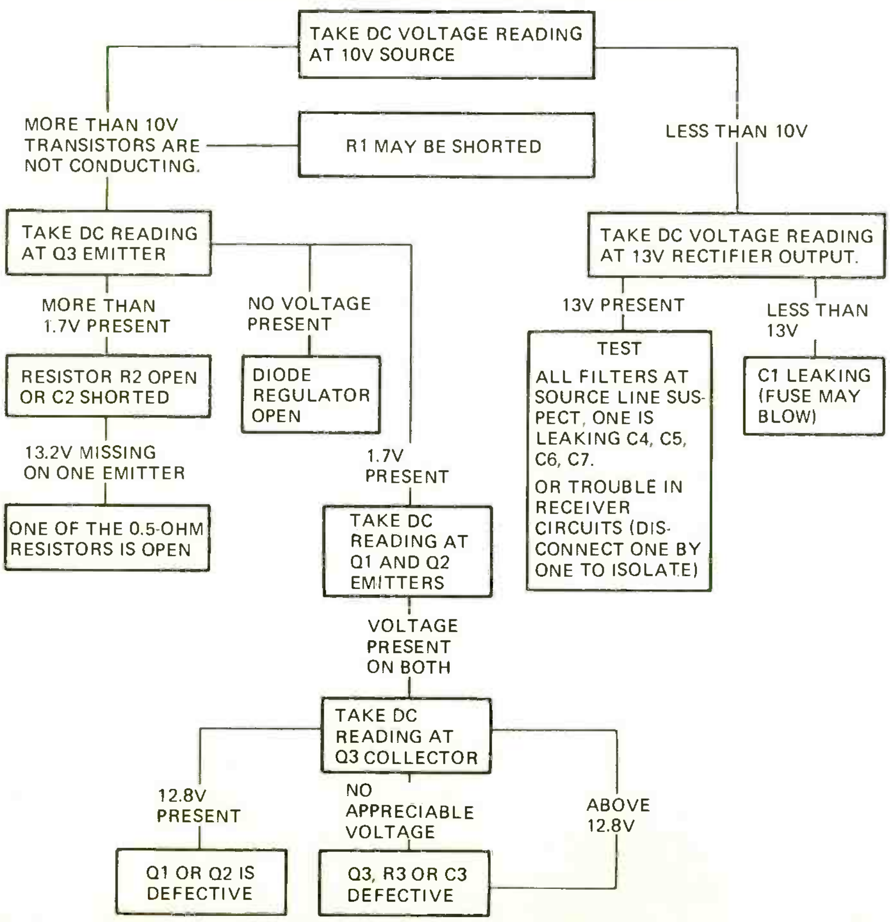
Active Power Filter. In solid-state circuits with their attendant low-voltage, high-current levels, large capacitance filters and expensive chokes must be used to take out ripple. The transistors also augment the B-plus filters.

Solid-state color sets operate from low-voltage, high-current supplies that would normally require filter chokes and very large amounts of filter capacitance to reduce residual ripple and interstage coupling to desired levels. In the interest of space and economy most sets have an *active* electronic filter that effectively *multiplies* the value of the filter capacitance in the circuit. For example, if a 30-volt B-plus source has a 250-mV ripple, it is possible to reduce the ripple at the output to 1 mV by using a capacitance multiplier with a factor of 250.

In the circuit shown, ripple and current pulses on the B-plus lines cause variations in the drop across R1 that appear as instantaneous variations in the V_{CE} of Q1 and Q2. Small amounts of the ripple and pulse voltages are fed to Q3's base. After amplification and inversion by Q3, these voltages are applied to the bases Q1 and Q2 to provide degenerative action. Now, any change in the voltage input to the filter or current drain will produce an opposite change in the voltage across the load. Thus, R3 not only sets the B-plus level, but also controls the ripple and decoupling between the three B-plus lines.

COLOR TV SERVICING

ACTIVE POWER FILTER TROUBLESHOOTING CHART



Troubleshooting

The active filter circuit can blow the line fuse if it develops a dead short to ground. For instance, if the input filter C1 shorts. Or, B-plus can be missing or too low if R1 opens.

However, typical failure in the circuit causes hum bars or shrinking or both. Too much or too little B-plus is produced and ripple is serious. When these symptoms start, the best approach is to take a dc voltage reading at the B-plus source. The rectifier output is 13 volts. The source should be 10 volts. The circuit is supposed to regulate and filter the 13 to a ripple-free 10 volts.

If the source is higher than 10 volts and R3 cannot be adjusted to restore 10 volts, then all the components around and including the three transistors are suspect. When the transistors turn off and present no load to the rectifier output, the voltage rises toward the 13 volts and cannot be adjusted. If the regulator diode and R2 are both shorted the load might drag down the B-plus, but that possibility is not very probable. In general a higher than normal source B-plus indicates the transistor circuit.

When the source is lower than 10 volts and R3 adjustment will not bring it back up to 10 volts, the input and output filter capacitors are suspect.

Take a dc reading at the rectifier output. If it is low there too, then C1 is leaking badly. Should the normal 13 volts be present, then C4, C5, C6 or C7 may be shorter or leaky. The chart goes into greater detail. **R-E**

AGC for automatic recording level

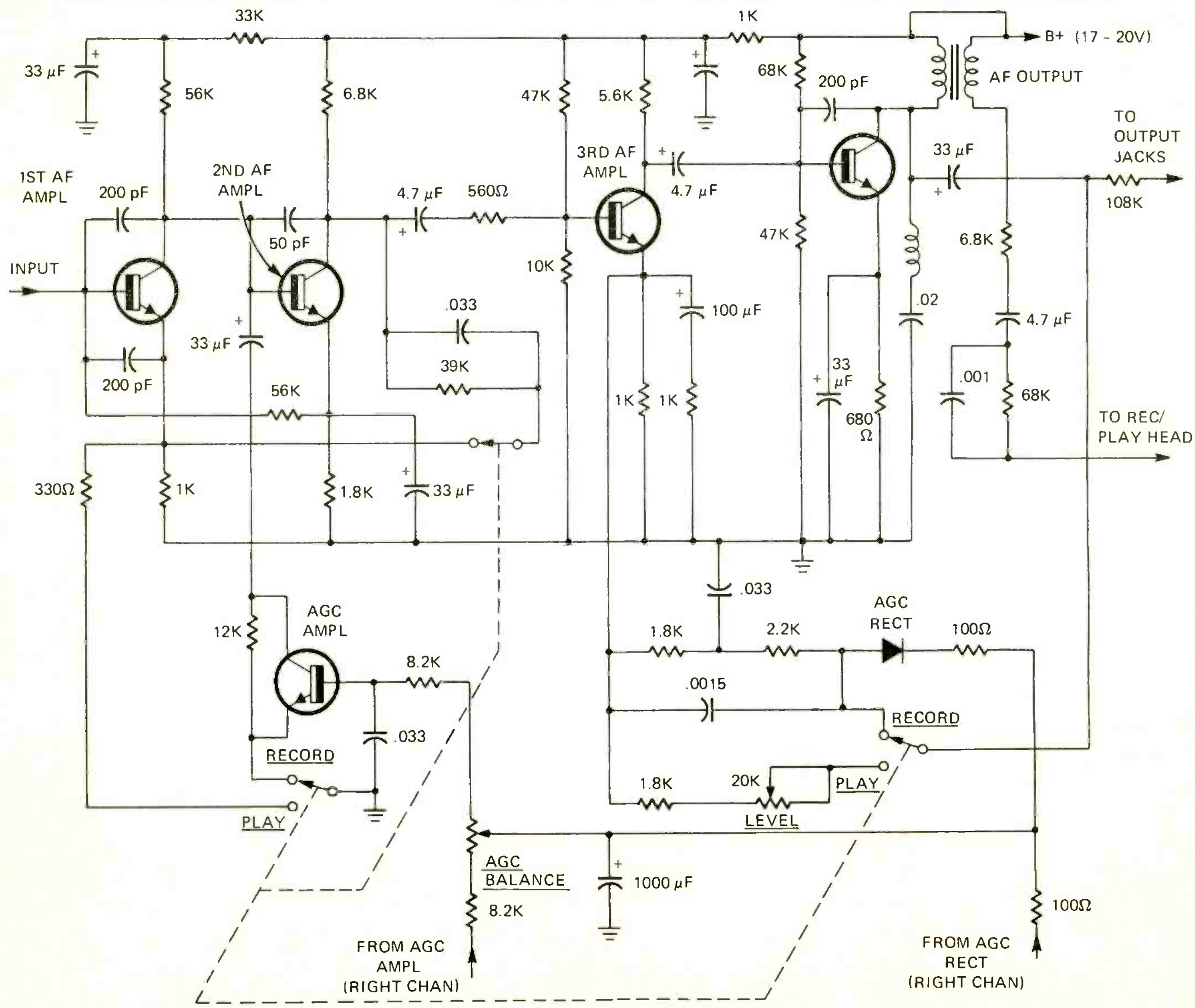
Admiral recorder uses transistor's collector-emitter resistance as heart of its recording circuit.

The Admiral model STR901 cartridge tape recorders do not have recording-level meters because the recording level is automatically controlled by an agc system. The diagram shows the simplified circuit of one of the channels of the recorder.

A portion of the signal from the collector of the output transistor is tapped off and rectified by the agc rectifier. The resulting dc signal is filtered by the 1000-μF electrolytic. The AGC BALANCE control determines the amount of the dc voltage that is applied as a variable base bias to the agc controlled transistors. The varying base bias makes the controlled transistor act as a variable control that determines the amount of the signal that will bypassed to ground through the transistor and the 12,000-ohm resistor.

During playback, the adjustable volume or LEVEL controls are switched into the circuits. A portion of the output of each channel is tapped off and fed as negative feedback to the emitters of the third af amplifiers. The out-of-phase signal fed back determines the bias and gain of the third stage amplifier. **R-E**

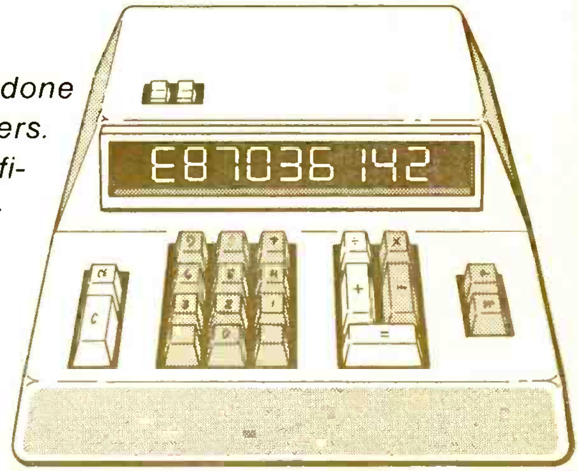
RECORDING LEVEL is held relatively constant by this circuit. It eliminates the need for a manual input control when recording.



CALCULATORS

The first "digital" calculating was done by early man using his fingers. Then came the abacus and finally the electronic calculator

by FORREST MIMS



from the abacus . . . . to the electronic calculator

IT'S NO COINCIDENCE THAT FINGERS AND THE NUMBERS 0–9 are all referred to as digits because man's first counting machine was his two hands. Finger counting, which is actually primitive addition, is still used throughout the world. But even before recorded history man invented counting techniques which permitted the counting of sums greater than the total of his fingers. Notched bones, marked sticks, and knotted strings made possible more advanced counting, an absolute requirement for time keeping, bartering, and establishing formal commerce.

The earliest mechanical calculator was the abacus. It's believed that the abacus was in use in Egypt as early as 450 B.C., and a type of abacus may have been used in China as early as 600 B.C. The first abacuses consisted of small pebbles moved through grooves drawn in loose sand, and the machine began to bear some resemblance to its modern form when the counting stones were placed in grooves formed in a wood or metal tablet.

The modern abacus consists of a frame which supports a dozen or more parallel rods. Five to seven moveable beads or counters provide the counting mechanism and there is generally a central bar across the top center of the frame to separate one or two beads on each rod from the rest. The beads on top correspond to fives, while the counters below the dividing bar correspond to ones.

To place a number on an abacus, the frame is first cleared by moving all the one's beads *down* and the five's beads *up*. By assigning one rod to be the one's column and those to its left the ten's, hundred's, thousand's, and so forth, it's easy to "write" numbers on the machine by moving the beads toward the central dividing bar.

Arithmetic with an abacus is remarkably simple and efficient, and with practice one can soon gain speed in the ancient art of abacus manipulation. In a now famous competition held in 1946 between a Japanese abacus operator and an American equipped with a mechanical desk calculator, the abacus beat the calculator in four out of five areas of competition. The abacus was faster than the mechanical machine since the operator performs the arithmetic as new numbers are inserted into the machine. In the case of the desk calculator, the operator must activate a total mechanism before the final answer can be calculated, but the abacus provides a running total and the final answer is ready as soon as the last number has been inserted into the machine.

Abacuses are still in use throughout the Orient, the Soviet Union, and other parts of the world. Chinese style abacuses have two beads on the top side and five on the bottom, while the modern Japanese version, the *soroban*, has one bead on top and four below. The soroban is designed for speed and efficiency since elimination of the additional beads forces the operator to "carry" as soon as each column of digits exceeds nine.

The abacus can easily be used for addition and subtraction by a beginner and for multiplication and division after a little practice. But as more advanced mathematical operations were developed a need for more comprehensive calculating machines was created. The first significant step beyond the abacus was a gear driven adding machine invented by Blaise Pascal in 1642. The teen-aged genius designed and assembled a mechanical calculator capable of adding series of eight digit numbers. Another important seventeenth century invention was John Napier's device for calculating with logarithms, and still another was William Oughtred's invention of the slide rule.

The basic concept of Pascal's mechanical adder is found in modern mechanical adding machines, and slide rules are still an important tool of modern engineering. But no inventor foresaw the resolution of the modern calculator as clearly as Charles Babbage.

An outspoken English mathematician and philosopher, Babbage was obsessed with the idea of designing and constructing an advanced mechanical calculator which would perform the four basic arithmetic functions as well as advanced manipulations of these fundamental operations.

In 1822 Babbage succeeded in constructing the "Difference Engine" for the solution of polynomial equations ($x^2 + x + a = 0$). The machine's success convinced him that he could construct a more advanced calculator, the Analytical Engine, with a punched card input, a memory of 1,000 50-digit numbers and both visual and hard-copy output.

Unfortunately the machining state of the art in Babbage's time was not sufficiently advanced to permit all the required mechanical parts of his highly complex Analytical Engine to be constructed with the necessary degree of precision. The apparatus required hundreds of precision mechanical components. Though Babbage completed literally thousands of intricate engineering drawings detailing the machine's assembly and internal operation, a feat in itself, the precision tooling required for fabricating the working parts was just not available.

Babbage spent the last 40 years of his life working on the Analytical Engine and died in 1841 without seeing his project completed. He did, however, make important contributions to the science of machining and designed the basic organization of a modern digital computer system. Indeed, some of the operations which would have been performed on Babbage's Analytical Engine bear an amazing resemblance to some of the basic FORTRAN statements used with many modern computers.

By the beginning of the twentieth century the basics of the two major classes of calculating machines had been discovered. The digital calculator, as represented by the abacus and other primitive counting systems, had reached its pinnacle with Babbage's Analytical Engine. And slide rules and Lord Kelvin's tide-prediction machine, an 1872 invention, represented the analog calculators. While both digital and

A FULLY PROGRAMMABLE ELECTRONIC CALCULATING SYSTEM, the Hewlett-Packard 9820A, with a built-in printer. This versatile machine represents the pinnacle in electronic desk calculators and offers many of the capabilities of a true minicomputer. The three keyboards to the right of the central arithmetic portion of the machine can be "user defined" by means of plug-in read-only memory modules.

analog calculators were designed to perform arithmetic, and even differential equations in the case of Kelvin's machine, their operation was fundamentally different.

Digital calculators utilize discrete quantities in making calculations, while analog calculators measure or approximate quantities. The differences between the two types of calculators gives each relative advantages and disadvantages. Digital machines, for example, are far more accurate than their analog counterparts and large-capacity digital devices can express answers accurate to one part in a trillion—or better. The accuracy of an analog device will rarely exceed 0.01%.

Analog calculators do have advantages, however, and they are well suited to modeling a complex physical problem and providing solutions to a variety of conditions. In aerodynamics, for example, analog calculators and computers are frequently used to simulate aircraft shapes. By simply turning potentiometers connected to simulate drag, velocity, air density, and other parameters, it's possible to conveniently select optimum aircraft configurations for particular flight requirements.

Getting back to the evolution of calculators, there were a number of important developments at the turn of the century which directly affected future prospects for both analog and digital calculating machines. One of the most important of these was the invention of electrically-read punched cards by Dr. Herman Hollerith. The Hollerith cards were first developed for use in the 1890 United States census and are direct predecessors of the modern IBM card.

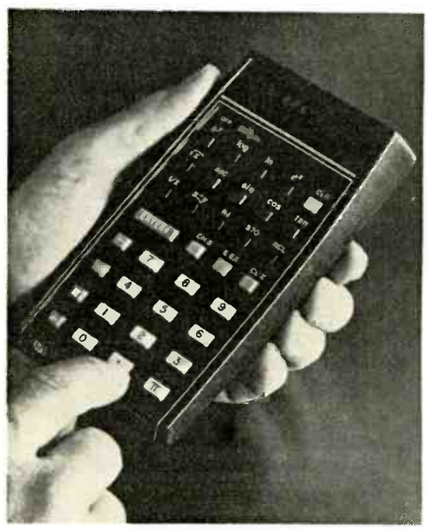
The next big development in the field was the design in 1925 of a large analog computer by Dr. Vannevar Bush. An advanced version of the Bush machine was secretly used during World War II to calculate artillery firing tables. Also in World War II a complex analog calculating system was used in the fire control system of B-29 bombers.

In 1944 interest in calculating machines suddenly shifted from analog devices back to digital techniques with the completion of the Mark I Automatic Sequence Controlled Calculator. Containing more than 3,000 relays, the Mark I could multiply two 23 digit numbers, its maximum capacity, in 4-½ seconds. The Mark I was conceived by Howard Aiken and built with the assistance of IBM. While designing the calculator, Aiken came upon some of Babbage's work and recognized its contribution to the principles of complex digital calculating machines. Aiken once remarked "If Babbage had lived 75 years later, I would have been out of a job."

The Mark I was followed by an even more significant calculating machine. In 1946 Drs. J. Presper Eckert and John Mauchly completed the ENIAC (Electronic Numerical Integrator and Calculator), a significant advance over the Mark I in that it used high-speed vacuum tubes instead of the much slower electro-mechanical relays. The new machine was a major scientific and engineering accomplishment, but it brought along some major problems as well. With 18,000 tubes, 11,000 switches and terminals and more than half a million solder connections, the ENIAC required two and a half years to assemble and more than 1,800 square feet of floor space. But the added complexity gave the ENIAC much faster speed than the Mark I. While the relay machine required a third of a second to add two numbers, the ENIAC could perform 5,000 additions in one second.

The ENIAC marked the beginnings of the computer age, and it was soon followed with high-capacity machines such as the EDSAC (Electronic Delay Storage Automatic Calculator), EDVAC (Electronic Discrete Variable Automatic Calculator) and SSEC (Selective Sequence Electronic Calculator). The EDSAC was unique in that it incorporated a *stored program* for the first time.

The stored program, a key to the success of modern digital calculators and computers, provides the internal instructions necessary for a calculator or computer to perform com-



THE MOST ADVANCED POCKET CALCULATOR made today—the Hewlett-Packard HP-35. This sophisticated electronic slide rule has trig functions, a memory, and can take square roots. It also handles logs and exponential terms. The HP-35 represents a major breakthrough in miniature electronic calculating machines.

plex operations with a minimum of outside instructions. A typical stored program, for example, will have the necessary instructions for determining trigonometric functions. The operator is then saved the laborious task of encoding the appropriate instructions each time he needs to refer to such a function. In a typical operation he merely instructs the machine to find the cosine (or tangent or sine) of a particular angle with a few code letters (usually "COS" in the case of cosine) and the machine's internal stored program automatically furnishes the detailed instructions required for the operation to the arithmetic section. Large digital computers frequently use magnetic tape for stored programs, while advanced electronic desk calculators employ solid-state memories for the same purpose.

In 1951 Eckart and Mauchly completed work on the famous UNIVAC, the first modern digital computer. The original version of this machine was purchased by the United States Census Bureau and was used until 1963 when it was replaced by more modern equipment. The first UNIVAC is now on permanent exhibition along with several other pioneering calculating devices at the Smithsonian Institution in Washington, D.C.

THE CANON POCKETRONIC is the only portable electronic calculator with a paper tape printout. This novel machine incorporates Texas Instruments MOS LSI circuitry but is manufactured in Japan. Texas Instruments also manufactures the semiconductor thermal printout device. The paper tape can be replaced almost instantly by plugging in a new cassette.

During the 1950's the UNIVAC was followed by a series of advanced digital computers developed by the newly founded computer industry.

Though the transistor had been invented in 1948, most computers employed vacuum tubes. But in the late fifties and early sixties reliability of the machines was significantly enhanced when the switch to transistor operation was accomplished. In addition to improving reliability, transistors meant the once bulky computers could be squeezed into much tighter spaces. The size reductions were vital to military and civilian aerospace endeavors and for the first time it became possible for an aircraft or missile to carry along its own portable digital computer for inertial navigation and other important roles. These early avionics computers were primitive by today's standards, but they represented an enormous step forward at the time of their introduction.

The semiconductor developments which made possible compact digital computer systems led to speculation about the prospects for electronic desk calculators. Integrated circuits had been invented by Texas Instruments in the late 1950's, and major technology improvements by Fairchild a few years later made possible the formation of several dozen electronic components on a single silicon substrate. Since even the first IC's crammed tens of components into the space normally required for one and since the components were all connected together within the IC itself, for the first time it became feasible to consider designing electronic desk calculators. But the development which began a literal explosion of electronic desk calculators was the *L*arge-*S*cale *I*ntegrated circuit (LSI). A product of metal-oxide semiconductor (MOS) technology, LSI made possible the compression of the hundreds or even thousands of transistors and other components required to perform the computer operations of arithmetic, memory, and control onto several semiconductor chips each about a tenth of an inch square. With the availability of calculator "chips" it became feasible to manufacture multiple-function electronic desk calculators that required less space than a telephone.

A size comparison between a modern LSI calculator and the first vacuum-tube calculator, the ENIAC, is truly impressive. Where the ENIAC required an entire room to house its racks of 18,000 vacuum tubes, a miniature LSI calculator containing the equivalent of 30,000 transistors will easily slip into a shirt pocket.

Continued developments in LSI technology have dramatically improved electronic calculators. Now, for example, nearly all the electronics required for a basic four function calculator (+, −, ×, ÷) can be placed on a single LSI chip. The result is calculators no larger than a portable transistor radio. In addition to LSI, these new calculators employ such recent developments as light-emitting diode (LED) displays and thermal printers. The market is highly competitive and more than a dozen firms produce the miniature machines.

Most miniature calculators employ LED or liquid-crystal displays, but there is one unit which provides a paper tape printout. Dubbed the Pocketronix, the machine represents a joint development by Texas Instruments, Inc. in this country and Canon, Inc. of Japan. The Pocketronix employs three LSI chips and a unique semiconductor thermal printer manufactured by Texas Instruments. As operations are pressed onto the keyboard, the entries, function signs, and results are immediately printed onto the cassette-loaded paper tape.

Another impressive miniature calculator is the HP-35. Manufactured by Hewlett-Packard, a major producer of programmable scientific desk calculators, the HP-35 has memory capability and can provide trigonometric functions, logs, pi, and square roots at the touch of a single function key. Since the HP-35 literally fits in a shirt pocket, it represents the fulfillment of many science-fiction predictions.

Miniature calculators are popular with students and anyone else requiring math assistance on-the-go, but for desk operation machines about the size of a cigar box are standard. Dozens of different types from as many manufacturers are now available and the perspective purchaser can choose from units that include such added features as memory capability, printers (electronic and electromechanical), special functions, and novel keyboard manipulation shortcuts.

A LATE MODEL DESK CALCULATOR, the Friden EC1117 has memory capability. Low-cost machines like this are popular with businesses. Friden also manufactures printing calculators and all electronic cash registers.

Prices for miniature and desk calculators begin at just under $100 and range up to several thousand dollars for a machine equipped with a printer and peripheral equipment. As with any other purchase, the buyer gets what he pays for and the cheaper machines do not necessarily represent the best bargain. Many of the low-cost machines require special keyboard manipulations to perform simple problems in addition and subtraction.

A possible solution for the prospective purchaser with a limited budget and soldering iron experience is one of the new kit calculators. Micro Instrumentation and Telemetry Systems, Inc. has been selling kit desk calculators since 1971 and now offers a line of machines ranging from a miniature machine to full function scientific calculator. Heathkit brought out a kit calculator in 1972, and the May 1972 issue of **Radio-Electronics** featured a construction article on a kit pocket calculator manufactured by Alpha Research Corporation.

Kit calculators are not difficult to assemble. Besides saving money, assembly of a kit machine provides background for future troubleshooting and enhances the kit builders' knowledge of general calculator construction and operation.

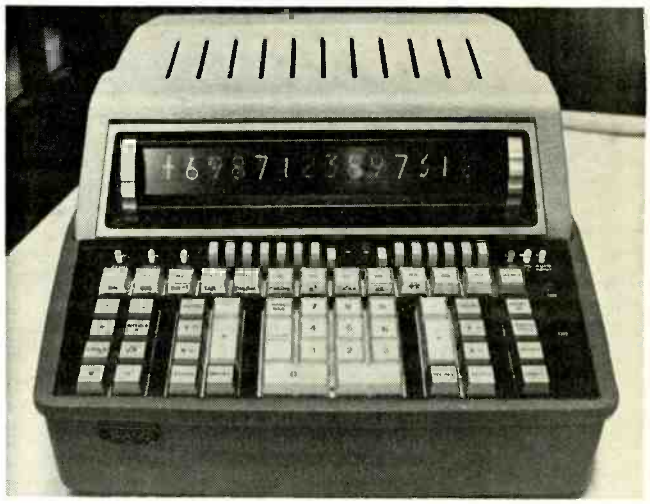
The development of other specialized calculator chips, particularly memories, has further enhanced calculator performance and now several companies are marketing *scientific* calculators. These machines include the standard four arithmetic functions on their keyboards but supplement the basic capability with keys for the various trigonometric funtions, pi, square and square root, e^x, logarithms, and other operations common to mathematics. In this way, the scientific calculator becomes an instant access book of mathematical tables as well as an easy operating calculating machine.

THE CANON PALMTRONIC LE-10 has an LED display and rechargable batteries. To extend battery life, which is indicated by the built-in meter, the LED display turns off after about half a minute. Note that the machine incorporates separate keys for each function, a desirable feature not often found on miniature calculators.

The scientific calculator has the ability to perform complex operations as a result of the same kind of internally stored program used in large scale computers. Read only memory (ROM) chips store the microinstructions necessary to tell the calculator's arithmetic unit to calculate the desired mathematical function. Since the expanded capability of the scientific machines is in large part dependent on the capacity of the ROM, its possible to further expand an existing machine by merely adding plug-in memory modules. Several manufacturers offer scientific calculators which are compatible with a variety of memory modules which let the operator literally custom-design his own keyboard in the time it takes to insert the module into the machine. A bank of unmarked keys is used to specify the operations and functions contained within the special ROM modules, and a snap-in label card notes the newly assigned function of each key. The calculator can be "redesigned" in the time it takes to exchange the ROM modules.

In what has become one of the fastest moving fields in electronics technology in recent years, scientific calculators have led to the next logical development—the programmable calculator. With the operating ease of a calculator and the power of a small computer, programmable calculators fill an important gap between scientific calculators and minicomputers.

It's important to understand the difference between the programmable calculator and the minicomputer. In the important area of operational ease the calculator has the unquestioned lead. Programmable calculators with an algebraic



WANG SERIES 100 ELECTRONIC DESK CALCULATOR. Manufactured by the first company into the electronic desk calculator business, the machine includes scientific and statistical keys as well as interfacing for an optional printer. The display panel is on an axle and can be rotated for convenient viewing by the user.

keyboard can handle complex equations just as they are written on paper while a computer program must be written before the minicomputer will handle similar problems. Cost is another important area where the calculator comes out ahead. Programmable calculators can be purchased for about \$3,000, and \$10,000 will buy a fully expanded model with accessories such as additional memory, printer, plotter, and input devices. The price may seem high to the uninitiated, but the calculating power makes it a genuine bargain.

For those who cannot afford the price of a programmable machine but are eager to have one anyway, help is on the way in the form of a kit programming unit. MITS, Inc. plans to bring out a programmer kit which can be mated to its machines already on the market. The cost for a complete kit programming unit and calculator will be about a tenth of a corresponding assembled unit's cost. A MITS 7400 series scientific calculator and programmer will provide the technician, engineer, or experimenter with many of the capabilities of a minicomputer.

So there you have it. The primitive abacus, the 3,000 year old digital calculator still being used throughout the world, has finally been outclassed by electronics. In a development which would have been labeled as science fiction just 10 years ago, complete programmable calculating systems which fit on a standard desk top and multiple function machines which fit in a shirt pocket are available today. **R-E**

ARC-OVER IN BRIGHTNESS CONTROL

I'm getting arc-over in the brightness control of an Electrohome Viking TV, TCO-299R. I can't understand it. Shouldn't be any really high voltage around there.—E.B., Minden, Ont.

Right. There should be no more than +135 volts on this control, and this won't arc to anything, unless it is very close indeed. There is one possibility: internal arcing in the pix-tube might cause it. Try tapping the neck carefully with a pencil eraser and watching for arcing inside the tube.

You might try adding an "arc-gap" to the pix-tube socket or wiring. Check the pix-tube for internal shorts. If you find one, say between G1 and the focus or screen grid, try this: place the tube face down on a pad and rap the neck (carefully!). This will sometimes dislodge small particles which cause the short; they'll fall into the bell where they won't hurt anything. If this fails—new tube.

USING THE COLOR-BAR GENERATOR

Trying to service a color set without a color-bar signal can be an exercise in futility

by FOREST H. BELT and ESTILLE DOBSON

A VIDEO PATTERN OF DOTS, LINES, AND crosshatch is the standard for converging color sets. That kind of generator has been around since color first came out. For color-circuit work, NTSC color bars were added. Only later did the keyed-rainbow color pattern come into vogue in their place. Today, the keyed rainbow is by far the more popular.

You can track down many chroma faults with a station signal. But the job is difficult because levels of chroma change from scene to scene. A keyed rainbow signal produces a steady display of ten color bars. When you study the screen or trace with a scope, you know what to expect. That makes it easier to spot when something's wrong, and to analyze what the trouble is.

A keyed-rainbow generator

To make a rainbow on the color picture tube, a generator modulates an rf signal with an offset subcarrier at 3.563795 MHz. That's offset from the color subcarrier, 3.579545 MHz, by the horizontal line frequency. (A few modern instruments use other offset subcarrier and horizontal-line frequencies, but operation is essentially the same as with this popular version.)

The 3.56-MHz signal goes to the receiver demodulators. There it is compared with a 3.58-MHz reference signal. Their mixing creates a continuous change in demodulator output phase that totals exactly 360° across each horizontal line. The output shift produces one complete "rainbow" of colors during each line.

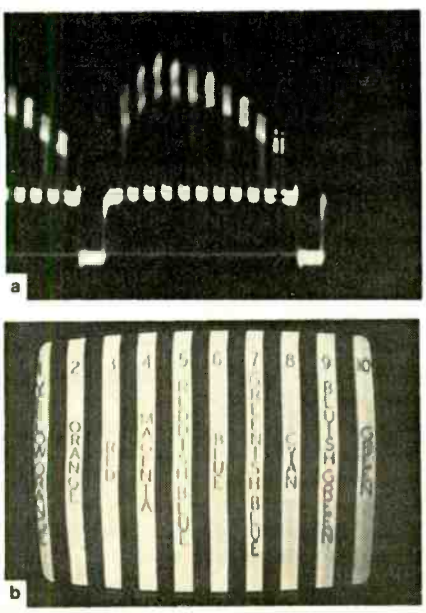
That makes a solid rainbow raster, *not* rainbow bars. So, the 3.56-MHz oscillator is shut off and keyed back on 12 times during each horizontal sweep. Those blank spaces interrupt the rainbow at 30° intervals, keeping it off for 15° each time. Off-time shows black on the TV screen, breaking the rainbow into bars.

Fig. 1-a shows the 12 bars that key the rainbow signal. Fig. 1-b shows the color-bar pattern on the color picture tube. The bar colors are labeled. Remember especially the positions of the red bar, third, at 90°; blue bar, sixth, at 180°; and green, tenth, at 300°.

Note that, of the twelve bars in the signal, only ten appear as color bars on the TV screen. This is because two of them fall during overscan. They are hidden at the sides of the screen. One is on the back porch of the horizontal sync pulse and acts as the color-sync reference burst; it triggers the 3.58-MHz color oscillator in the receiver.

For servicing, you need a way to find out if a set can hold color on weak signals. For this, some generators have a control for reducing color-signal level without lowering the rf output. You turn the color level down to check for poor color sync. Tune the station selector off-channel and back several times. Color should lock in solid every time, without delay.

FIG. 1—KEYING GENERATOR'S OSCILLATOR on and off makes the bar signal at (a). Only ten bars show on the screen (b), two are lost in overscan.



You can turn the generator's color level up higher than normal to force stability while you troubleshoot a set you know has poor color sync. This gives you a constant signal level to work with in color-sync or automatic color control circuits. Without this strong input, the color-sync signals may fluctuate and you can't get a steady voltage or scope waveform to measure. Too, you can check how well the acc (automatic chroma control) handles signal variations.

In the color stages

Suppose you suspect a color amplifier. Inject the keyed-rainbow signal, on its rf carrier, into the antenna terminals of the TV set. You can spot a dead chroma stage or loss of gain readily. Just scope the waveforms at the input and output of each color amplifier stage.

But the solution isn't always that simple. You can find an inoperative color amplifier but still not know whether the fault is there or in the color killer. Improper bias from the killer may be cutting the amplifier off.

There's a way to find out. Fig. 2 illustrates. Connect the negative lead of a variable bias supply to point Q, positive lead to ground. Set the bias knob to 6 or 8 volts. There should be no color in the bar pattern on the picture tube. Turn the bias knob down until you're applying only 0.5 volt of negative bias to the grid of the first color amplifier. That should bring out a good strong display of color in the bars.

If decreasing artificial cutoff bias lets the color amplifier work, the cause for it not working must lie in the natural bias-voltage source. Color-amplifier bias comes from the acc/killer system. So that's where to look for the defect.

Color bars tell you more. From

their appearance, you can see if tuned circuits need alignment. Poor frequency response or unwanted phase shift in the color amplifier shows up as color trailing the bars. Color smears over to the right of whatever video information it belongs with, as Fig. 3 shows.

About hue

The hue control permits the viewer to refine the color demodulation angle so colors come out accurate on the screen. This is necessary because the phase of chroma signals can vary among different television stations.

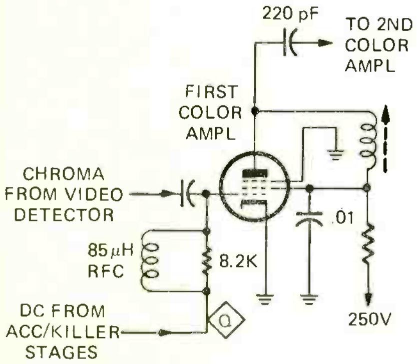


FIG. 2—USE VARIABLE DC SUPPLY to clamp the bias line of the color amplifier controlled by color killer. In this and similar Zeniths, bias goes to point Q.

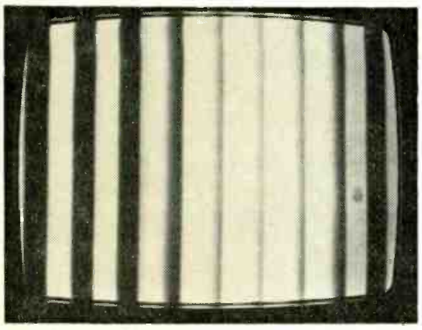


FIG. 3—THE SMEARS to the right of the bars are a result of color trailing video. This indicates a need for chroma alignment.

In some sets, controlling hue consists of manually altering the phase of the color reference burst before it reaches the color oscillator. In others, the control alters phase of the restored 3.58-MHz subcarrier itself. In occasional chassis, the control varies the phase of the chrominance sidebands before they are applied to the demodulators.

A keyed-rainbow generator has two uses here. One use: it can show if hues are about right when the hue control is at midposition. The bar colors should appear in the order labeled in Fig. 1-b. The red bar, remember, belongs at position 3.

Also, the generator lets you check whether the hue control shifts phase far enough for adequate hue range. Turning the hue knob back and forth moves the whole rainbow pattern to right and left. Twisting the control from one stop to the other should move the red color from bar 2 to bar 4. That's the minimum for suitable viewing, and will handle the hue variations of most stations and programs.

If the color-bar positions are not correct, afpc (automatic frequency and phase) adjustment is in order. Put the hue control exactly in midrange. Adjust the burst-amplifier plate coil (or whatever other adjustment the manufacturer says) until the red bar is in the number-3 position. If other bars are then out of sequence, hunt the cause in the demodulator section.

Keep in mind that an older generator may be slightly "off." Make it a practice to recheck the hue range on color programs from several different stations. Refine the hue phase until the set produces good skin tones on as many stations as possible with the hue knob near center.

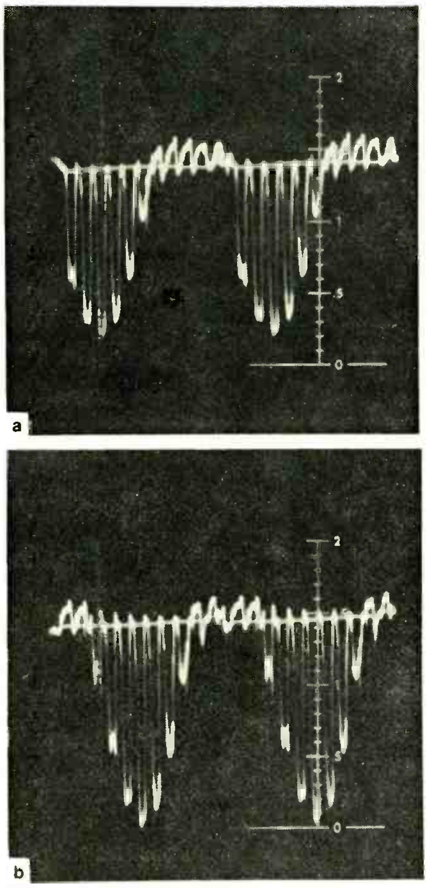


FIG. 4—SCOPE WAVEFORMS for color picture tube should have the third bar the most negative on the red grid (a) and the sixth bar the most negative on the blue grid (b).

3.58-MHz phasing

Many color sets operate with from 90° to 105° of phase difference between the two 3.58-MHz CW reference signals fed to the color demodulators. Phase shift between them is accomplished by feeding one signal through a coil or series of coils. Generally, the X or the R – Y demodulator gets the direct signal from the CW oscillator. The signal for the Z or the B – Y demodulator is shifted.

These two 3.58-MHz signals, separated by the phase shift, mix with chroma sidebands in the demodulators. One demodulator recovers R – Y. The phase of its CW signal forces that. The other recovers B – Y. The phase difference between the recovered color-difference signals must be accurate for the set, or hues won't be correct.

You can check the demodulator output phases by injecting a keyed-rainbow signal to the set. Attach a low-capacitance scope probe to the red grid of the picture tube. Adjust the hue control so the third bar goes furthest negative, downward from the waveform's zero reference line. Fig. 4-a shows how it should look on your scope.

Without changing the hue control, move the scope probe to the blue picture tube grid. Here, the sixth bar should be furthest negative (Fig. 4-b). If not, phase shift is wrong. The keyed-rainbow signal can be traced from the demodulators to find out why.

As an example, one RCA CTC28A chassis had all magenta color bars. Tracking was good on black-and-white, so the color difference amplifiers and the picture tube were apparently working OK. Presumably, one of the demodulators was not. New demodulator tubes didn't help.

The next step was to scope the red and blue picture-tube grids. Both grids had exactly the same waveforms, and that's not normal. The same thing was true at the R – Y and G – Y amplifiers, and at the outputs of the demodulators. The logical explanation was no phase shift between the two demodulators.

The circuit is shown in Fig. 5. Shorting phase-shift coil L703 with a clip lead made no change in the magenta bars. A new coil restored normal

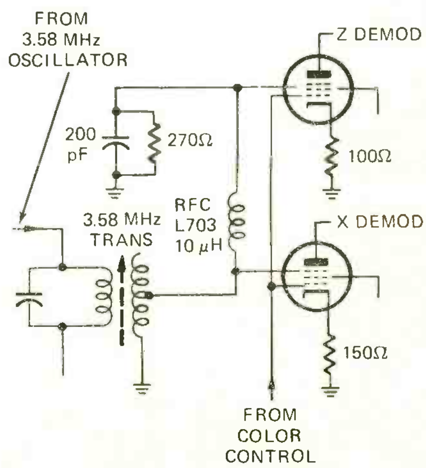


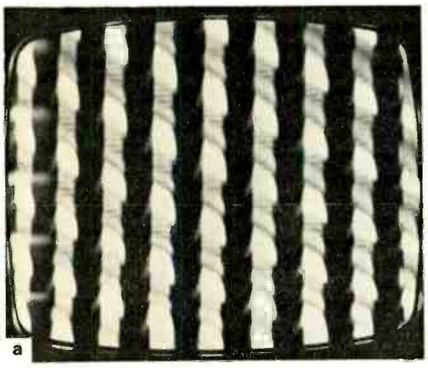
FIG. 5—COLOR DEMODULATORS are fed with a phase-shifted CW signal from the 3.58-MHz oscillator. Bad rf choke caused all-magenta bars on the receiver's screen.

colors for a satisfactory repair.

Integrated-circuit chroma demodulators, such as in recent Zenith chassis, may be checked by the same method. Connect the low-capacitance probe to the base of each video output transistor. You should find in the waveforms the phase difference described in Fig. 4.

Checking color lock

Color-sync problems can be diagnosed quickly with a keyed-rainbow generator. Lack of color sync makes color in the bars look like the stripes around a barber pole (Fig. 6-a). This is



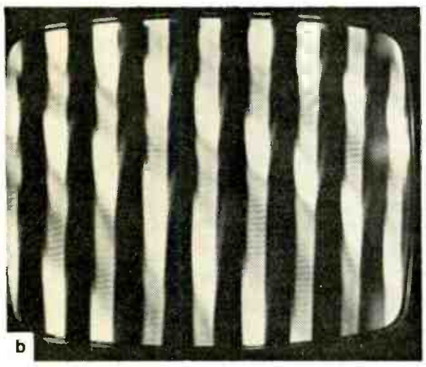


FIG. 6—BARBER-POLE EFFECT develops when color sync is lost. Colors are at angle to the upright bars. Frequency is away off in (a) and is almost right at (b).

because the phase difference between the set's own 3.58-MHz oscillator and the incoming offset subcarrier changes slower or faster than 360° per line. Many times, curing bad color sync only requires readjusting the set's color oscillator so it beats properly with the incoming color signal.

Connect the keyed-rainbow generator to the antenna terminals. Ground the grid circuit of the 3.58-MHz reactance control tube. Follow the manufacturer's instructions carefully for this procedure; it is easy to get misled. Adjust the oscillator plate coil until the colors stand still or float slowly "behind" the black bars. Try to make the color fill the bars from bottom to top and not in horizontal segments.

If you can't get zero beat, the barber-pole colors might continue to float rapidly through the bars. Look for a defective or off-value component in the oscillator circuit itself.

One set (Fig. 7) still had that problem after a technician had tried aligning the coils. He disabled the reactance tube by grounding point A. Adjusting the reactance plate coil should stop barber pole. In this set, it only slowed the barber pole down to about three diagonal stripes of color (Fig. 6-b). Since the oscillator could be brought that close to zero beat, the technician suspected the resonant circuit itself. Substituting a new 10-pF capacitor across the reactance coil cured the fault. The old capacitor was open.

If you can lock color near zero by

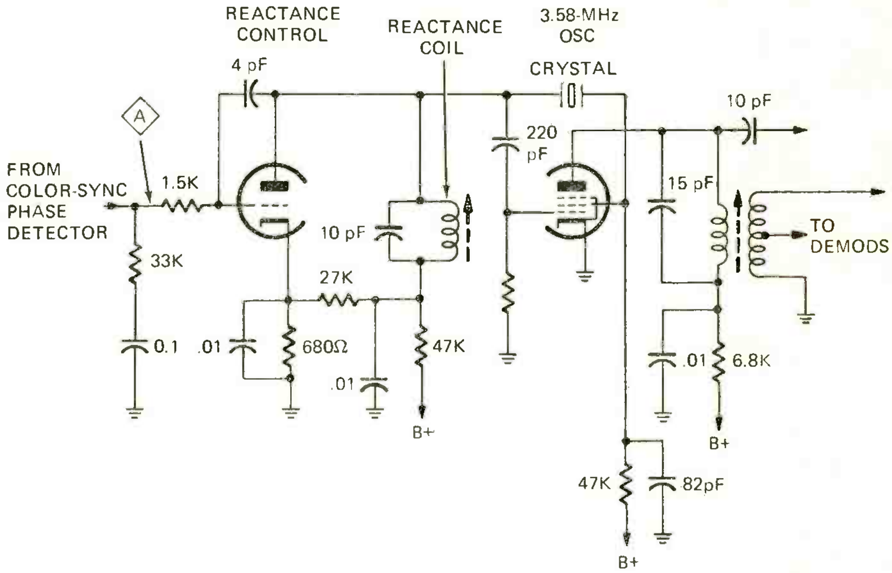


FIG. 7—COMMON COLOR-SYNC CIRCUIT uses reactance stage to lock CW oscillator on frequency. With point "A" grounded, reactance coil adjustment should pull frequency close to 3.58 MHz but leave it in a free-running state.

FIG. 8—PHASE DETECTOR compares signal from CW oscillator with incoming color sync. A phase difference causes diodes to develop an off-balance dc voltage to correct the oscillator through the reactance stage.

coil adjustment, then you know the 3.58-MHz oscillator operates in close phase relationship with the incoming signal. Look to the burst amplifier for defects. The color sync isn't locking the oscillator in solid.

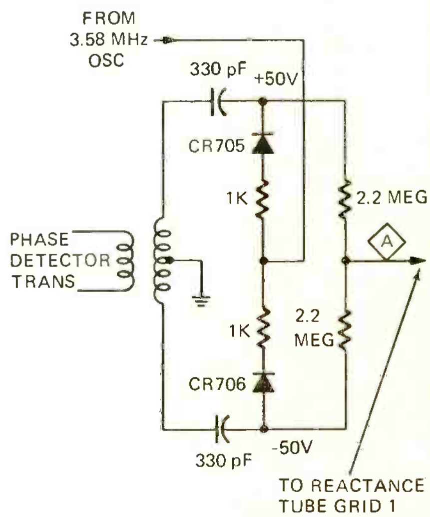
On a similar set, the customer complained of rolling color in the picture. The technician brought the oscillator to zero beat OK, but when he removed the ground from point A the color fell out of sync again. That pointed to trouble in the color-sync phase detector (Fig. 8).

Checking there with a vtvm revealed a positive 50 volts at the cathode of CR705. The anode of CR706 had only 30 volts negative. These voltages should be alike but of opposing polarities.

None of the resistors had changed value. Reversing the diode connections switched the voltages, but left them unbalanced. That pointed to the diodes. Replacing them with a new matched pair returned color sync to normal.

Color balance

The ratios between R – Y, B – Y, and G – Y signals are important. Most color hues in a scene are not primary colors but mixtures of all three. True colors (especially skin tones) demand a proper amplitude relationship among the three primary colors. Fig. 9 illustrates these relationships. With blue amplitude at 100%, red is about 85%, and green about 35%. Each varies with screen phosphors, but only slightly. You can connect up the rainbow generator



to produce the waveforms. Scope them at the grids of the picture tube.

Most service scopes measure peak-to-peak voltages. For an ordinary large-screen color tube, B – Y is around 140 volts p-p, R – Y about 120 volts p-p, and G – Y about 40 volts p-p.

Weak or missing blue, due perhaps to failure of the B – Y color-difference amplifier, leaves only red and green color bars on the screen. The left half is red, the right half is green. This might

(Continued on page 77)

OP-AMPS AT WORK
10 audio circuits

by B. R. ROGEN

WHEN THE OUTPUT OF AN OP AMP is directly proportional to the input, it is operating in a linear mode. And, we have learned in these past articles, that by selecting the feedback network judiciously, we can make the op amp do almost anything that we want it to. We are now going to apply some of our basic op amp know-how to various types of audio circuits, where the op amp can be used to make a low-component-count, almost noise-free, and better circuit than one of discrete semiconductor types.

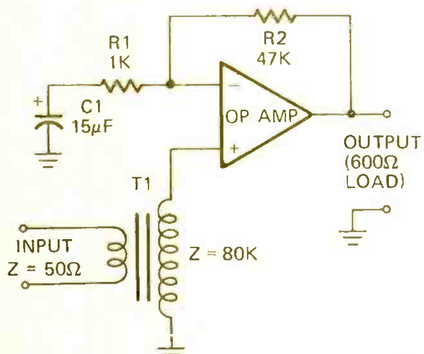


FIG. 1—THE BASIC LINEAR CIRCUIT, used here as a microphone-to-line preamplifier.

A basic linear amplifier such as that shown in Fig. 1 will make a good start. In this circuit, input transformer T1 steps up the voltage from the microphone by a factor of 40. This approach reduces the overall noise because the noise is the product of the transformer plus amplifier noise divided by the noise of the transformer. The amplifier overall gain is determined by (R1R2)/(R1 + R2) remembering that capacitor C1 acts as an almost perfect audio bypass. In fact, the low-end 3-dB point is determined by R1 and C1 to produce a 10 Hz rolloff. The gain of the amplifier shown is approximately 1,000 (60 dB). The same circuit may be used as a variable-reluctance cartridge amplifier simply by connecting the cartridge between the non-inverting (plus) input of the op amp and ground. You can also connect a dynamic microphone in the same fashion.

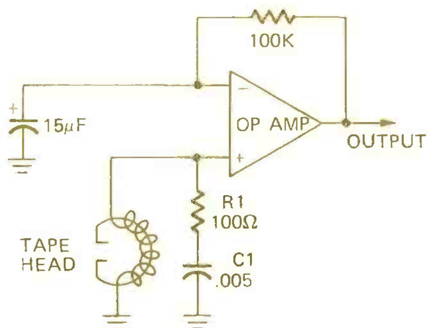


FIG. 2—A TAPE HEAD PREAMPLIFIER.

A low-noise high-quality tape-head preamplifier, appears in Fig. 2. Here the tape head is connected between the non-inverting input and ground. To remove any tendency for the tape head to self-oscillate, R1 and C1 (which do not affect the frequency response) have been added. To get the maximum gain from the op amp, the resistor at the inverting (−) input is removed, and the op amp operates at full gain.

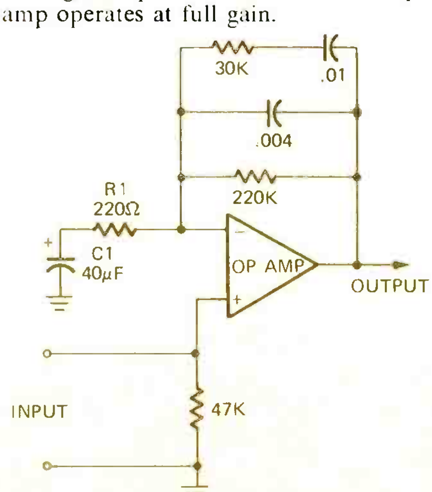


FIG. 3—RIAA DISC RECORD EQUALIZER.

An RIAA equalization preamplifier is shown in Fig. 3. The low-frequency break point is determined by R1 and C1 to produce a 6-dB per octave shelving off below 20 Hz. The feedback network around the op amp has a break frequency of 50 Hz going down at 6 dB per octave to about 2 kHz, where the circuit takes over and flattens out the curve until about 30 kHz where it once again shelves off at about 6 dB per octave. If you want a non-critical, yet good version, use a .005-μF capacitor in parallel with a 220,000-ohm resistor as the total feedback network.

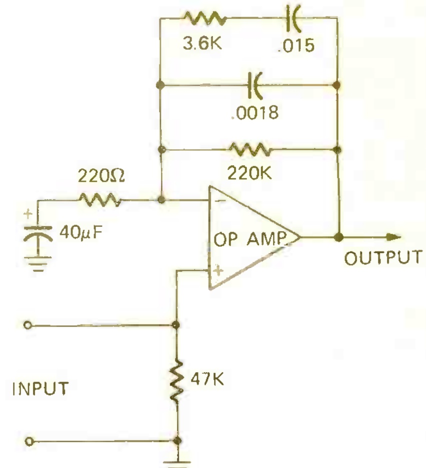


FIG. 4—NAB EQUALIZER, FOR TAPES.

The NAB tape equalizer in Fig. 4 is very similar to the RIAA equalizer except for the feedback network. In this case, the low-frequency break point is about 20 Hz, and the first upper break is at 50 Hz where the amplitude starts dropping at 6 dB per octave to 500 Hz.

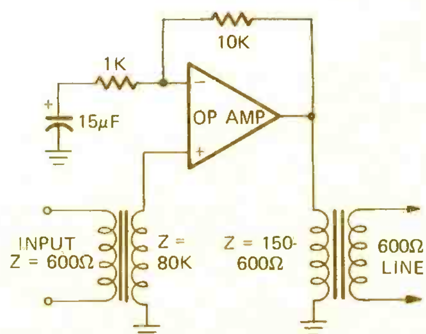
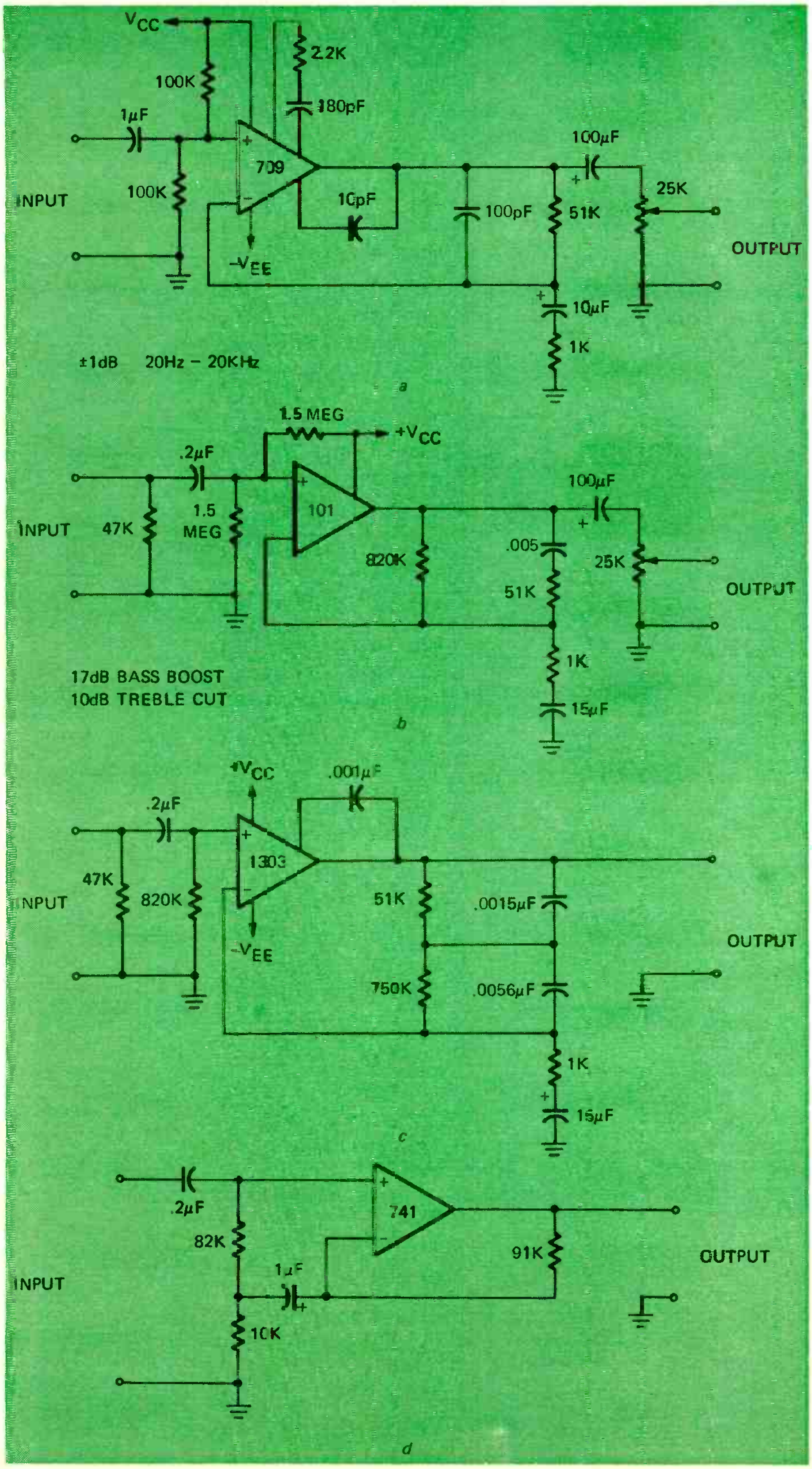


FIG. 5—LINE DRIVER (600-600 ohms).

There's a tape head preamp; an RIAA disc record equalizer; a line driver; a mike preamp; a crystal cartridge preamp; a unique tone-control circuit and five others



At this point the gain remains constant till 2 kHz, then drops at 6 dB per octave. Like the RIAA circuit, if you want a non-critical use, substitute a .002-µF capacitor in parallel with a 220,000-ohm resistor as the total feedback network.

To drive an audio line of the standard 600-ohm), use the line driver in Fig. 5. The circuit should be familiar. If you want to increase the output level, make the primary of the output transformer about 150 ohms.

A group of audio op amp circuits appears in Fig. 6. In **a** is shown a microphone preamplifer with a flat response from 20 Hz to 20 kHz; **b** shows a tape-head preamplifier having the required frequency tailoring; **c** illustrates a compensated magnetic cartridge pre-

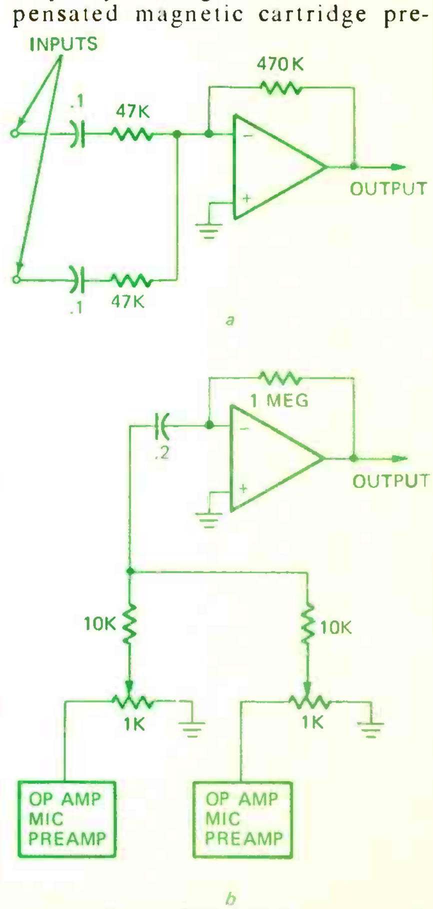


FIG. 7—(above) TWO AUDIO MIXING CIRCUITS. 7-a is a simple audio mixer; 7-b combines a number of the mike amplifiers of Fig. 1.

FIG. 6—(left) OP AMP AUDIO CIRCUITRY. a—mike preamp flat from 20 Hz to 20 kHz; b—an equalized tape head amplifier; c—a compensated magnetic cartridge preamp; d—a high-impedance preamplifier for use with a crystal cartridge.

amplifier, while **d** shows a high input impedance preamp for a crystal cartridge. Note that other than the 709 can be used in audio circuits.

To mix a bunch of audio signals, Fig. 7 shows a couple of approaches. In **a**, a number of inputs can be fed to a single op amp where they will all be combined. In **b**, a large number of op amp mike amplifiers (see elsewhere in this article) can be coupled to an op amp mixer or summer. The summer op amp can be operated with gain, unity gain, or less-than-1 gain, depending on the feedback resistor. The coupling capacitor removes any dc offset that might be present from any of the amplifier op amps.

Unique Tone Control, In the usual bass and treble controls found in audio systems, the maximum benefit is at the ends of the audio spectrum. When using either the bass or treble control, you have no control over just where in the spectrum you want the boost or cut. The circuit shown in Fig. 8 is unique in that you can rig the bass and treble cut and boost controls so that you can not only control how much boost or cut, but pretty much call the turnover frequency. This is a form of graphic equalizer circuit and can be used (for example) to boost only the low frequencies *below* the point at which the speaker falls off. It also makes an excellent "presence" filter, or can be used to set up almost any type of frequency response curve you want without the ringing associated with a number of equalizers.

The circuit uses four filters, each having its own control with the cut filters positioned before the op amp, and the boost filters in the op amp feedback circuit. Each controls the 3-dB frequency of a 6-dB-per-octave slope in accordance with the name of the control. For example; as greater treble boost is brought in, with all other controls flat, the 6-dB-per-octave treble boost curve is brought down in frequency. In this way, you could start the treble boost at 5 kHz and have 12 dB boost at 20 kHz, or start at 500 Hz and get about 36 dB of boost at 20 kHz. You can then bring in the treble cut as desired, and where the two curves meet and pass over each other, the result is a flat curve which can be shifted up and down the spectrum as desired. The bass controls act the same way but at the low end of the spectrum. Because of the low input impedance of the cut filters, an emitter follower is used to drive the op amp. If you run a frequency response test, any slight "bumps" at the end of the spectrum can possibly be reduced by changing the value of the 270-ohm resistor of the filter coming from the output of the op amp.

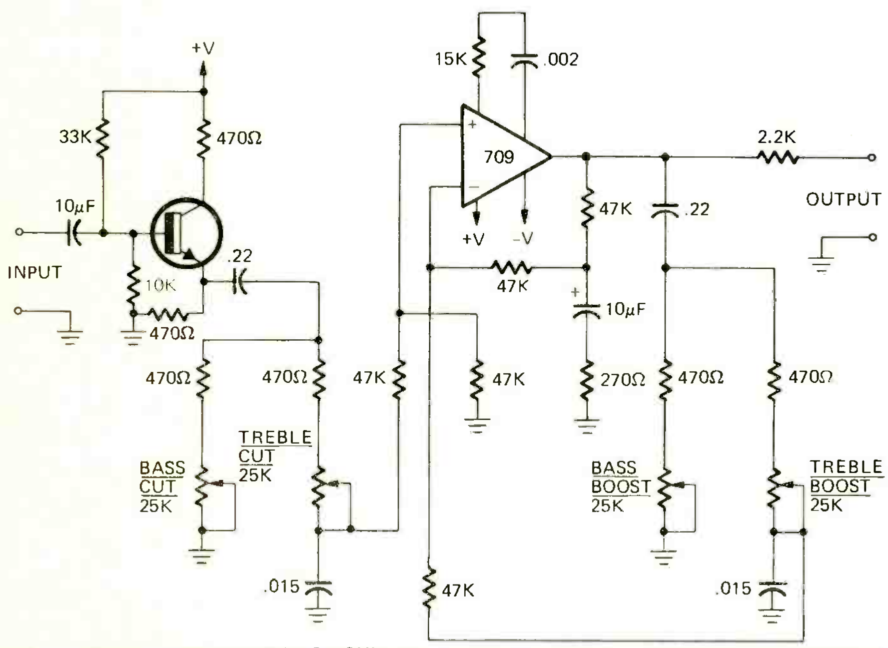


FIG. 8—UNIQUE TONE-CONTROL CIRCUIT gives you four separate tone controls for maximum versitility. Each tone control affects a different part of the response curve.

Once you get used to the idea of having *four* tone controls, you might find this circuit far more useful than any other tone control you have encountered in the past.

Such a circuit would be difficult to mechanize using discrete components, as the amplifier must deliver at least 36 dB of gain across the spectrum. **R-E**

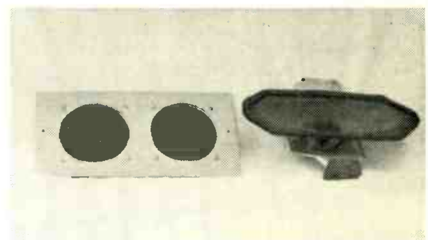
MORE TO COME

We will be presenting three more articles on op-amp uses. One will cover biomedical circuits; the second will describe an assortment of active-filter circuits; and the third is a roundup of "oddball" op-amp uses. Don't miss them.

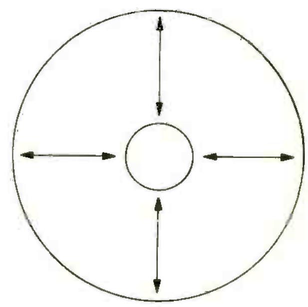
AUTO RADIO SPEAKER REPLACEMENT

Automobile speakers mounted face up either in the dash or the rear deck are particularly susceptible to deterioration. Temperature and moisture extremes are rough on these speakers, especially if the speaker has an oval-shaped cone, as most of them do.

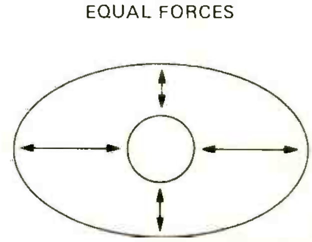
What usually happens under these conditions is that the voice coil is pulled out of round by the oval speaker cone. Expansion and contraction produces unequal forces on the voice coil assembly as shown in the drawing. The solution, of course, is to use a round replacement speaker to keep physical distortion of the voice coil at a minimum.



Better yet, use *two* round speakers to fill the speaker opening. You will have to make a speaker baffle out of cardboard or thin plywood as shown in the photo and in some cases exercise a little ingenuity in mounting the new speaker assembly, but the trouble-free service is well worth the effort.



EQUAL FORCES



UNEQUAL FORCES

For a nominal load impedance of 3 or 4 ohms use two 8-ohm speakers in parallel. For a nominal load impedance of 6–8 ohms use two 3- or four-ohm speakers in series. The load impedance requirements are not critical. Two 4- or 5-inch speakers will serve as a replacement for the usual 5x7-inch speaker.—*F. J. Bauer* **R-E**

the state of SOLID STATE

Christmas shopping suggestions, circuits from readers, a dvm on a chip, and device/product news of new IC's and semiconductors

by LOU GARNER
SEMICONDUCTOR EDITOR

THE HOLIDAY SEASON BRINGS WITH IT the usually pleasant, but sometimes frustrating, chore of choosing gifts for one's relatives, friends, neighbors, business associates, and, if a student, school chums. Of course, when it comes to giving, some people stop at nothing, but if you'd like to do better than that, you might consider solid-state-operated products for your gift list. Using the catalogs issued by the larger electronics distributors as guides, it is possible to select gifts for almost everyone at virtually every price level.

For our purposes, we like to use the catalogs published by *Radio Shack* (2725 West 7th St., Fort Worth, Texas 76107); *Lafayette Radio Electronics* (111 Jericho Turnpike, Syosset, L. I., N.Y. 11791); *Olson Electronics* (260 S. Forge St., Akron, Ohio 44327); and the *Heath Company* (Benton Harbor, Mich. 49022).

Stuck for an "under \$5.00" gift? An AM transistor radio is almost always a good choice. All the catalogs offer receivers in this bracket. If you'd like to add a truly personal touch to your gift, however, you might assemble a reading or table lamp for that special someone using a solid-state lamp dimmer socket. This inexpensive (under \$5) device features a compact triac circuit and continuous control via a miniature potentiometer, and can be used either for new lamp construction (use an interesting wine bottle, varnished block of wood, or whatever strikes your fancy as a base) or for replacement of an old-fashioned switch type socket.

If your intended recipient is a subteen who's a budding scientist or engineer, you could select one of Radio Shack's *Science Fair* kits. Ranging in price from less than two dollars to \$24.95 for a 100-in-1 Electronic Project Kit featuring an integrated circuit, these kits are suitable for hobbyists into their teens. Similar items are available from the other catalogs.

Perhaps you'd prefer something a little more difficult for the more sophisticated experimenter who would rather "roll his own" project, but still within a limited budget? Then you might consider one of the solid-state experimenter's modules. Offered at prices from as little as \$1.49 for a guitar amplifier, wireless code oscillator, or guitar tremolo module to as much \$5.00 for various shortwave and vhf converter modules, these encapsulated circuit elements are used with external accessories such as telegraph keys, batteries, loudspeakers, microphones, potentiometers, and switches to assemble complete functioning projects. The builder can exercise his imagination and skill in selecting a suitable housing and creating his final design.

If you can afford to spend up to twenty dollars for each gift, your choice widens considerably. An FM wireless microphone is a good "fun" gift at about \$20.00, or you might choose a portable solid-state cassette recorder in the same price range. A thoughtful family gift would be a Disaster Alarm Kit. This instrument can be a real life-saver. Featuring a gas-sensing semiconductor device, the Disaster Alarm will respond to isobutane, methane, or other ionized gases, even smoke, alerting the household with a loud buzzer alarm. If your intended recipient is interested in automobiles, or simply owns one, consider an Automobile Alarm System Kit (about \$15), an Automatic Windshield Wiper Delay Control Kit (about \$15) or a solid-state tachometer.

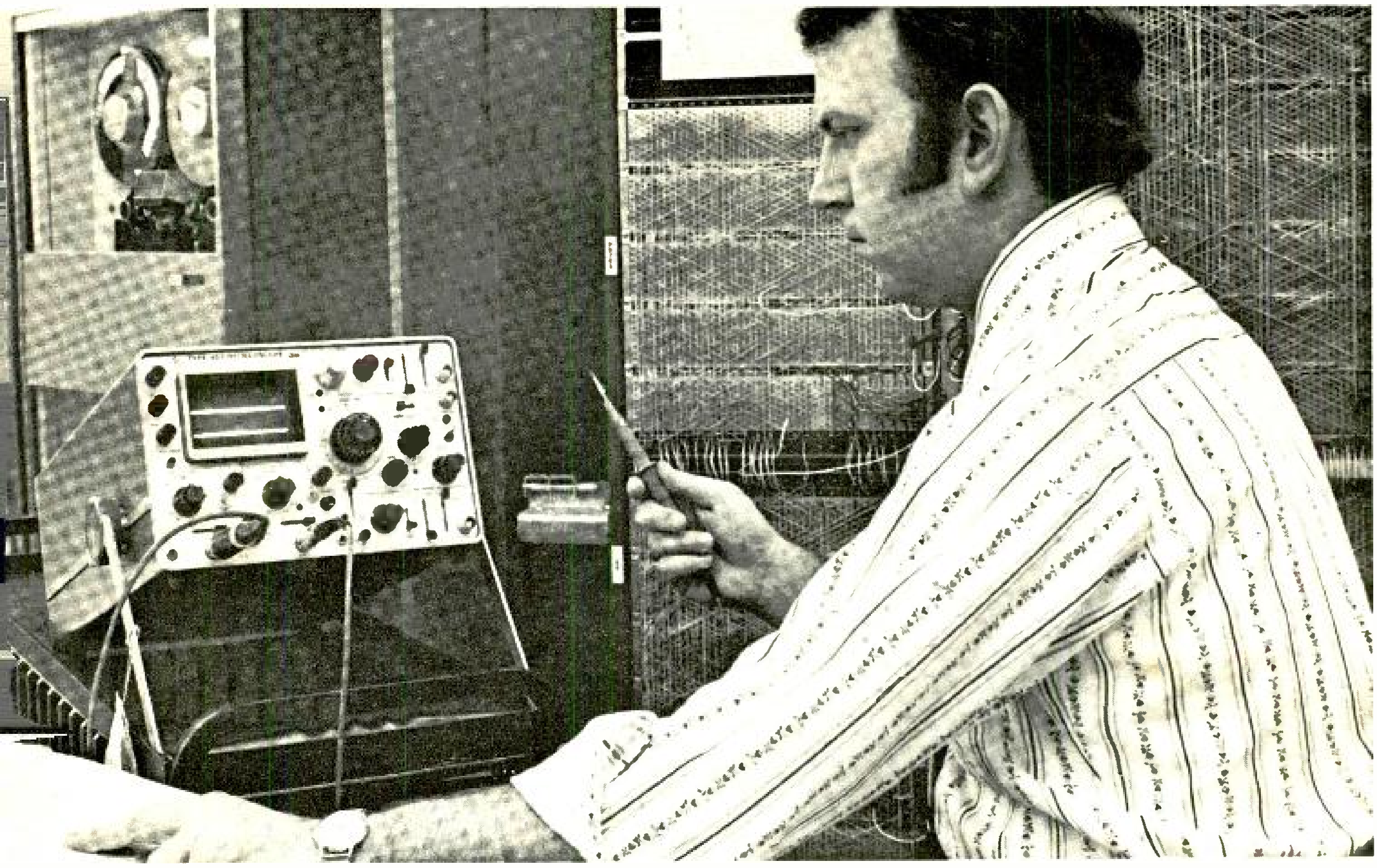
With the next bracket—gifts up to fifty dollars—you should be able to find something to please almost everyone, even the legendary person who "has everything." For the outdoorsman, you might choose a sensitive metal detector (about \$35). Your hobbyist friends undoubtedly would appreciate a variable dc power supply capable of furnishing from 0 to 24 volts at currents of up to 1 ampere (about \$30).

We can't think of anyone who would refuse an all solid-state FM/AM/police/aircraft receiver (about \$50). If you're looking for a family gift, then you might take note of the rising crime rate and present your favorite family with a Security System (\$40 and up). Another good under fifty choice, which should be welcomed by travellers and stay-at-homes alike, would be an FM/AM travel clock radio.

Should your financial resources be large and your heart generous, your only considerations need be the interests and desires of your intended recipient—you might give a complete high-quality stereo system, for example, a solid-state color TV receiver, or even a video tape recording system. At a more modest level, however, our personal choice of gifts between, say, fifty and one hundred and fifty dollars would be either of two new state-of-the-art products . . . a compact cassette tape recorder or a pocket-sized portable electronic calculator. Either gift should be suitable for students, housewives, authors, storekeepers, engineers, technicians, salesmen, scientists, architects, accountants, or business or professional men and women—anyone, in fact, who may have occasion to make verbal notes and lists, to conduct interviews, or to perform mathematical calculations, whether totalling a grocery bill, determining income tax liability, figuring installment payments, or designing a machine, building, road, bridge, or electronic circuit.

Regardless of which gifts you choose, remember that your care in picking the item best suited to your re-

(continued on page 66)



STATE OF SOLID STATE
(continued from page 61)

cipient's interests and desires is more important than the gift's cash value.

All prices quoted are from current catalogs. Mailing costs, local or state sales taxes, and optional accessories are extra.

Our readers respond

We've received letters from a number of readers expressing interest in the complementary amplifier/oscillator circuit described in our September column. Most of the letters described adaptations and modifications of the basic design for specialized applications. Two of the more interesting circuits are illustrated.

Joe DeRosa (365 Willow Ave., Long Branch, N.J. 07740) submitted the electronic siren circuit shown in Fig. 1.

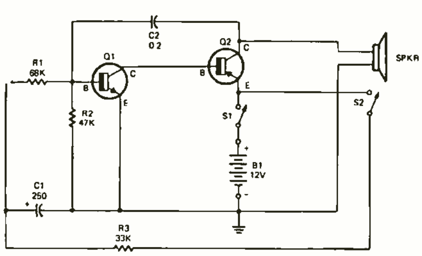


FIG. 1—SIMPLE SOLID STATE SIREN CIRCUIT suggested by reader Joe DeRosa.

He writes that he developed it as an inexpensive substitute for an electromechanical siren in an automotive burglar alarm system used in a friend's car. He assembled his model on perf-board and encapsulated it in epoxy for maximum protection.

Referring to the schematic, Joe's principal modification of the basic design is the addition of an RC circuit (R1-R2-R3-C1) to vary Q1's base bias in accordance with the changing instantaneous voltage of a charging capacitor, thus causing a corresponding change in the circuit's repetition rate (frequency) and simulating the changing pitch characteristic of a siren.

Joe used standard components in his design. Q1 is a general purpose *npn* small signal transistor, while Q2 is a *pnp* power type. All resistors are half-watt units. C1 is a 250-μF 15-volt electrolytic, C2 a 0.2-μF low-voltage ceramic or Mylar capacitor. An 8-ohm PM loudspeaker is used. Spst switch S1 serves as the master power switch, while S2 is used to initiate siren operation. The power supply, B1, may be either a car's 12-volt battery or, for other applications, a power pack made up of eight series-wired flashlight cells or two 6-volt lantern batteries.

In a letter commenting on the amplifier version of the original complementary circuit, reader Reinhard Metz (9 S. 705 Barkdoll Rd., Naperville, Ill. 60540) has observed—correctly—that the basic design has low input impedance, poor temperature stability, and is intolerant of slight overloads, despite its extreme simplicity, high output impedance, and very high gain characteristics. These shortcomings can be overcome quite easily, however, albeit at some loss of gain, by providing stabilized base bias and adding inverse feedback. Reinhard suggests the modified circuit given in Fig. 2 for more critical applications, indicating he has used it a number of times as a line, tape, or tone control driver in audio systems.

In operation, divider R1-R2, in conjunction with tapped emitter resistor R4-R5, stabilizes Q1's base bias. Inverse feedback is provided by the unbypassed emitter resistor, while R3 serves to stabilize Q2's base bias. C1 and C2 serve simply as dc blocking capacitors.

For practical applications, Reinhard suggests type 2N3645 for Q1, type 2N6008 for Q2. The resistors are half-watt types and C1 and C2 25 to 50 volt electrolytics, with a 25 to 50 volt dc power supply (B1) used, controlled by spst switch S1.

According to reader Reinhard, his tests, made with high-quality laboratory equipment, indicate that the specified circuit has a virtually flat frequency response to 500 kHz and a total harmonic distortion of less than 0.05%, while furnishing a voltage gain of approximately 10 and relatively high input impedance.

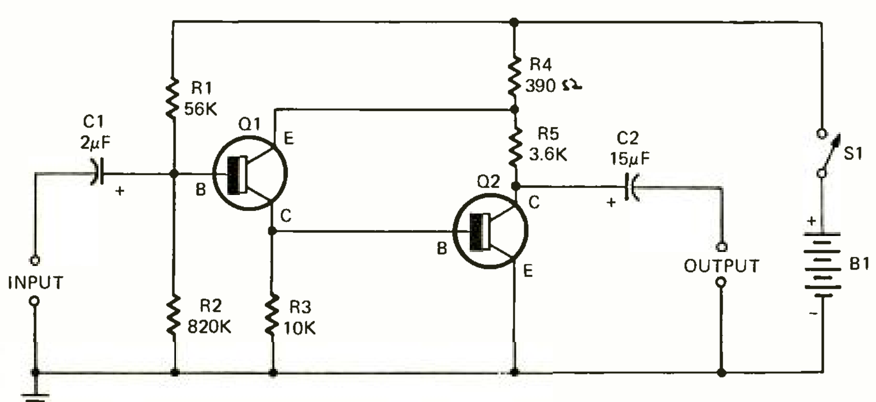


FIG. 2—STABILIZED COMPLEMENTARY AMPLIFIER circuit submitted by reader Reinhard Metz.

He recommends it for both preamp and line driver applications.

Device/product news

A new line of low-cost hybrid IC uhf/vhf broadband amplifiers has been introduced by the Amperex Electronic Corporation (Solid State & Active Devices Division, Slatersville, R.I. 02876). Designed for MATV/CATV systems, the devices are intended for use in antenna amplifiers and signal processors, but can be employed wherever a design calls for high gain and low distortion between 40 and 890 MHz. Four types are currently available. The ATF415 and ATF419 deliver 16 dB gain ± 1 dB between 40 and 890 MHz, with a VSWR of 2.0 at the input and 1.8 at the output. Noise figure of the ATF415 is only 4 dB; output is 30 mV at -60 dB intermodulation distortion. The ATF419 has a rated noise figure of 6 dB, with an output of 60 mV at -60 dB intermodulation distortion. Type ATF417 is a high-gain device, furnishing 26 dB ± 1 dB gain from 40 to 890 MHz; its noise figure is 4 dB; VSWR is 2.0 at the input and 1.8 at the output. Finally, the ATF414, illustrated in Fig. 3, offers an

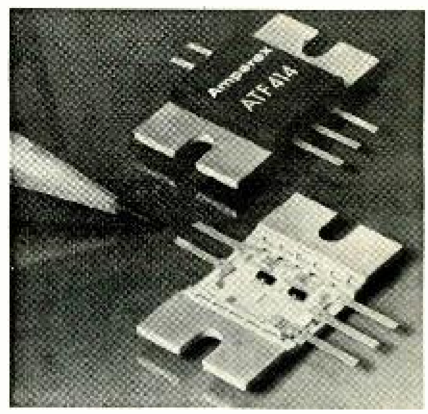


FIG. 3—NEW HYBRID IC UHF/VHF AMPLIFIERS introduced by Amperex for MATV/CATV applications.

extremely flat gain of 15 ± 0.5 dB over the same frequency range; its noise figure is 7 dB with a VSWR of 1.5 at both input and output. As shown, the ATF414 is packaged on a small metal heat sink, while the other three devices are offered in plastic encapsulations. All four devices are intended for operation on a standard 24-volt dc supply and have a rated operational temperature range from -25°C to 70°C.

DVM on a chip

A complete digital voltmeter on a single IC chip? Not quite, but almost. Fairchild's Semiconductor Components Group (464 Ellis St., Mountain View, CA 94040) is now producing a MOS IC that combines all the logic functions of a 4.5-decade DVM in a single array. Designated type A7R 3814 19X, the new device operates from dc to 600

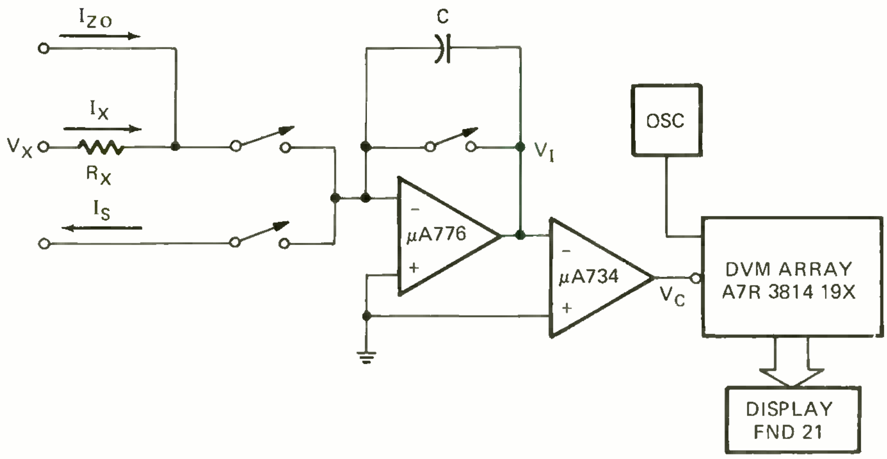


FIG. 4—SIMPLIFIED SCHEMATIC ILLUSTRATEING use of Fairchild's 3814 DVM logic array in a digital voltmeter.

MHz and interfaces directly with TTL logic. All that's needed to assemble a DVM with the 3814 are a couple of amplifiers, an oscillator, a multiplex display module such as the FND 21, a few resistors and capacitors, a couple of switches, and a suitable dc power supply. A simplified schematic of a DVM using the 3814 is given in Fig. 4; more complete details are furnished in the Application Note and data sheets.

Special translation circuits are needed in any system composed of differing logic families, such as a computer and its peripheral equipment (see Fig. 5), to convert back and forth between

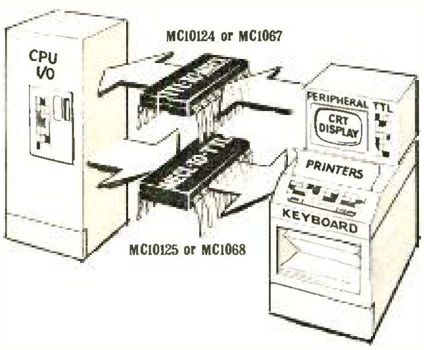


FIG. 5—AS SHOWN HERE, MOTOROLA'S NEW logic translator IC's can be used to interface between TTL and MECL systems.

differing voltage and current levels. Recognizing this, Motorola Semiconductor Products, Inc. (P.O. Box 20912, Phoenix, Ariz. 85036) has introduced a series of four new IC devices designed to serve as translators between TTL and MECL logic families. Types MC10124 and MC10125 are intended for interface between TTL and the MECL 10,000 Series systems, while types MC1067/1267 and MC1068/1268 are specified for corresponding applications between TTL and MECL II Series families. Types MC10124 and MC1067/1267 are designed as TTL in, MECL out translators; types MC10125 and MC1068/1268 are MECL in, TTL out translators. All four devices are supplied in 16-pin dual in-line packages.

More *good news* from RCA's Solid State Division (Route 202, Somerville, NJ 08876). Last month, you may recall, we announced joyfully that RCA had reduced prices on its entire line of commercial COS/MOS IC's. Our friends in Jersey have now topped themselves by announcing corresponding reductions in the prices of some 16 types of linear IC's, including such popular units as the CA3085 positive voltage regulator, CA3741CT high-gain operational amplifier, and CA3060E operational amplifier array.

Down south, the good guys at Texas Instruments, Inc. (P.O. Box 5012, M/S 308, Dallas, Tex. 75222) have introduced a number of new IC's, including two new TTL hex and quad Schmitt-trigger devices and a pair of TTL quad bus buffer gates. The Schmitt-trigger IC's are designed specifically for interface between unsuitable input waveforms and TTL inputs, while the quad bus buffer gates (Fig. 6) are in-

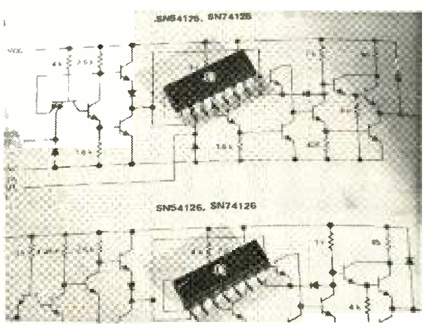


FIG. 6—NEW TTL QUAD BUS BUFFER GATE IC's recently introduced by Texas Instruments.

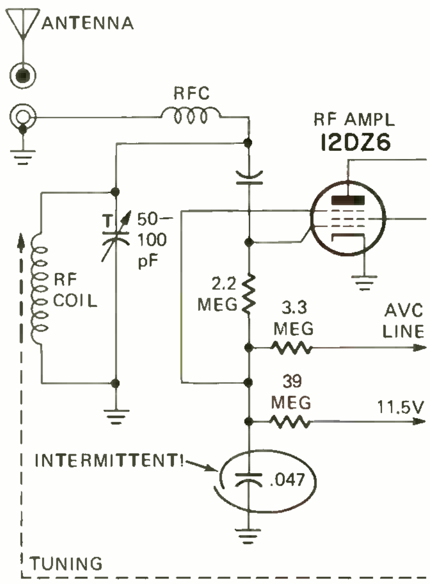
tended for interfacing directly with the data-bus in a bus-organized system. All four devices are supplied in standard 14-pin DIPs. The hex Schmitt trigger, designated type SN54/7414, features six interface circuits in a single package, each having a typical delay time of only 15 nanoseconds and a dissipation of but 25 mW. With similar delay times and dissipation ratings, the quad Schmitt trigger, type SN54/74132, provides four 2-input NAND interface circuits. The quad bus buffer gates, types SN54/74125 and SN54/74126, feature tri-state outputs which can be enabled or disabled individually by separate control inputs; with the exception of this control, each circuit is simply a non-inverting data buffer for use between standard TTL outputs and a system bus. The output of the 125 is enabled when the control input is low, the 126 when its control is high; conversely, opposite logic levels disable the respective outputs.

That covers the solid state story for December—now you can relax and have fun—**HAPPY HOLIDAYS!!!** **R-E**

CHEVROLET 985159, 985315

This car radio developed an annoying intermittent after playing normally for about ten minutes-less on a hot day. It would suddenly get very loud and distorted. The first attempt at diagnosis was negative; the problem would not repeat on the bench, even with heat applied from a hair dryer.

Months later, as the problem occurred more and more frequently, the set was pulled into the shop again. This



time, persistent testing with a voltmeter and futile replacement of a couple of resistors finally revealed an intermittent short in C3, the avc filter capacitor in the rf amplifier circuit. Replacement cured the problem.

The symptom of loud, distorted output was never duplicated on the bench because the short indoor antenna used did not provide as large a signal as the radio received in the car.–*Donald R. Hicke* **R-E**

R-E's Service Clinic

Troubleshooting problem—unexpected

Wattless current produces bugs in old trouble-shooting kink

by JACK DARR
SERVICE EDITOR

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

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

QUITE A LONG TIME AGO, I "INVENTED" an emergency wattmeter. I used this in a couple of books, and many articles. It consists of a 1-ohm resistor with an ac voltmeter hooked across it. Connect this in the primary of the ac power supply and it will indicate 1 volt for each 1 ampere of current. Theoretically, this is an *Automatic Ohm's Law Calculator.*

If you know the current, you can easily figure the wattage by multiplying by the line voltage. I tried it out on my bench on several different kinds of equipment and found it worked very well. For a check, I compared the readings against my pet wattmeter fed through an isolation transformer. It checked very closely.

However, I got a letter a few weeks ago from a reader, giving me fits because my "wattmeter" didn't work. He had used it in another one of my pet tests, for shorts in power transformers. This consists of disconnecting all loads from the transformer, then plugging it into a wattmeter. If the transformer is good, you'll see only a very small reading, about 3 to 4 watts. This is the iron-loss of the transformer. If it has a shorted turn, you'll get a high reading, usually from 50 watts on up.

The irate reader claimed that he had tried this out on a large guitar-amplifier transformer, and it showed him a reading of 35 watts. So, he ordered a new transformer. Before installation, he checked this one, and it too showed him a 35-watt reading. (The problem turned out to be a leaky filter capacitor.) This is neither here nor there, in relation to this problem, of course.

So I rushed to the shop, got out a couple of old power transformers from the junkbox, and proceeded to run some tests. No-load current on the professional wattmeter showed the right answer. Practically no reading at all. Checking the same transformer on the resistor/voltmeter setup *did show a much higher reading!* On an old Philco TV power transformer with about 3 inches of iron, I got a reading of 0.62 V. Figuring this out, it is the equivalent of 74.4 watts! Another power transformer showed a reading of 0.3 volts, or 36 watts.

Oh, oh! Something *is* wrong, but what? The answer finally dawned on me. The professional wattmeter is a dynamometer movement, or a "true wattmeter." It has two coils; a current coil and a voltage coil, plus a resistor. The resistor helps to correct for any reactance; so this type of instrument will read the actual power drawn, without regard for its power factor.

The resistor-voltmeter setup is apparently being upset by the fact that an *unloaded* transformer primary winding is acting as a more or less "pure inductance." So it causes a phase shift between voltage and current, and the resistor-voltmeter wattmeter is reading what someone called "wattless current." (Current out of phase with voltage.) This is causing the voltmeter to show a reading.

Further checks, and many, many tests in the past, show that a power transformer *under load* shows the same reading with either instrument. The loading of the primary brings the voltage and current back to an in-phase condition. Tests on pure resistive loads showed exactly the same readings on both meters. Incandescent lamps, soldering irons, heating elements, and so on: all matched.

So I came to the conclusion that this one test—the no-load transformer check, was the only one where the resistor-voltmeter setup was in error; or any test where the current through a pure inductance must be measured, of course. Actual testing seems to bear this out.

So, if you're using this test, with the resistor-voltmeter wattmeter, remember this. On an unloaded, *unshorted* power transformer primary, your reading will be high. Higher than it ought to be, that is. If the transformer *is* shorted, you'll be able to tell, very easily. You'll get a full-scale reading of several volts, or many, many watts, a definite indication of trouble. Just for luck, you might check a couple of new power transformers and see what the reading is. As an average, this will be dependent on the thickness of the iron core. On the old, heavy power transformers, you'll probably see readings of 40 to 60 watts or more, due to the greater iron-loss. On the typical power transformer, it'll run somewhere around 30-40 watts.

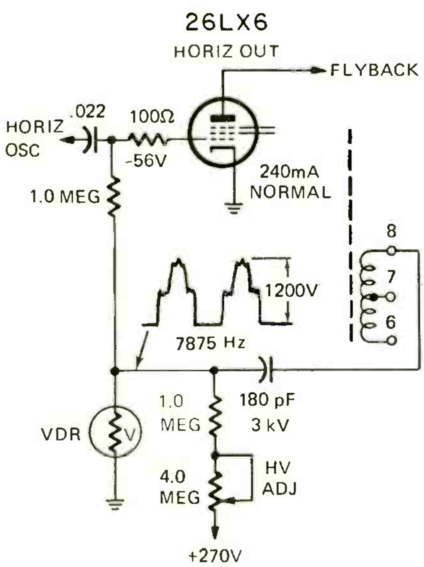
There's a double-check you can always make on a suspected power transformer. Just plug it in, and let it sit there for about 10 minutes. If it's shorted, it will get very hot. A good transformer will be barely above room temperature.

My sincere thanks to the alert Irate Reader who spotted this for me. Because I do have the built-in bench wattmeter, I had never tried this one test with the resistor-voltmeter setup. Never occurred to me. However, with my customary perfect 20-20 hindsight, now I can see the reason for it. **R-E**

reader questions

POOR HIGH-VOLTAGE REGULATION

I seem to have a high-voltage regulation problem in this Zenith 19CC19 color TV chassis. The raster blooms when the brightness control is turned, the high voltage fluctuates from about 16 kV to 27 kV at the same time, and everything is messed up in general. The HV ADJUST



control has some effect, but the regulation is very bad. I don't see any high-voltage regulator in this one.—F.D., Ames, Okla.

There is no high-voltage regulator, of the type we're used to, in this circuit. They use a "rectified-pulse" system, that takes a 1200-volt pulse from the flyback, and feeds it to a network consisting of a VDR, with a "bucking-voltage from the +270 volt source (see diagram). This controls the grid bias, and so the conduction, of the horizontal output tube.

Check at the junction of the pulse-coupling capacitor, a 180-pF unit connected to No. 8 on the flyback, and the VDR. Be sure that the pulse is present, at the correct amplitude. (By the way, there's a typo in the factory service manual. This pulse is shown as waveform No. 54, at 500 volts peak-to-peak. It should be the same shape as waveforms 19 and 20, but at 1200 volts peak-to-peak.

You could have one of two problems in this case. The 4.0-megohm high-voltage adjustment control could be open, or the VDR could be open. Disconnect the control and check it. If the bucking voltage is not present from B+, which acts to clamp this bias voltage, you'll get wild fluctuations. To check the VDR, lift the ground end and connect a milliammeter in series. Vary voltage (HV ADJUST) and see if you get about 1.0 to 1.5 mA current; if so, OK.

VERY SLOW HEATER

I've a TV set with a set of really odd symptoms. Everything seems to be OK, but no high voltage. I went off and left it running with the high-voltage meter hooked up, and in about 15 minutes it

started up. In about 2 hours it had gotten up to 5 kV. Later on, it came up a little faster.

Now, I can get a fair picture by running the ac line voltage up to 125 volts, but it still takes about 20 minutes to warm up.—L.F., Poughkeepsie, N.Y.

I'll tell you the exact truth; I haven't the faintest idea. However, you can get a good deal of information by reading the cathode current of the 6JE6. If it is very low at first, and gradually rises, this would indicate some problem in the dc voltages on the tube. A slow-heating damper tube could also do it; or an open (intermittent or thermal) boost capacitor.

This cathode current will be the key clue. Check it.

"FLICKER" IN CAR-TAPE PLAYER

I have a Panasonic 8-track auto tape player. Works fine in the car, but when I hooked it up to a home-made 12-volt dc power supply for use in the house, the pilot light flickers with the loudness of the music. It doesn't do this in the car.—F.V., San Francisco, Calif.

You've got a little voltage regulation problem. The flicker is due to voltage drop on loud passages in the music. In all Class-B transistor amplifiers, there is a great difference between the resting current (no signal) and full-volume current.

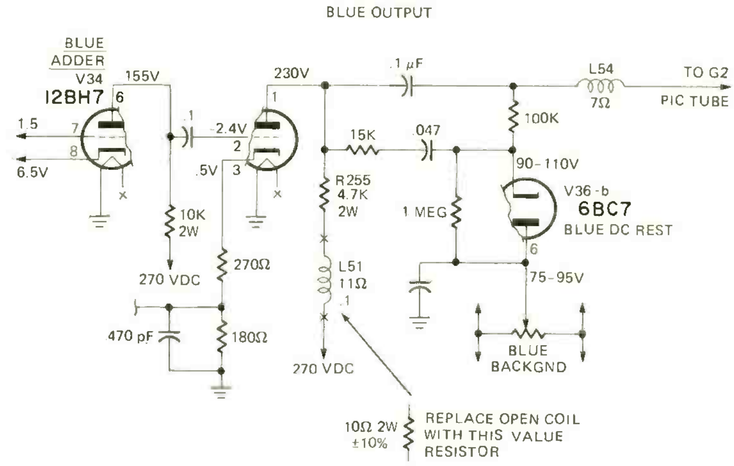
Your power supply will give you the right voltage under small load, but on loud passages the supply voltage is dropping, causing the flicker. Try using a bigger output filter capacitor; it may help. If not, uou'll have to get a power supply with a greater *current* rating.

EMERGENCY REPAIR, OPEN CHOKE

A reader writes: I had no blue in the picture on my CTC-2 RCA. Checking, I found that I had no plate voltage on the blue output tube. The choke, L51, was open. I tried to rewind it but it broke up on me. Couldn't find a replacement anywhere.

Looking at the schematic, I noted that this coil had a dc resistance of 11 ohms. Roughly figuring the reactance from this, I came out with about 12 ohms. Having nothing to lose, I put in a 10-ohm, 2-watt resistor in its place. Worked beautifully! Colors good, and everything lovely.

This might help out another technician in the same kind of jam. Leroy Brown, Baltimore, MD 21229



CIRCUIT BREAKERS TRIPPING

This has nothing to do with electronics, but I'm deeply confused! The two 50-ampere circuit breakers in the service entrance to my home trip at odd intervals. I called the power company the first time it happened, and they simply threw the breakers back on and everything was fine. I can't find anything that would cause this. It would take a big short somewhere to trip a 50-ampere breaker, wouldn't it? This could be dangerous.—R.A., Pine Bluffs, Ark.

Not a bad idea to be worried. However, it could have a simple explanation. Try this. Get a clamp-on ammeter from the power company or a friend. Open the entrance breaker box, and hook this around *one* of the hot wires. Don't hook it around two; it won't read.

Now have a helper go through the house and turn on as many heavy load appliances as possible; electric irons, air-conditioner, and so on. Watch the meter (the ammeter, that is). You may find that the "50-ampere" breaker will trip at about 25-30 amperes. When a breaker has been in service for a long time, it is possible for the contacts to corrode. This generates heat, and makes the breaker trip below its rated current.

CATHODE CURRENT

I have sound but no high-voltage on an Admiral portable, H1-1A. You're always saying "Check the horizontal output tube cathode current," but how do you do it on one of these? The cathode pin is part of the PC board-socket assembly.—P.F., Lone Pine, Calif.

With great difficulty. That is, if you

try to unsolder the pin from the PC board. The only practical way, with this type of construction, is the tube-socket adapter with the cathode pin brought out; pin 8 in 33GY7's.

VIDEO-TAPE SYNC PROBLEMS

I have an odd horizontal problem. It shows up as an offsetting of parts of the picture, making vertical lines look jagged. It's intermittent, and often comes out when the station, changes cameras or programs. I can't do anything to the set that will make it show up. Seems to show up mostly on local programs.—W. L., Brooklyn, N.Y.

From the description, and the symptoms, this could be video-tape

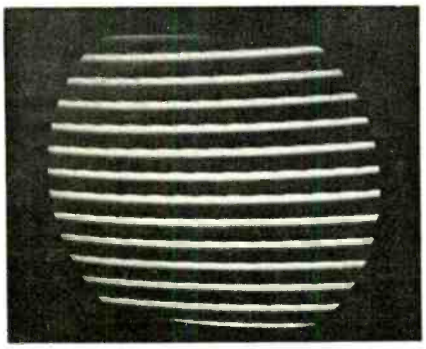


FIG. 1

trouble at the station. It is either a complete loss of horizontal sync, as in Fig. 1, or a partial loss as in Fig. 2. Notice that the "sawteeth" or bends here are about

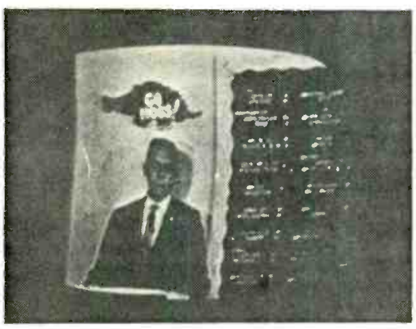


FIG. 2

16 lines apart. One bad head on a standard video-tape recorder will do this.

In color tape programs, this usually shows up as orange streaks (still 16 lines apart) across solid-color backgrounds. In any case, it's not in the set.

NO BOOST

Help! I have no boost voltage on an Admiral 2G750 chassis. Only 230 volts instead of +540 as called for. I've been all over the place, and can't find out why. What do I do now?—A.J., Pawtucket, R.I.

Open the 38HK7 cathode (pin 8) and put a dc milliammeter in series to ground. If your cathode current is higher than normal (which is 150 mA) I'd suspect a small short in the horizontal yoke windings.

Now check. Disconnect the horizontal yoke coil (leave it on the tube) and clip on another yoke with about the same inductance—25 mH. Now fire it up and see if your boost and high voltage come back. If so, the original yoke is shorted.

If the cathode current is below normal, check the .022-mF boost capacitor; it will probably be open. This connects from terminal 2 on the flyback to B+; 170 volts.

NO HORIZONTAL SWEEP

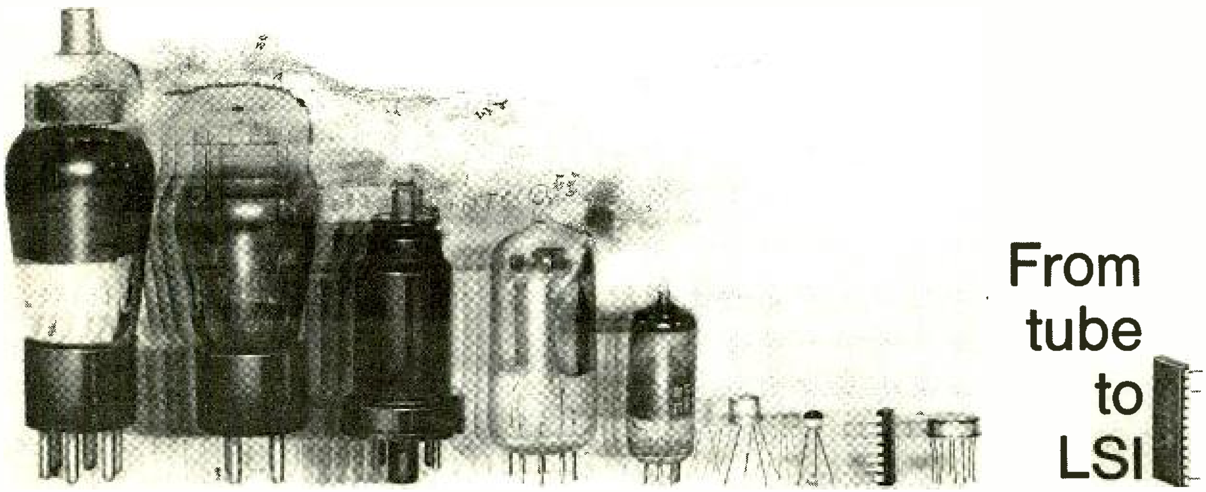
I'm just getting started in color TV servicing. I've got a problem. I had arcing all around the flyback in an Emerson 835A. I replaced it. Now I have a bright vertical line down the middle of the screen.—W.K., Hicksville, N.Y.

You go get your ohmmeter. We have an *open* horizontal yoke. You are getting high voltage, and vertical sweep, obviously. However, your horizontal yoke coil is open somewhere between the flyback and the yoke itself.

Pull the yoke plug, and take an ohmmeter reading between pin 1 and pin 6. This will tell you whether the yoke windings are open; should be about 10 ohms. From either 6 or 3 you should read 4700 ohms to pin 1; this resistor is inside the yoke cover.

If these readings are ok, then recheck the flyback connections! **R-E**

Changes come fast in electronics.



Take a look at the race in circuit technology. In the 1960's the tubes at the left made way for the transistors at the right. Today, transistors are surpassed by the large scale integrated circuit (LSI) at the far right. This circuit, less than a quarter inch square, replaces over 6000 transistors!

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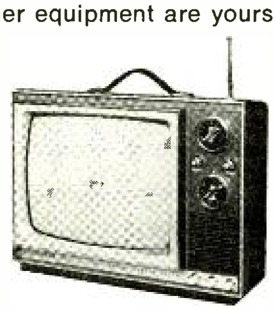

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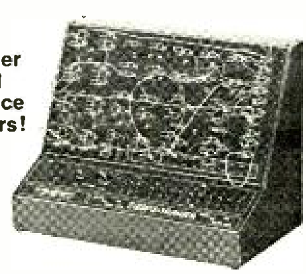

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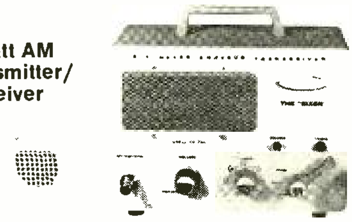

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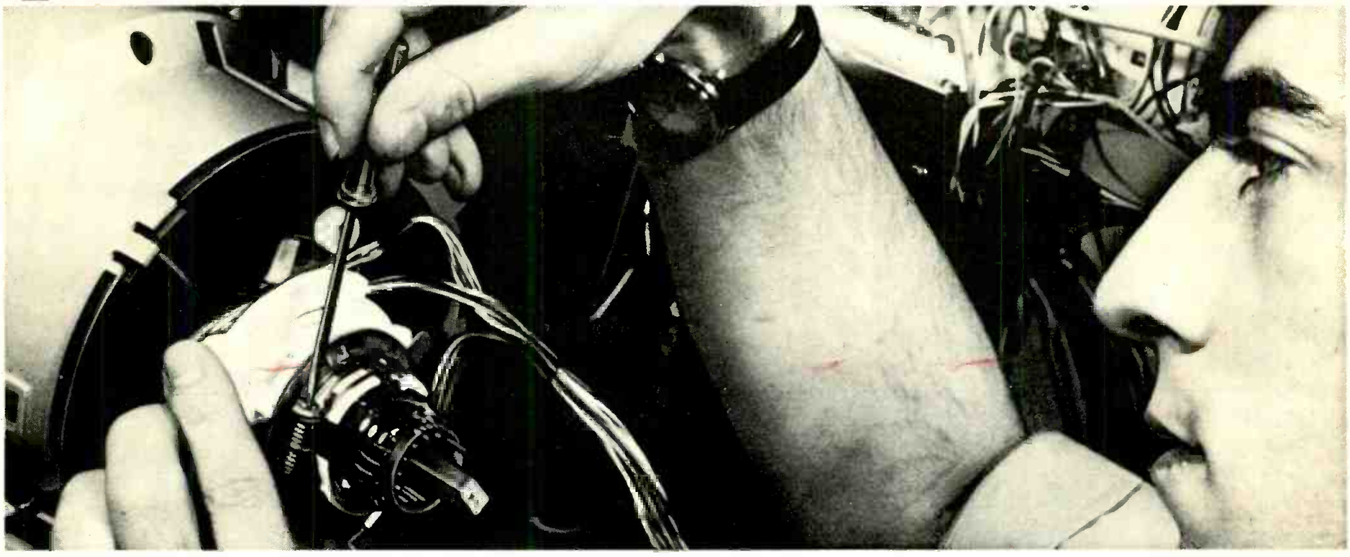

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USING COLOR BAR GENERATOR
(continued from page 57)

be caused by an open coupling capacitor at the grid of the B – Y amplifier.

Sometimes color amplitude and phase difference appear correct according to waveforms on the picture-tube grids, but bar colors still are not right on the screen.

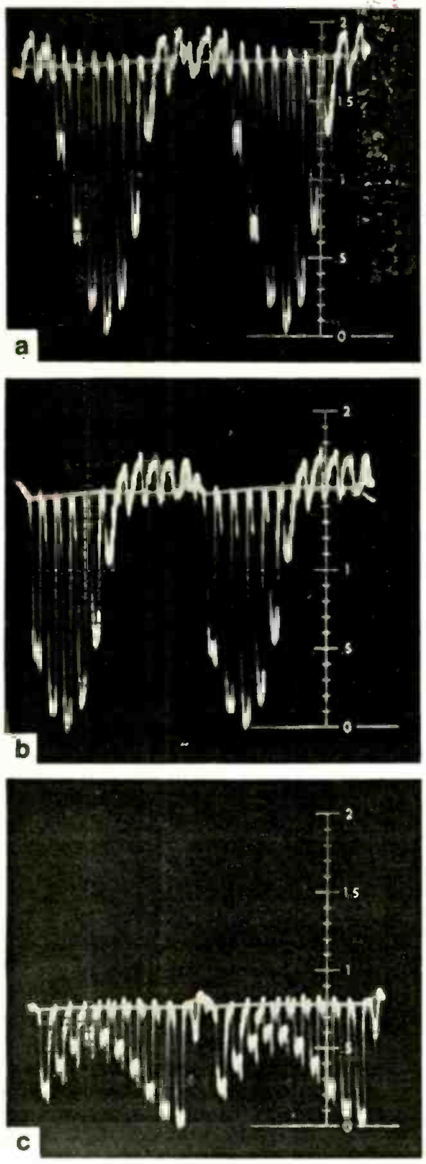


FIG. 9—COMPARATIVE AMPLITUDES of color-difference signals. Blue (a) at 100%, red (b) at 85% and green (c) at 35%.

In one such set, red was very weak. Gray-scale tracking was not as good as it should be. The technician connected his keyed-rainbow generator to the antenna terminals and scoped waveforms on the picture-tube grids. They showed exactly the amplitude and phase to reproduce proper color bars. He could only suspect the picture tube. A picture-tube tester confirmed his suspicion.

The keyed-rainbow generator does a large part of the work. You just supply the thinking. **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.

STEREO AMPLIFIER, *model LA-150,* unit features built-in circuit to provide derived 4-channel sound from regular 2-channel stereo program sources. Power output is ±1 dB, 125 watts IHF at 4 ohms; frequency response ±1.5 dB, from 22-20,000 cycles; total harmonic distortion 1% or less at rated output, 0.05% at 1 watt. Power bandwidth, 13-35,000 Hz;

channel separation, 65 dB at 1 kHz. Includes tape monitor switch, low filter, high filter, loudness level A and level B and power on/off switches. Controls include bass, treble, volume, balance, mode selector, input function selector and speaker mode selector. $149.95.—**Lafayette Radio Electronics,** 111 Jericho Turnpike, Syosset, L.I., N.Y. 11791.

Circle 31 on reader service card

LOW DISTORTION AMPLIFIER, *model D-60,* stereo power amplifier delivers 41 watts rms per channel into an 8-ohm load. Frequency response ±0.1 dB from 20-20,000 Hz at 1 watt. Power bandwidth is ±1dB from 5-30,000 Hz at 30 watts. IM distortion less than 0.05% from 0.01 watt to 30 watts. Harmonic distortion

less than 0.05% at 30 watts from 20-20,000 Hz. Hum and noise 106dB below 30 watts per channel output. Separation, typically 106 dB at 1,000 Hz. Unit is protected against shorts, mismatching and open circuits. $229.00. Walnut cabinet, $29.00 additional—**Crown International,** Box 1000, Elkhart, Ind. 46514.

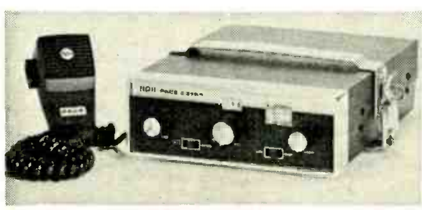
Circle 32 on reader service card

STEREOPHONES, *model PRO-B VI.* Transparent housing reveals printed circuit crossover network and inner acoustic chamber. The heart of the unit is its woofer with controlled acoustic suspension and matched new ceramic tweeter. Has a 15-foot coil cord and a three-foot straight section at the headphones with an attached clothing clip permitting coil cord pull to be absorbed at the belt or shirt

pocket. $60.—**Superex Electronics Corp.,** 151 Ludlow St., Yonkers, N.Y. 10705

Circle 33 on reader service card

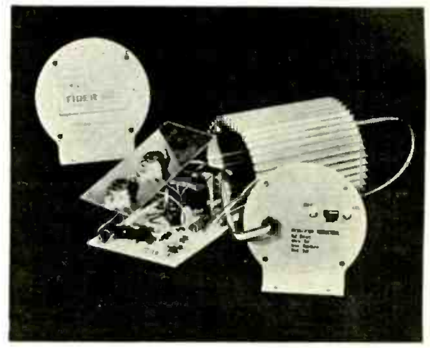
CB TRANSCEIVER, *model 2376A,* provides 23 channels of operation with crystal synthesizing technique and compensates for drift in crystal tolerances caused by temperature change. The transmitter provides 5 watts input power and a modulation boost circuit. The re-



ceiver has a six-section tuned filter that provides noise limiting in addition to the regular series gate noise limitings circuitry. Additional features include an S meter and public address function. $159.95—**Pathcom Inc.,** P. O. Box 306, Harbor City, Calif. 90710.

Circle 34 on reader service card

ELECTRONIC IGNITION SYSTEM KIT, *Tiger SST CD* capacitive discharge unit. Using a transformer-inverter with capacitors, diodes, resistors and a SCR, the unit transforms 12-volt battery power to 400 volts input to the coil primary. The coil then produces up to 50,000 secondary volts to the spark plugs. The system reduces the 4-6 amperes at the points to only 0.5 amps. The high-intensity spark, three times normal, plus the fast rise time, 0.5 μs compared to 80 μs in a normal sys-



tem, helps keep the plugs clean. $39.95 assembled; $29.95 kit.—**Tri-Star Corp.,** P.O. Box 1946, Grand Junction, Colo. 81501.

Circle 35 on reader service card

PHOTOELECTRIC ALARM SYSTEM, *No. 1318,* has a range of up to 1000 feet. Uses a solid-state light source to send a pulse modulated invisible beam from the transmitter to the receiver. Transmitter and receiver are quite small, extending only 3½"

from the wall. No internal mirrors are used and a rechargeable battery with 24-hour standby capacity is built into the unit—**Ademco, Alarm Device Manufacturing Co.,** Syosset, NY 11791.

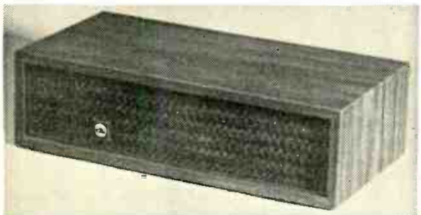
Circle 36 on reader service card

AUTOMOBILE THEFT ALARM, *model MDL-4,* uses no external locks or inside

switches. Works in all 12 V negative-ground vehicles. Unit monitors current drain in courtesy lamp circuit of vehicle. Opening the door starts the timer in the alarm. If the vehicle's ignition key is turned within the delay period, the alarm is turned off. If the ignition key is not turned on, the alarm sounds. When leaving the vehicle, turning off the ignition key starts another timer which allows about 30 seconds for the operator to leave the vehicle and shut the door. $49.95.—**TM Electronic Enterprises,** P. O. Box 10633, Pittsburgh, Penn. 15235.

Circle 37 on reader service card

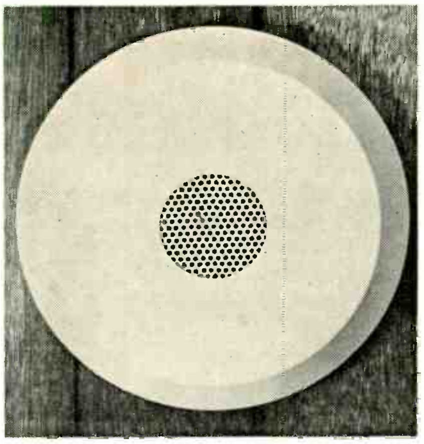
ULTRASONIC INTRUSION DETECTOR, *model DS 501,* transmits and receives back a characteristic pattern of inaudible sound waves. An intruder entering this sound pattern sets off the alarm. Pro-



tects an elliptically shaped area 25′ long, 15′ wide, 15′ high.—**Detection Systems, Inc.,** 211 Byer Bldg., East Rochester, N.Y. 14445.

Circle 38 on reader service card

SMOKE DETECTOR, *No. 580,* operates on the ionization principle. The unit detects fire at its earliest stage, before smoke, heat and flame develop. Self-contained, battery powered unit requires no wiring. As battery voltage decreases



to a pre-set warning level, the alarm notifies the user that a new battery is required.—**Alarm Device Manufacturing Co.,** Syosset, N.Y.

Circle 39 on reader service card

TELEPHONE ANSWERING SYSTEM, *Ansafone 590.* The system will answer an unattended telephone, play a message, record messages and permit remote interrogation of stored messages by telephone. To hear the stored messages, the user dials his office number, places a transistorized Dictacall next to the mouthpiece, presses a button and automatically hears his messages. Incoming message capacity is 40 minutes with choice of voice activated or fixed time

recording. $695.00—**Dictaphone Corp.,** 120 Old Post Rd., Rye, N.Y. 10580.

Circle 40 on reader service card

AUTOMATIC TELEPHONE DIALER, *Hot liner,* transmits up to six minutes of a cas-

sette tape recording of your message. Silently dials up to four different telephone numbers sequentially, then resets. Multi-circuit terminal block allows simple connections to your phone system, your primary alarm system and a secondary alarm system (optional). A standard four-prong phone jack is also available for plug-in installation. $249.00—**Teletronics, Inc.,** Box 4350, Hamden, Conn. 06514.

Circle 41 on reader service card

SHIRT POCKET CALCULATOR, *Titan RBM,* measuring 4" x 3" x ¾". This pocket-size calculator adds, subtracts, multiplies, divides and makes chain calcu-

lations. The 10-ounce unit has LED readouts and will run four hours before charging the built-in rechargeable batteries is required.—**Titan RBM,** 12 W. First St., Havre, Mont. 59501.

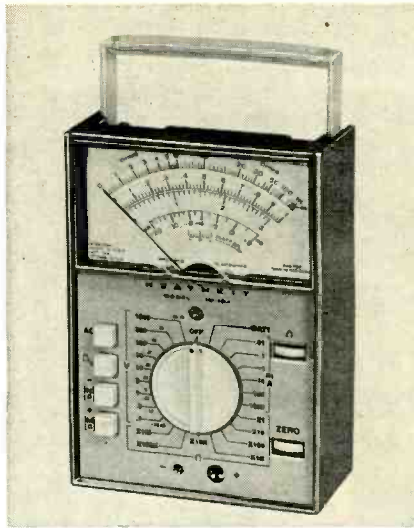
Circle 42 on reader service card

DUAL TRACE SCOPE, *model PM3110,* offers simplified operators panel that has only four signal adjustment knobs. Level and stability controls for triggering as well as balance controls have been eliminated and replaced by automatic circuits. Triggering is fully automatic. Three selector switches control trigger source, trigger

polarity, and trigger mode. When TV triggering is selected, the unit automatically selects either line or frame sync pulses as trigger signals depending on the setting of the time base control. $550.—**Test & Measuring Instruments, Inc.** 224 Duffy Ave., Hicksville, NY 11802.

Circle 43 on reader service card

FET VOM, *model IM-104* a portable lab-grade unit that combines accuracy, versatility and convenience in an easily assembled kit. Fifty-three ranges on 4 scales include 9 dcV and acV ranges from 0.1 V to 1,000 V; six current ranges from 0.01 mA to 1,000 mA, both ac and dc; seven resistance ranges from 1 ohm to 100 megohms, conventional or low voltage modes; decible ranges from −40 dB to +62 dB and dc null scale with better than 1 mV resolution. 4½" taut-band meter is diode protected and built-



in circuitry shows the condition of the battery. $79.95. —**Heath Co.,** Benton Harbor, Mich. 49022.

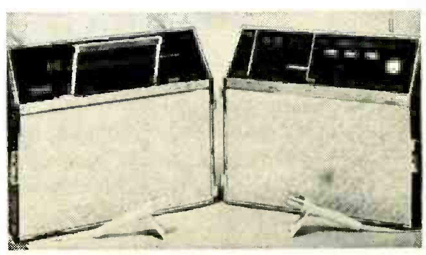
Circle 100 on reader service card

DIGITAL MULTIMETER, *model LDM-850,* ac/dc unit measures voltage, current and resistance in 25 ranges. Has scale accuracy of 1% or better and provides 3½ digit non-blinking display up to 1,999. Dual-slope operating mode. Maximum input voltage of 1,000 volts dc and 350 volts ac with 10-megohm input im-

pedance. Automatic polarity reversal and overrange lamp indication. Display has a hold and lock position and there is a segmented display lamp test position. $299.50.—**Leader Instruments Corp.,** 37-27 27th St., Long Island City, N.Y. 11101.

Circle 44 on reader service card

PORTABLE 8-TRACK CARTRIDGE RECORDER, *model 410,* includes AM/FM stereo radio, is complete with



two dynamic microphones, stands, patch cords. Plays and records all standard 8-track cartridges. Records stereo live or off the air with level meters and fast forward control. Features automatic and manual program switching, continuous play or automatic stop. Frequency response is 100-10,000 Hz with 8 watts total music power into 8 ohms. Flutter and wow 0.3% rms. Tape speed, 3¾ ips. Signal-to-noise ratio 45 dB. $219.95.—**Toyo Radio Co. of America, Inc.**, 1842B West 169th St., Gardena, Calif. 90247.

Circle 45 on reader service card

EIGHT-TRACK HEAD CLEANER/DEMAGNETIZERS, *model QM-280* and *model QM-281*. The new units are designed to remove accumulated dirt and oxide from magnetic heads in cartridge machines preventing spacing losses, damage to heads and protecting

pre-recorded tapes. Both cleaners also contain a demagnetizer to completely remove residual magnetism. The *QM-280* is for use on 117 Vac. The *QM-281*, plugs into an automobile cigar lighter.—**Nortronics Co., Inc.**, 6140 Wayzata Blvd., Minneapolis, Minn. 55416.

Circle 46 on reader service card

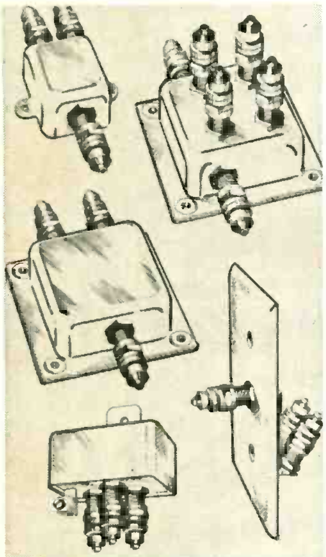
COMPONENTS KIT, for servicing *XL-100* RCA TV chassis. The new kit contains all the transistors, diodes, resistors and

And just how will you feel if it turns out to be your wife who is going to miss her favorite soap opera because of you?

one circuit breaker, 27 components in all. Selected by RCA Consumer Electronics as those most important for fast efficient service of the XL-100 chassis. A special parts location diagram and separate cross-reference chart speed the use of the kit.—**RCA, Parts & Accessories,** Deptford, N.J. 08096.

Circle 47 on reader service card

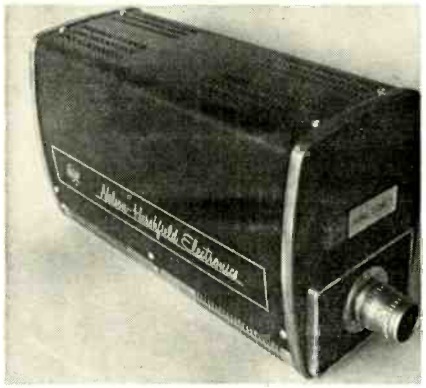
MATV-CATV PRODUCTS, line includes matching transformers, two and four-way



splitters, directional taps, multidirectional taps, directional wall plates and lightning arrester blocks with and without splitters. Units are housed in cadminum steel covered with epoxy resin. Circuits are completely embedded in polyurethane foam and encased in epoxy resin—**Workman Electronics Products, Inc.,** P. O. Box 3828, Sarasota, Fla. 33578.

Circle 48 on reader service card

TV CAMERA, *model PB940R,* offers 875-line resolution, available with a variety of Vidicons. 2:1 interlace programmed sync generator, crystal-controlled EIA sync option, remote control of beam, target, focus and automatic light control with



low-voltage remote power feed. Low light level operation is possible with silicon diode Vidicon.—**Nelson-Hershfield Electronics,** 1848 West Campbell Ave., Phoenix, Ariz. 85015.

Circle 49 on reader service card

new lit

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.

MAIL ORDER CATALOG, featuring audio components, Citizens-band equipment, radios and phonos, TV, kits and hobby items, antennas, tools and hardware, small parts, tubes and books. The catalog lists dozens of major names in electronics and includes some very new and unusual electronic items.—**Olson Electronics,** 260 S. Forge St., Akron, Ohio 44327.

Circle 50 on reader service card

OSCILLOSCOPES *Catalog 5,* 13 pages of complete specifications on this manufacturers full line of oscilloscopes. Includes a selectors' guide of points to look at when purchasing an oscilloscope. Three dual-trace scopes, four single-trace scopes and one dual-beam scope are detailed and illustrated.—**Telequipment,** P.O. Box 500, Beaverton, Ore. 97005.

Circle 51 on reader service card

SEMICONDUCTOR CATALOG, 92-page directory of transistors and integrated circuits made by Motorola, RCA, Fairchild, National and HEP. The catalog contains many device connection diagrams and also how-to-use circuits for IC's. Associated parts such as resistors and capacitors are also listed. A separate section contains complete equipment including CB gear, treasure finders and assorted test instruments.—**Circuit Specialists Co.,** Box 3047, Scottsdale, Ariz. 85257.

Circle 52 on reader service card

SCOPE ACCESSORIES CATALOG, 25-page two-color catalog of accessories available for the entire line of oscilloscopes manufactured by Philips and sold in the United States. Contains detailed applications and information as well as illustrations and descriptions of both passive and active scope probes, camera systems and related photographic equipment, scope carrying cases, battery packs, cables, plugs, adaptors, etc.—**Test & Measuring Instruments, Inc.,** 224 Duffy Ave., Hicksville, N.Y. 11802. **R-E**

Circle 53 on reader service card

GUEST EDITORIAL

Eugene Aisberg, the author of this month's guest editorial on page 6, was for many years publisher and editor of the French Technical Journal Toute l'Electronique. He is also the author of about 20 texts on Radio, TV and Electronics including the famous "TV, It is a Cinch!" which ran as a serial for many months in Radio-Electronics, in the 1950's.

next month

JANUARY 1973

10TH ANNUAL COLOR TV ISSUE
It's crammed with informative articles on the latest developments in color television. There are articles on every important phase of color television in North America today

- **New Color Circuits**
  The '73 sets include some interesting innovations in circuits. Take this close-up R-E tour

- **ABC's Of Color Convergence**
  How to set up a color set as fast as possible with as little difficulty as possible

- **Color Controls**
  How they work: Instamatic, Auto Color, AFT, ACC and more. Take a look at what they will and won't do

- **Color TV Test Jigs**
  How to use them effectively to speed troubleshooting and avoid carrying color picture tubes

- **Color TV—Tomorrow**
  An expert in this field looks at what we might expect to be looking at in 1983.

PLUS
State Of Solid State
TV Service Clinic
Appliance Clinic

new books

***HOW TO BUILD PROXIMITY DETECTORS & METAL LOCATORS,* by John Potter Shields. Howard W. Sams & Co., Inc., 4300 W. 62nd St., Indianapolis, IN. 46268. 8½ x 5½ in. 160 pp. Softcover, $2.95**

A complete text on proximity detectors and metal locators, including detailed instructions on how to build several different devices. While a number of practical circuits are described for building proximity detectors, metal locators and Theremins, the projects are broken down into two categories: Elementary and Advanced. The elementary circuits usually consist of one or two tubes or transistors. The circuits in the advanced category are more sophisticated and usually consist of two or more tubes or transistors. The final chapter discusses the Theremin, an electronic musical instrument that uses the beat-frequency, proximity-detector principle.

***HANDBOOK OF PRACTICAL SOLID-STATE TROUBLESHOOTING,* by John D. Lenk. Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. 6 x 9¼ in. 310 pp. Hardcover edition, $12.00.**

This book is a straightforward, practical guide to pinpointing both circuit and component failures in today's solid-state and digital electronic equipment. The first chapter introduces fundamental troubleshooting theory and provides the framework for learning step-by-step servicing procedures. Coverage includes servicing and repair of basic solid-state circuits as well as specific equipment and systems. It also covers the use of test equipment and hand tools.

***PRACTICAL ELECTRONIC SERVICING TECHNIQUES,* by Larry Allen. TAB Books, Blue Ridge Summit, PA 17214. 5-¾ x 8-¾ in. 255 pp. Hardcover, $7.95, Softcover, $4.95.**

Here's a text that tells how to sharpen electronics troubleshooting ability with the methods used by the "old pros". To condition the reader's thinking, the author begins Part I with an analysis of what troubleshooting really is and then he goes on to show the thinking of a tough-dog expert. The remainder of Part I deals with logical approaches to time-constant circuits, tube circuits and an in-depth treatment of transistor circuits. In Part II, the author shows some actual treatment of real problems in audio gear, including automatic turntables and tape recorders. Part III hits transistorized circuits hard, showing valuable short-cuts to save time and methods of testing transistors in circuit. Part IV goes into the most troublesome parts of TV receivers, sweep systems and high voltage. Part V helps the reader get better acquainted with his test equipment. In this section is also a chapter devoted to efficient operation.

***REPAIRING TRANSISTOR RADIOS,* Revised Second Edition, by Sol Libes. Hayden Book Company, Inc., 116 West 14th Street, New York, N.Y. 10011. 6 x 9 in. 192 pp. Softcover, $4.65.**

This revised second edition is a practical, easy to use guide that clearly explains methods and procedures for troubleshooting and repairing the latest types of AM and FM transistor radios, including home, portable and auto radios. The book briefly explains the theory and structure of semiconductor elements, then covers transistor characteristics and types. Operation and servicing of all types of transistor circuits are discussed in-depth and accompanied by comprehensive troubleshooting charts for each receiver circuit.

***AUTOMOTIVE TUNE-UP AND TEST EQUIPMENT,* by Charles R. Cantonwine. Chilton Book Co., 100 East 42nd Street, New York, N.Y. 10017. 6¼ x 9½ in. 350 pp. Hardcover, $10.50.**

Here's a book that explains and illustrates the principles of operation, adjustments and calibrating procedures for representative models of tune-up and test devices. The book covers the fundamentals and principles of operation of all electronic equipment likely to be encountered in the automotive service field. All circuits in this book have been traced from equipment serviced by the author and are up to date. The author has also developed several pieces of special test equipment to service automotive engines. In this book are many original ideas not found anyplace else. A listing of sources of supply and brand names is provided and these are referred to in the text as appropriate.

199 TV TOUGH-DOG PROBLEMS SOLVED, by Art Margolis. TAB Books, Blue Ridge Summit, PA 17214. 5-¾ x 8-¾ in. 256 pp. Hardcover $7.95, Softcover $4.95.

Here is a massive collection of actual case-history solutions for both color and black-and-white sets, covering all popular makes from Admiral to Zenith. The book is organized so that solutions to particular problems can be located quickly and all solutions are drawn from practical experience; 199 toughies that required the best efforts of top technicians to solve. A cross reference of troubles by brand name and chassis is included. Contents include problems such as no high voltage, no raster, not enough high voltage, blooming, vertical oscillator and output troubles, wrong colors, no video, motorboating and more.

ARTIFICIAL INTELLIGENCE, by James R. Slagle. McGraw-Hill Book Company, 330 West 42nd Street, New York, N.Y. 10036. 6¼ x 9½ in. 196 pp. Hardcover, $9.65.

An integrated description of intelligent machines presented by this book, shows that machines can mimic the behavior or performance normally associated with human intelligence. Among the machines described are some that deduce answers to questions from given facts, play games, prove theorems and balance assembly lines.

CORRECTION

The price listed for the EICO Model FC-100 burglar alarm in their advertisement in the November issue was incorrect. The price in the ad was $59.95. The **correct price** should have been $69.95.

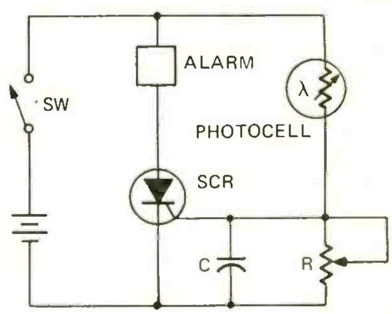
Circle 68 on reader service card

Circle 69 on reader service card

circuits

TORNADO DETECTOR AND ALARM

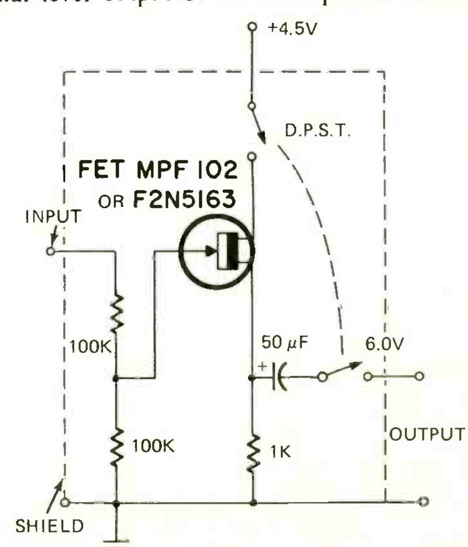
The trick of using a TV set to detect the approach of a tornado has been described several times over the past few years (for example "Electronics Hunts Tornados", October, 1972, page 12). A TV is tuned to channel 13 and then the brightness control is turned down until the raster is just extinguished. The set is then switched to channel 2. A tornado within 10 to 20 miles causes the TV screen to light up.



Electronic disturbances within the vacuum funnel of a tornado turn an energized but black TV screen white. The alarm (see diagram) consists of a photocell, a capacitor and resistor network to absorb transient voltage peaks and the affects of nearby lightning strokes, an SCR (rated for the alarm voltage and current), a battery and a switch. A suction cup holds the photocell against the picture tube. The alarm or alarms can be located away from the TV set as in a bedroom or barn.

MIKE MATCHING PREAMP

When a crystal microphone is fed into a 600-ohm input, the signal level output of the microphone is about 44 dB



lower than the level available into a high input impedance.

The simple matching amplifier shown here is for feeding the crystal microphone into a low-impedance input. For an adjustable gain control use a 200,000-ohm potentiometer in place of the fixed input voltage divider.—*H.E. Goldstine* **R-E**

technotes

CONVERGENCE AND PURITY PROBLEMS

Problems associated with screen purity and convergence frequently result from inadequate degaussing of *all* metal near the picture tube. Any magnetized metal near the tube can affect the landing points of the beams on the screen. For this reason, all metal—other than the permanent magnets purposely located close to the picture tube—must be completely demagnetized. Some sets have a metal back cover or a metal pix-tube neck cup attached to the back cover.

Frequently the back cover is not in place when the set is being degaussed. The back cover of the neck cup must be completely demagnetized to prevent it from affecting either convergence or purity. Be sure to degauss the metal portion of the back cover each time the set is degaussed.—*Magnavox Service News Letter*

G-E C2/L2 COLOR CHASSIS

In cases of no horizontal sync, check the horizontal feedback resistor (5R251). If it has overheated, replace this ½-watt resistor with a smooth-body type which has a better voltage

breakdown rating (Allen Bradley or IRC are preferred types). Don't use the round-end types (see illustrations) in this application.—*G-E Service Hints*

RCA CTC39 TUBE CHANGES

New tube types are used in the shunt regulator and horizontal output circuits in the CTC39 chassis used in "Q" line TV receivers. The chassis now has a 6EN4 in the shunt regulator circuit in place of the familiar 6BK4. The 6EN4 is designed especially to provide a margin of safety within the X-radiation standards established by H.E.W. **Do not** attempt to replace the 6EN4 with a 6BK4. The chassis is wired for a 6EN4 and will not accommodate the 6BK4. The 6EN4 **can** be used as a replacement for the 6BK4.

The 6ME6 horizontal output tube is also designed for limited X-radiation. Do not replace it with any other type. The 6ME6 **can** be used as a replacement for the 6LQ6.—*RCA Television Service Data*

SYLVANIA TV SERVICE NOTES

Vertical trouble—D05 chassis: C318, a .0056-μF capacitor is a chronic trouble source in this chassis. Also check C320, the other .0056-μF capacitor in the circuit for leakage or shorts.

Vertical jitter and rolling after warmup—D05, D06 and D011 chassis: Replace C310 with a 2-kV capacitor and relocate it under the circuit board away from the heat of the vertical oscillator and output tube.

Insufficient range; vertical linearity and height controls—D06 chassis: Try a new 6LU8 vertical tube. Check C322, .068 μF. Check for open or leaky filter capacitor.

Insufficient width—D012 chassis: The 18,000-ohm, ½-watt resistor (R428) in the horizontal oscillator plate circuit has increased in value. Replace this resistor with a 1-watt unit to prevent future trouble.—*GTE Sylvania Service Notebook*

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*Construction articles: † part of larger article, ER (Equipment Report), NC Noteworthy Circuits, Corr (correction), CI (Service Clinic); P (programmed), Corres (Correspondence)

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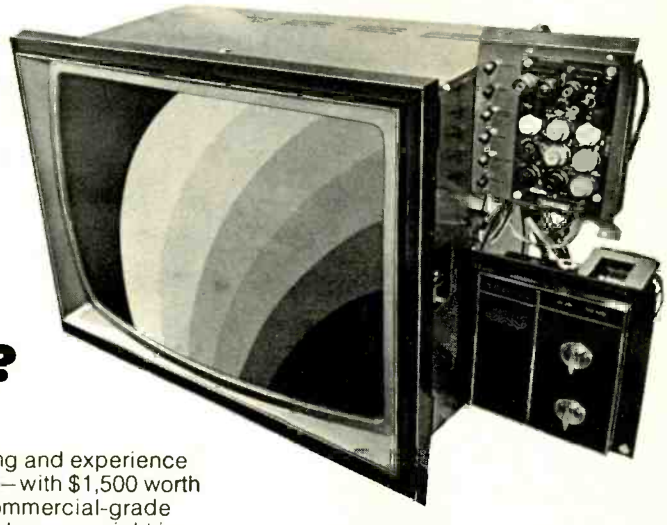

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BUILD GRINCHWAL

by DON LANCASTER

HERE ARE THE FINAL DETAILS TELLING how to build the mainframe for your grinchwal digital test equipment mainframe. Plug-ins start in February.

Preliminary checkout

You'll need a previously tested and working counter module and your power supply for checkout. Hookup the circuit of Fig. 4-a and check out the counting unit for normal brightness, counting, and "hold-follow" operation. Next checkout the reset and lamp test modes. Finally, check the overflow lamp by resetting the counter and watching it light and stay lit on count number 10,000.

Now, go to the circuit for Fig. 4-b. Doublecheck the voltages on your PC board for IC1, making sure you have -12 volts **only** on pin 16, +6 **only** on pins 7 & 15, and ground **only** on pins 2, 3, 5, and 6. You can now solder IC1 in place using a small *iron* and fine solder. When you reapply power, the counter should promptly start running at a 100-Hz rate. If it doesn't, first make sure you are in the FOLLOW position, and then try several adjustments of the trimmer capacitor. In case of difficulty, the 1-MHz oscillator output may be monitored with an oscilloscope with a 10× probe directly on pin 10 of IC1.

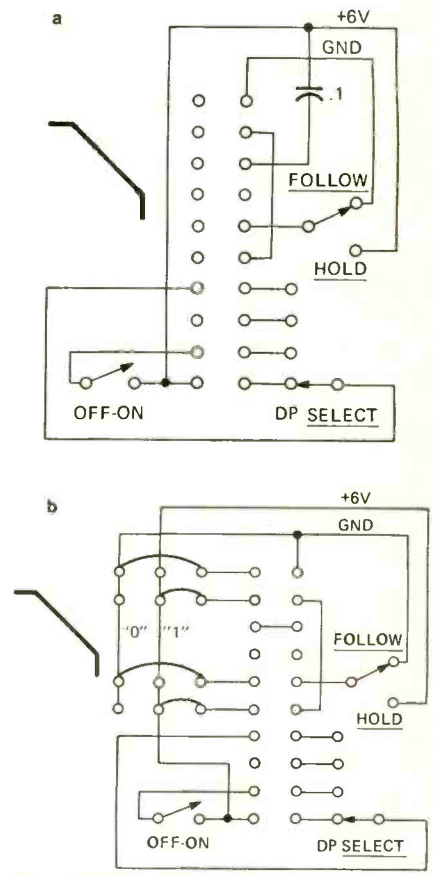


FIG. 4—WHEN UNIT IS ASSEMBLED test for proper operation with these two circuits.

When you switch off the +6-volt line, the -12-volt line is also switched off through "relay" Q2 and Q3. A connector PC pattern for the plug-in is shown in Fig. 5.

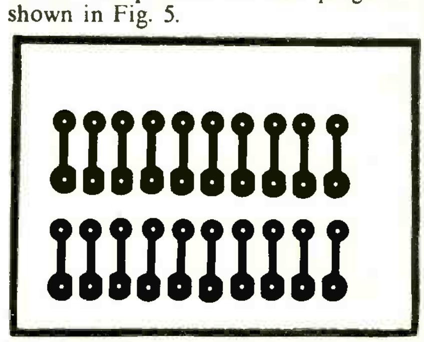
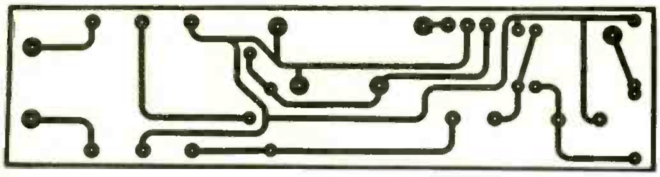
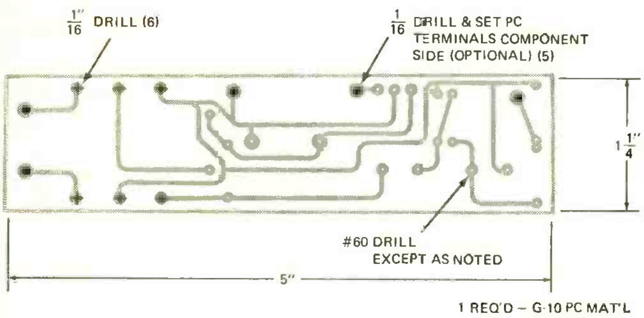


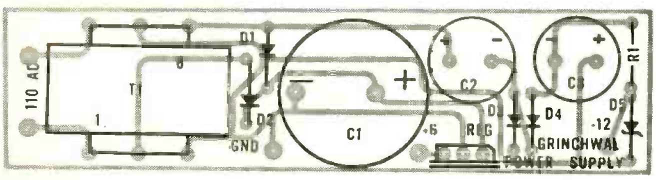
FIG. 5—CONNECTOR FOIL PATTERN. Each plug-in will use one of these connectors.

NOTE: The following are available from Southwest Technical Products, 219 West Rhapsody, San Antonio, Texas, 78216: PC Board, etched and drilled No. DGM-b, $4.85 postpaid. Circuit board for readouts, No. DGR-b, $3.85 postpaid. Kit of parts for readout, No. DR-C, $34.50. Kit of parts for mainframe and timebase plug-in, including case and front panel, No. DM-C, $26.75, less readouts and batteries, postpaid.

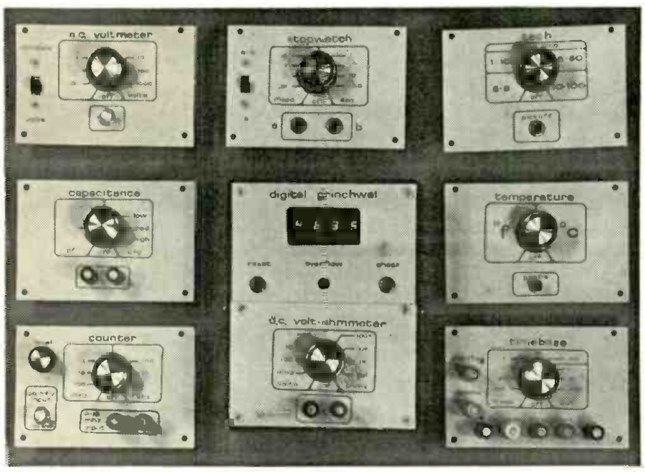
DIGITAL TEST EQUIPMENT



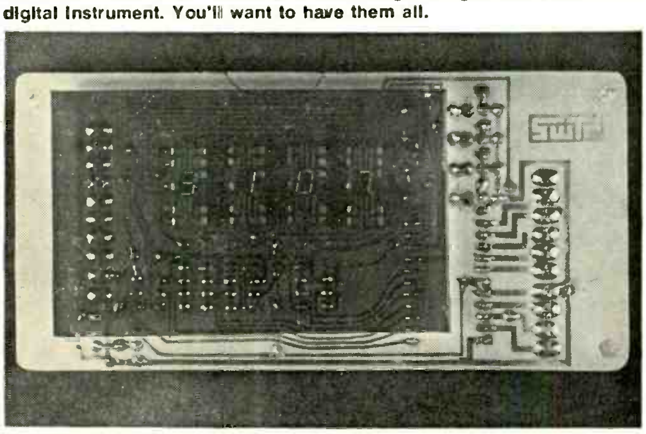




POWER SUPPLY CIRCUIT BOARD DETAILS. Three diagrams are shown. At the top is the foil pattern for the board. Next is the drilling guide. Last is a diagram showing parts placement on the circuit board.



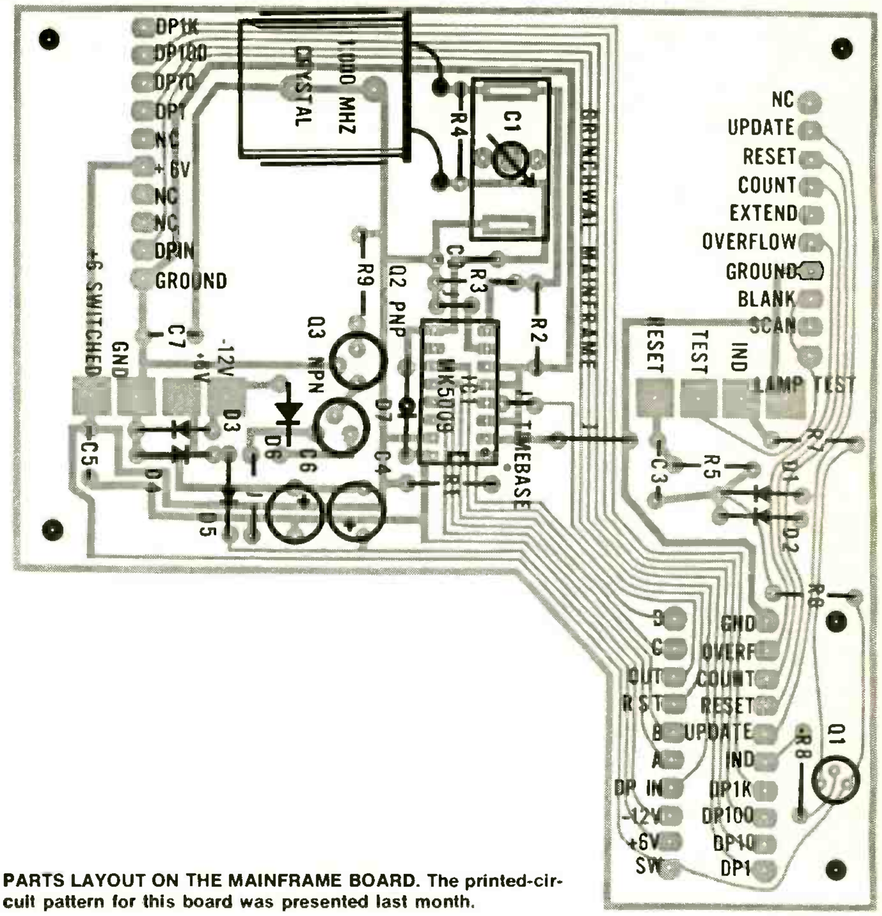
THESE ARE SOME OF THE PLUG-INS that go along with the Grinchwal digital instrument. You'll want to have them all.



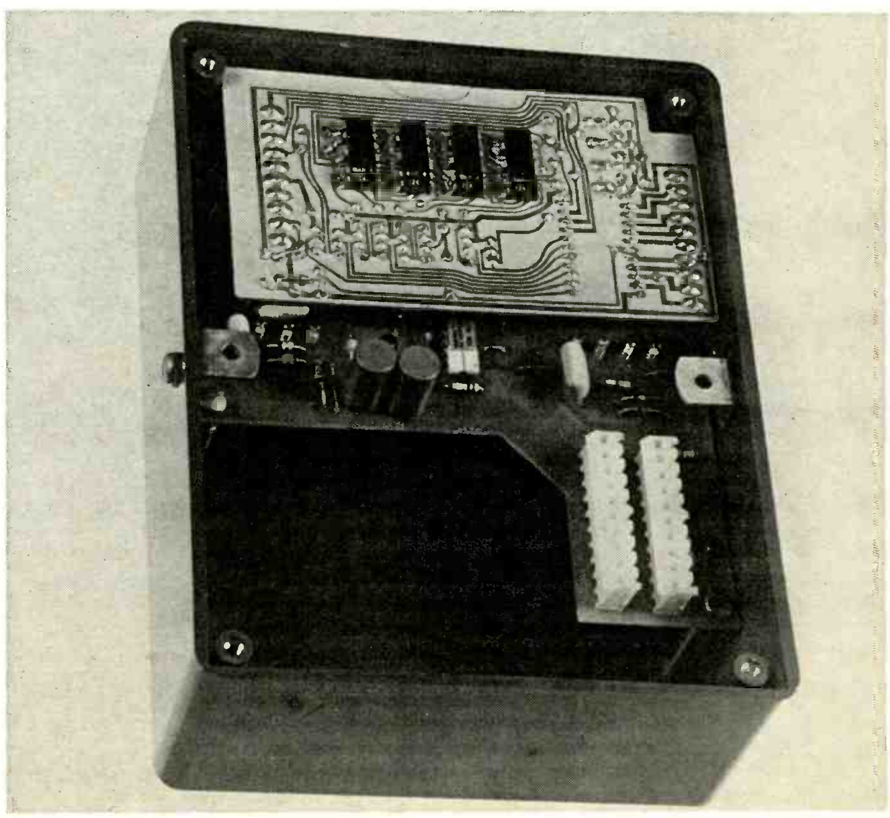
AN ASSEMBLED READOUT BOARD. The numerals are illuminated for this photo. Do not operate your unit out of its case.

(continued on page 96)

GRINCHWAL TEST EQUIPMENT
(continued from page 95)



PARTS LAYOUT ON THE MAINFRAME BOARD. The printed-circuit pattern for this board was presented last month.



COMPLETED MAINFRAME WITH front panel removed to show the location of major components inside the case.

SPECTACULAR!! PRICE WAR ON SURPLUS SEMICONDUCTORS

LINEAR DEVICES, OP AMPS, REGULATORS

- □ 709 High performance Op-Amp .... $.50
- □ 711 Dual Comparator .... $.50
- □ 723 Regulator $1.25
- □ 741 Compensated Op-Amp. .... $.50
- □ 558 Dual 741 .... $1.00
- □ LM309 5 Volt 1 amp Regulator, TO-3. .... $2.25

FAIRCHILD VOLTAGE REGULATOR

Fairchild UGH7805 5 Volt 1 amp voltage regulator. Perfect for logic supplies, very compact $1.95

SPECIAL I.C.'S, PHASE LOCKED LOOPS

- □ NE560 Phase Locked Loop $4.65
- □ NE561 Phase Locked Loop $4.65
- □ NE562 Phase Locked Loop $4.65
- □ NE565 Phase Locked Loop $4.65
- □ NE566 Function Generator/Tone Encoder. . $4.65
- □ NE567 PLL/Tone Decoder $4.65
- □ NE595 Four Quadrant Multiplier. $3.75
- □ NE555 Timer, 2u Sec to 1 hour, Special ... $1.25
- □ NE540 Power Driver, for 100w AB amp. .. $2.25

MEMORIES, SHIFT REGISTERS, ROM'S

- □ 1101 256 Bit RAM.MOS $4.00
- □ 1103 1024 Bit RAM.MOS $8.75
- □ 7489 64 Bit RAM,TTL $3.75
- □ 2513 Character Generator ROM. $14.75
- □ 1402 Shift Register $4.00
- □ 1403 Shift Register $4.00
- □ 1404 Shift Register $4.00
- □ 8224 Programable ROM. $14.75

Dear Customers,

We want to take this opportunity to thank you for your patronage. Your response, has in a few short years allowed us to grow to become one of the largest surplus dealers in the U.S., and because of our buying power, we are able to offer you "state of the art" components at prices the hobbyist can afford. Offering the latest technology though, has its pitfalls. Sometimes manufacturers, promising us the latest in LED's, MSI, or other advanced technology, have had problems getting their production lines going and have delayed shipment to us which resulted in a delay to you. We hope you will understand this at these times and accept our apologies.

In order to offer you still better service in the future, we have made some significant changes here at B & F. We have formed a joint venture with Aries Inc. to develop, manufacture and market kits only. (You will find their ad elsewhere in this magazine). The engineering staff represents some of the finest engineering talent in the United States, even if we say it ourselves. The division leaves us free to pursue the surplus business and to devote our full time to servicing your orders and finding new "buys".

We also have increased our staff and can now offer more service on information requests. Please keep them simple, however, as we can not do the engineering for you, but will do all within our power to provide you with complete data on everything we sell.

Thank you again, and we look forward to many more years of offering you the latest in electronics and electro-optical technology.

Very truly yours,

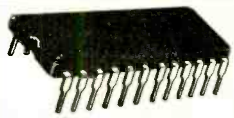
Franklin G. Fink
Peter E. Boniface
Partners - B & F Enterprises

HIGH POWER SCR's

SCR's - invaluable for high power applications, motor speed controls, lighting circuits, welding controls, etc. Never before at this low price. Brand new packaged devices, complete with data sheet and 24 page consumer applications manual.

□ 2N5062	Plastic 100V 1 amp	$.35
□ 2N5064	Plastic 200V 1 amp	.40
□ 2N4169	100V/8 amp stud	1.45
□ 2N4170	200V/8 amp stud	1.65
□ 2N4172	400V/8 amp stud	1.95
□ 2N3525	400V/3 amp press fit	.95
□ 2N1772/C15A	100V/8 amp stud	1.75
□ 2N1774/C15B	200V/8 amp stud	1.95
□ 2N1777/C15D	400V/8 amp stud	2.50
□ 2N1844/C20A	100V/12 amp stud	1.75
□ 2N1846/C20B	200V/12 amp stud	1.95
□ 2N5169	200V/20 amp stud	3.75
□ 2N5170	500V/20 amp stud	4.75
□ 2N5171	700V/20 amp stud	6.75
□ 2N3896/C30A	100V/25 amp stud	2.95
□ 2N3897/C30B	200V/25 amp stud	3.95
□ 2N3899/C30E	500V/25 amp stud	4.95

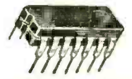
CALCULATOR CHIP SPECIAL



B and F has purchased a quantity of MOS large scale integration chips for calculators. We are not allowed to mention the manufacturers name, however, the specs should make them self-evident.

- □ Set "X" - Four 24 pin I.C.'s, BCD output, 16 digit, fixed automatic decimal point, possible memory expansion, constant $29.00
- □ Set "Y" - Single 40 pin, 7 segment output, 12 digit, fixed automatic decimal, no constant ... $15.00
- □ Set "Z" - Single 40 pin I.C., 7 segment output, 8 digit, floating point, constant $19.50

7400 SERIES TTL SUMMER CLEARANCE MOST POPULAR I.C. SERIES MADE !!!!!!



B and F maintains an inventory of over one million brand new, factory packaged integrated circuits, and is continually buying more from sources throughout the country. We intend to offer these at the lowest prices of any supplier, and to prove this point we have just cut our own normally fantastic low prices even lower. We will meet or better any 7400 series price. Data sheets are included with all items. On orders over $20.00 we will include free, a TTL data book or Linear data book, totaling over 200 pages. Orders over $100.00 will receive a 1000 page data file. An additional discount of 5% will be allowed for orders over $250.00 and 10% for orders over $1000.00.

□ 7400 - .22	□ 7451 - .22	□ 74150 - 1.55
□ 7401 - .22	□ 7453 - .22	□ 74151 - 1.13
□ 7402 - .22	□ 7454 - .22	□ 74153 - 1.55
□ 7403 - .22	□ 7460 - .22	□ 74154 - 2.30
□ 7404 - .27	□ 7470 - .40	□ 74155 - 1.39
□ 7405 - .27	□ 7472 - .36	□ 74156 - 1.39
□ 7406 - .50	□ 7473 - .48	□ 74157 - 1.48
□ 7407 - .50	□ 7474 - .48	□ 74158 - 1.48
□ 7408 - .30	□ 7475 - .76	□ 74160 - 1.79
□ 7409 - .30	□ 7476 - .53	□ 74161 - 1.79
□ 7410 - .22	□ 7480 - .72	□ 74162 - 1.79
□ 7411 - .27	□ 7481 - 2.45	□ 74163 - 1.79
□ 7413 - .55	□ 7482 - 2.45	□ 74164 - 3.75
□ 7416 - .50	□ 7483 - 1.55	□ 74165 - 3.75
□ 7417 - .50	□ 7485 - 2.45	□ 74166 - 3.75
□ 7420 - .22	□ 7486 - .55	□ 74167 - 4.75
□ 7421 - .22	□ 7489 - 4.00	□ 74170 - 5.75
□ 7426 - .32	□ 7490 - .76	□ 74180 - 1.13
□ 7430 - .22	□ 7491 - 1.35	□ 74181 - 4.90
□ 7437 - .53	□ 7492 - .76	□ 74182 - 1.13
□ 7438 - .53	□ 7493 - .76	□ 74184 - 2.95
□ 7440 - .22	□ 7494 - 1.12	□ 74185 - 2.95
□ 7441 - 1.64	□ 7495 - 1.12	□ 74190 - 2.95
□ 7442 - 1.21	□ 7496 - 1.12	□ 74191 - 2.45
□ 7443 - 1.21	74100 - 1.44	□ 74192 - 1.87
□ 7444 - 1.21	74107 - .49	□ 74193 - 1.87
□ 7445 - 1.62	74121 - .53	□ 74194 - 2.95
□ 7446 - 1.17	74122 - .67	□ 74195 - 1.95
□ 7447 - 1.10	74123 - 1.06	□ 74198 - 2.65
□ 7448 - 1.37	74141 - 1.55	□ 74199 - 2.65
□ 7450 - .22	74145 - 1.33	

FLAT NYLON LACING TAPE

One pound tube of black lacing, about 1,000 yards, should last the average hobbyist several years. Usual price is $10.50. At this price you can use it for all kinds of applications besides lacing. Test over 50 lbs.

- □ Lacing Cord 1 lb. $2.00

SANKEN HIGH POWER, HIGH PERFORMANCE HYBRID VOLTAGE REGULATORS

These hybrid regulators are easy to use, requiring no external components. Excellent for operational amplifier supplies, logic supplies and other high performance applications. All regulators have less than 50 millivolts ripple and better than 1% line and load regulation, some models far exceeding this specification.

- □ SI3120E 12 Volts, 1 Ampere $2.25
- □ SI3150E 15 Volts, 1 Ampere $2.25
- □ SI3240E 24 Volts, 1 Ampere $2.25
- □ SI3050E 5 Volts, 1 Ampere $2.25
- □ SI3554M 5 Volts, 3 Amperes $7.00

SANKEN HYBRID AUDIO AMPLIFIER MODULES

We have made a fortunate purchase of Sanken Audio Amplifier Hybrid Modules. With these you can build your own audio amplifiers at less than the price of discrete components. Just add a power supply, and a chassis to act as a heat sink. Brand new units, in original boxes, guaranteed by B and F, Sanken and the Sanken U.S. distributor. Available in three sizes: - 10 watts RMS (20 watts music power), 25 watts RMS (50 watts M.P.) and 50 watts RMS (100 watts M.P.) per channel. 20 page manufacturers instruction book included. Sanken amplifiers have proved so simple and reliable, that they are being used for industrial applications, such as servo amplifiers and wide band laboratory amplifiers.

- □ SI1010Y 10 watt RMS amplifier, industrial grade $4.75
- □ SI1025A 25 watt RMS amplifier, industrial grade $14.75
- □ SI1050A 50 watt RMS amplifier, industrial grade $22.50
- □ SI1025E 25 watt RMS amplifier, entertainment grade $14.00
- □ SI1050E 50 watt RMS amplifier, entertainment grade $21.00
- □ Transformer for stereo 10 watt amplifiers (2 lbs.) $3.95
- □ Transformer for stereo 25 or 50 watt amplifiers (5 lbs.). $5.95
- □ Set of (3) 2000 mfd 50V capacitors for 10 watt stereo. $4.00
- □ Set of (3) 2200 mfd 75V capacitors for 25 or 50 watt amplifiers $5.00
- □ 4 Amp Bridge Rectifier, suitable for all amplifiers $2.00
- □ Complete kit for 100 watt RMS stereo amplifier (200 watt music) including two 50 watt Sanken hybrids, all parts, instructions, and nice 1/16" thick black anodized and punched chassis $88.00
- □ Same for 50 watt RMS stereo amplifier, includes two 25 watt Sankens, etc. $58.00
- □ Same for 20 watt RMS stereo, includes two 10 watt Sankens, etc. $30.00

SGS TAA 621 AUDIO AMPLIFIER

□ I.C. audio amplifier in 14 pin DIP package, provides up to 4 watts power with proper heat sink, and 28 Volt supply. Can be used at 12 Volts with reduced output power. - $1.95 .... 6 for $10.00

16 DIGIT POCKET CALCULATOR

COMPLETE WITH CARRYING CASE AC/DC TYPE

UNBELIEVABLE? A COMPLETE POCKET CALCULATOR FOR ONLY $99.00

We are closing out some demonstrator Sanyo pocket calculators for only $99.00. This is a complete unit with nickle cadium battery. Has eight digit LED display, with sixteen digit capability. Fixed automatic decimal at 0, 2, or 4 places. Units are demonstrators, but are in original factory cartons with guarantee cards, instructions, etc. Carries full one year factory guarantee by Sanyo. Only 35 available so order now.

- □ Sanyo Pocket Calculator $99.00
- □ AC Power Pack/Recharger $19.00

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

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

master charge THE INTERBANK CARD — $10.00 Minimum Charge — your BANKAMERICARD welcome here

B. & F. ENTERPRISES
Phone (617) 532-2323
P.O. Box 44, Hathorne, Massachusetts 01937

3

Circle 78 on reader service card

appliance clinic

USE YOUR ELECTRICAL APPLIANCES WHEN ABROAD

by JACK DARR
SERVICE EDITOR

AMERICANS TRAVEL A LOT—PLEASURE, business, military, and so on. A lot of them like to take their home with them in the form of their electrical appliances—razors, clocks, record and tape players and most popular of all lately, hair dryers, styling combs, and the like. (Guys as well as gals, in this category!) This can lead to problems in most areas of the world. U.S. electrical things are built to work on a 115 to 120-volt 60-Hz power supply. Not so in a great many other countries.

The rest of the world uses a bewildering variety of power supply voltages and frequencies. Although dc power has been displaced by ac in this country, (at least in most places) you may still find it in use in homes of other countries; Spain, Sweden, Austria, Germany, Ireland, and so on. Only in the British Isles is there any semblance of a nation-wide standard. They use 230 volts, 50 Hz ac for residential power.

The undisputed champion for variety would probably be Italy. There, you'll find dc voltages at 110, 125, 150, 160, and 250; and ac supplies of 110, 115, 125, 135, 150, 220 and 260 volts, at either 42, 45 or 50 Hz. France runs them a close second, with 110, 120, 125 and 250 volts dc; and 110, 115, 120, 125, 200 and 230 volts ac at either 25 or 50 Hz. Other countries use similar voltages; all of Europe seems to use 50 Hz, as well as all of Asia and Africa. There are a few "60-Hz enclaves" here and there, such as Taiwan.

This poses problems for our travelers. How and where can they use their electrical appliances? The answer in some cases is "Forget it!" Units that have synchronous motors—clocks, tape-recorders, phonographs, will run slow on 50 Hz. More on this later. One helpful development in the clock and tape-recorder line is battery-powered clocks and tape-recorders, with dc motors.

Other units with "universal-wound" motors can be used on the right voltage. Many of these will even run on dc. Appliances with heating elements, of course, don't care at all about the frequency, as long as the voltage is right.

This brings us to a question often received in the Clinic; "What can I do to make my ___ work overseas?" Within the limits mentioned, a great many of them can be used very well with a simple addition. Something to change the local line voltage to 115-120 volts ac. A simple autotransformer can be used to step down the British 230-volt line (remember to say "mains" so they'll know what you mean.) The power rating of the autotransformer depends on how much the appliance draws. Check the rating plate on yours to see what it needs.

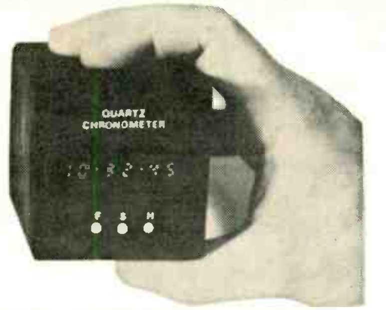
Razors need only very small amounts of power; probably from 20 to 30 watts at a guess. Hair-dryers, however, have heating elements as well as fan-motors. The motor will draw perhaps 35 watts, but the heating element can take up to 1500 watts. So check it. If the wattage isn't given, just multiply the voltage rating by the amps, and this will be good enough. Recharger units for cordless appliances draw only minute amounts; 2 to 3 watts maximum. So, a very small autotransformer will take care of these very nicely.

I get a lot of inquiries about "making up a simple dropping resistor" for these. It would work, but frankly, I'm not too fond of it. A tapped dropping resistor could be "calibrated" to work with a single appliance, but if one of a different wattage were plugged into it, the voltage would be far off. Such a device would be impractical for high-drain units like hair-driers; your dropping resistor would get hotter than the drier.

So, the suitably-rated autotransformer is probably the most practical solution for low-power units. It wouldn't be too big or too expensive. However, an autotransformer capable of handling a 1500-watt hair-drier would run about *50 pounds* in weight! A 100-watt unit weighs only 7 pounds.

(continued on page 100)

ARIES



AIRCRAFT/AUTO/BOAT QUARTZ CRYSTAL CHRONOMETER

Revolutionary!, was the reaction of our customers when they saw our latest kit. Measuring only 2-1/2" x 2-1/2" x 4", and accurate to 10 seconds a month, this chronometer promises to entirely replace mechancial clocks in cars, boats and airplanes.

Fits into a standard 2-1/4" 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 negligable power drain. The low price is only possible because of a new one chip MOS clock circuit, developed for quartz crystal wristwatches.

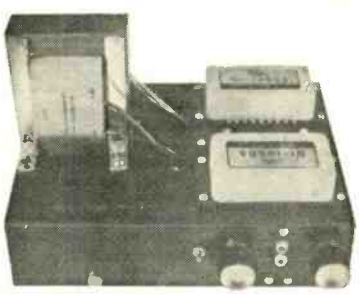
Operates from 10-14 Volts D.C. An accessory unit which mounts on the back adapts the unit to 20-28 volts for twin engine aircraft and larger boats using 24 Volts ignition. Know how disgusted you are with the usual car clock? Order this fine unit now for rallying, sports events, navigation, or just to have a fine chronometer that will give you a lifetime of superbly accurate time.

- □ Quartz Chronometer, Kit Form $59.50
- □ Quartz Chronometer, Wired $99.50
- □ 24 Volt Adapter $10.00

DIGITAL CLOCK KIT WITH NIXIE DISPLAY

Because we have made an extremely good purchase of over 20,000 nixies, we can sell a complete digital clock kit for less than the usual cost of the display tubes alone. We provide a complete etched and thru-plated circuit board, all integrated circuits, complete power supply, display tubes, I.C. sockets and a nice front panel with polaroid visor. We have never seen anyone offer this kit for less than $100.00 before. Includes BCD outputs for use as with timer option. May be wired for 12 or 24 hour display. Indicates hours, minutes and seconds.

- □ Clock Kit, complete less outside cover . . . $57.50
- □ Aluminum blue or black anodized cover . . $4.50



AUDIO AMPLIFIER KIT

This is not our prettiest kit, but it sure does perform. Hybrid Sanken audio modules make wiring easy. Output ratings are maximum continuous at 1000 Hz with a distortion less than 0.5% into a load of 8 ohms. Response is ± 0.5 db 20-20KHz @1 watt. Chassis supplied is heavy guage anodized aluminum. Capacitors are all computer grade. Level controls on both inputs.

- □ 100 Watt (RMS) Stereo Kit $88.00
- □ 50 Watt (RMS) Stereo Kit $58.00
- □ 20 Watt (RMS) Stereo Kit $30.00

50 MHz DIGITAL COUNTER LABORATORY SPECIFICATIONS AT A BUDGET PRICE!

We feel the most important thing about building a kit is saving money. There are a lot of other advantages of course . . maintainability, use of standard parts, complete documentation, and the experience and fun of building it, but the overriding consideration is economy. This kit costs less than half that of the lowest priced competitive unit on the market.

The Aries 50 MHz counter is designed for years of maintainence free service. MSI integrated circuitry, cold cathode display tubes and conservatively rated transformers mean low temperature rise. All displays and I.C.'s are in sockets for easy maintainability. The master oscillator is a 1.0 MHz crystal in a custom designed cosmos oscillator circuit, having a stability of ± 3 PPM. Accuracy is 0.005% worst case, 0.0002% or better when adjusted to WWV with a communications receiver. A front panel selects a timing interval of 1.0 seconds, 0.1 seconds or 10 milliseconds. A variable monostable multivibrator holds the count on the front panel for a period of a fraction of a second to infinity. For use in the period mode, the 1.0 MHz oscillator is connected to the main counting chain and gated by the input signal.

Assembly time for the kit is approx. 10 hours. The semiconductor complement is (1) 7400, (1) 7408, (1) 7442, (10) 7490, (2) 74122, (6) 74141, (1) 74193, (1) 74196, (1) 74S11, (1) CD 4007AE, (1) LM309, (6) Diodes, and (1) Transistor. If you always wanted a laboratory quality counter, but could never justify the price, here is your chance.

□ **50 MHz Counter Kit, Complete with Crystal Time Base and Case – Postpaid in USA $125.50**

POCKET CALCULATOR

We expected a favorable reaction to our calculator, however, we were overwhelmed when we received orders for hundreds at a time. The reaction of our customers was that they felt this was the most advanced pocket calculator on the market, and priced so low, they could assemble and market it at a profit. The features that make this so exciting are:

- **So compact it fits in a shirt pocket (3-13/16 x 4-5/8 x 1-1/4).**
- **Performs every function you would expect in a desk calculator, and them some, multiplies, divides, adds, subtracts and gives true credit balance. Includes constant and chain operation, full floating decimal, suppressed trailing zeroes, and automatic single entry squaring.**
- **Powered by self contained AA batteries with up to six hours operation (Nicad batteries with charger option, up to five hours per charge).**
- **Calculations performed by a single 40 pin LSI (large scale integration) chip. Displays are 8 digit LED's (light emitting diodes) and overflow and minus signs are also LED's.**

As a student, engineer, salesman, accountant or anyone who would like fast accurate answers, this calculator fills the bill, and at a price that unquestionably makes this the lowest price high quality calculator available.

- □ Pocket Calculator Kit $75.00
- □ Pocket Calculator Completed $99.00
- □ NiCad Batteries & Charger $17.50
- □ Batteries & Charger Completed $25.00

16 DIGIT ELECTRONIC DESK TOP CALCULATOR KIT

Just one evening puts it together. Even if you have never assembled a kit before, our comprehensive step-by-step manual makes it easy. This calculator adds, subtracts, multiplies, divides - multiplies & divides by a constant. Has full 16 digit capacity with 8 decades of display and zero suppression. Entries and answers with greater than 8 digits can be displayed in their entirety in two alternate sections: the last eight digits and those digits exceeding eight. Negative results are correctly displayed, and an error symbol indicates an overflow beyond the 16 digit capability. Sequential operations can be performed using the answer to the previous operation as one of the entries for the next. The decimal point can be positioned following any of the eight least significant digits and will be carried automatically during subsequent operations. An additional good feature, concerning the beginner, is that all major components are in sockets, making trouble-shooting easy. And if all else fails, (an unlikely occurance) you can send it back to Aries and we will fix it for a maximum of $10.00, no matter what is wrong, baring gross negligence.

□ Kit - with Power Supply & Case $99.00

Dear Customers;

Due to the tremendous demand for B & F Electronic kits a new company, ARIES/BF, has been formed. This move provides a complete, well staffed organization to deal with kits and only kits, thus offering faster delivery, better service, and most important of all, a continuing flow of new kits that will advance the "state of the art" in their fields.

The activities of the entire staff of ARIES/BF will be devoted full time to satisfying your needs and providing you with a large selection of interesting and up-to-the-minute kit devices for the home, the car, and the electronic shop.

Although ARIES is still at the mercy of vendors for their delivery in some cases, every effort is being made to develop sufficient inventory to be able to assure off-the-shelf delivery of all our kits.

Sincerely,

Arthur Pennell

Arthur Pennell
President, ARIES/BF

ARIES INC.
119 Foster Street, Peabody, Mass. 01960
(617) 532-0450

Please send:

Qty.	Description	Amount

Name ____________

Address ____________

City/State ____________ Zip ______

□ Check Enclosed □ Master Charge □ BankAmericard

M.C. No. ____________

B.A. No. ____________

Expiration Date ________ Bank No. ________

Please call factory for quantity prices

Circle 81 on reader service card

APPLIANCE CLINIC
(continued from page 98)

Frequency changers

It is, of course, *possible* to make frequency-changers. All you need is a power supply, an oscillator that will run at the desired frequency and a power amplifier. However, it would be shockingly un-economic. For very low-power units OK; but for high-power output, the output transistors alone would probably cost more than the price of a new appliance that would work on the "native" current. This says nothing at all about size, either. A 40-pound, \$250.00 converter running a \$19.95 electric razor would not make sense.

To sum up, it would be easiest to select cordless type appliances for your overseas journey, if possible. For the rest, check the power ratings on the plate. If they run up around 1000 watts you'll probably be better off leaving them at home. You can get power-adapters such as auto-transformers, in this country. One type is handled by the Franzus Co. Box 395, Shamokin Pa. 12872.

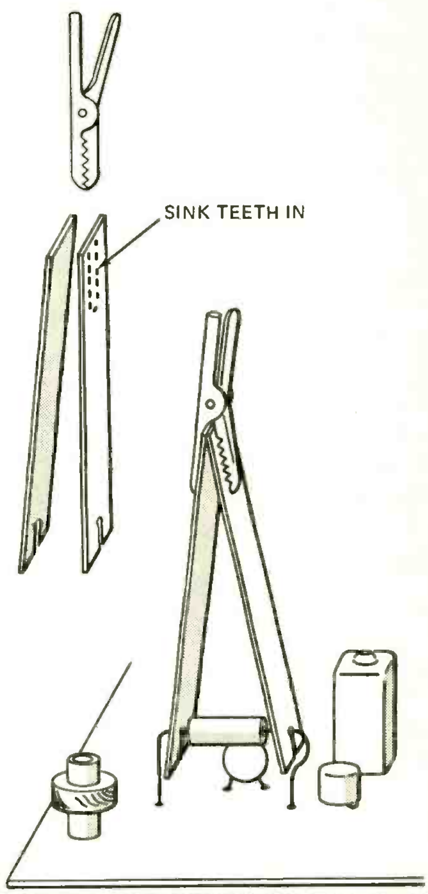
Of course, there are simple solutions. If time is your problem, just lift the phone and say "Bonjour, m'selle. Q'est-ce-que le temps du jour?" Of course, this won't work too well in England; there, the response would probably be "Coo! Wot did 'ee sye?" Of course, you could always listen for Big Ben.

One final cheerful note. By choosing your tour carefully, you can get along very well. The *Society Islands* in the South Pacific use good ol' 120-volt, 60-Hz power! Aloha. **R-E**

try this

LOW-CAPACITANCE PARTS SUBSTITUTOR

This parts holder lets you try resistors and capacitors in a circuit without the loss of video or sound signals usually caused by hand capacitance. Cut



two strips of stiff plastic, then drill and slot their ends to take the part's lead wires. Clamp the strips in an alligator clip and heat both sides until the teeth sink in. When cool you have the tool.—*Peter Legon* **R-E**

market center

TUBES

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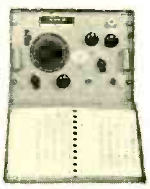

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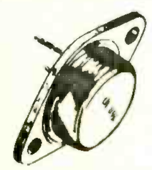

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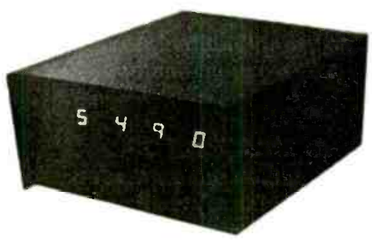

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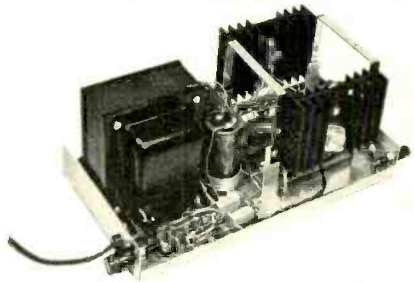

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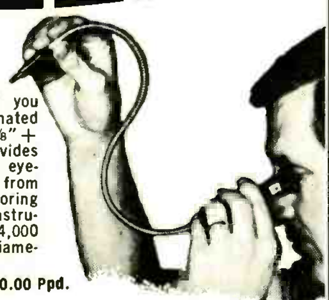

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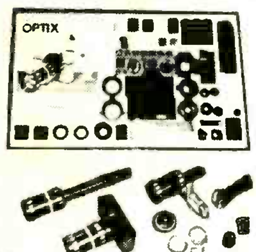

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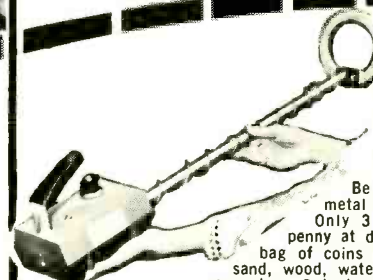

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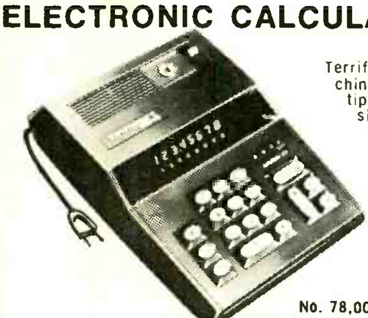

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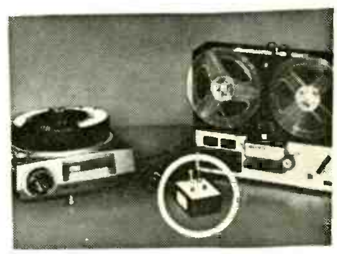

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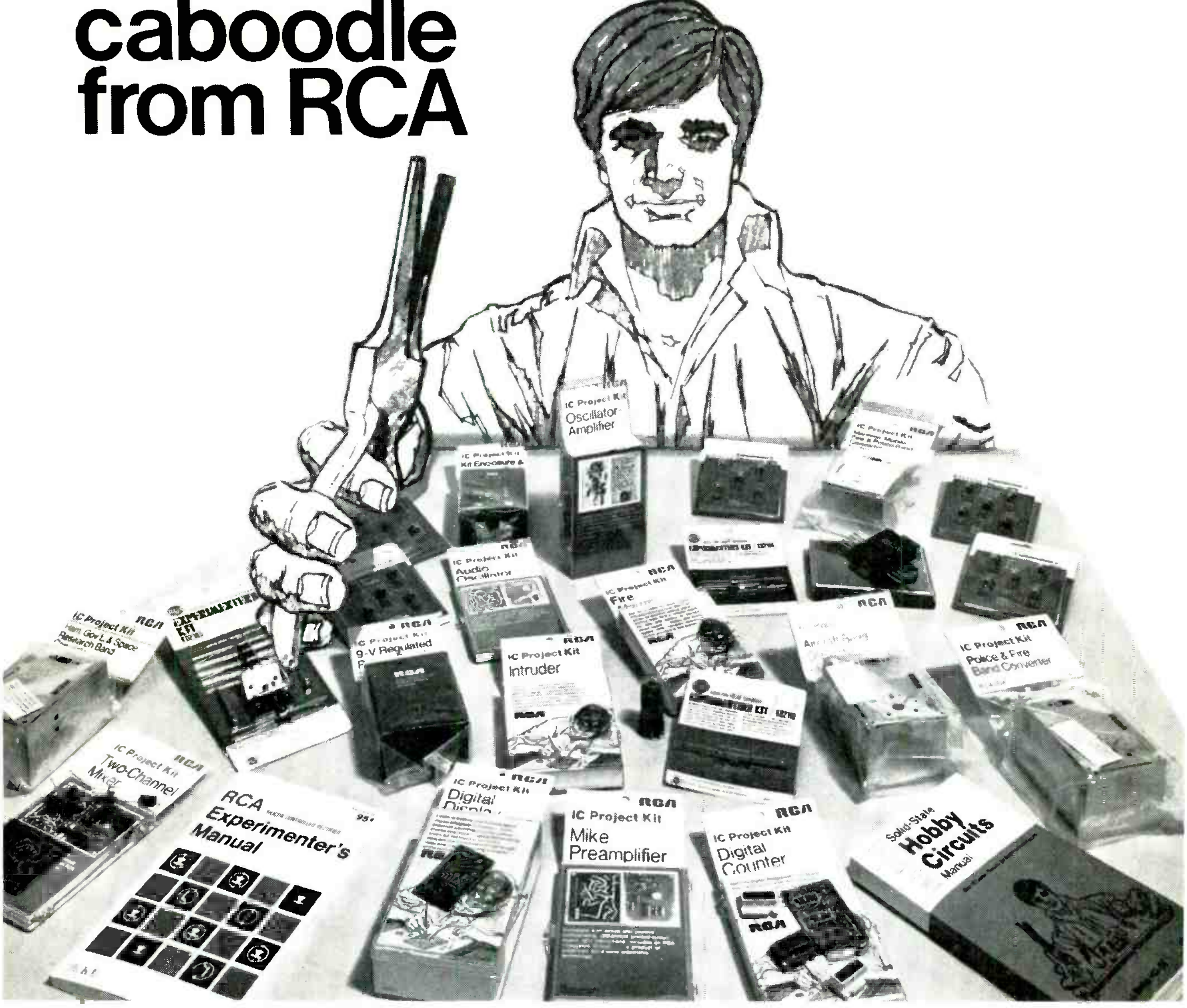

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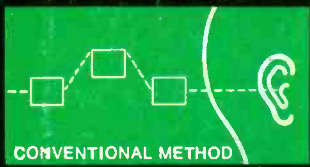

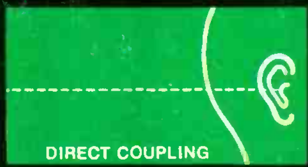

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