Electronics World

JANUARY, 1969
60 CENTS

Adding Remote Speakers to Hi-Fi Systems
Unique C-D Ignition Design for Cars
TV Systems for Teacher Education
BART—Prototype for Future Mass-Transit?

New 1969 COLOR-TV RECEIVERS

Should you be a nitpicker...

Should you be a nitpicker when it comes to selecting a stereo deck? Only if you want to get yourself a deck you'll be happy with for years to come.

Because every manufacturer *claims* to have the "guts" to make the best sound. But, if you had the opportunity to "tear apart" most of the tape recorders on the market, you'd find a lot of surprises inside.

Like flimsy looking little felt pressure pads to hold the tape against the heads which actually cause the heads to wear out six to eight times faster than Ampex heads.

Like stamped sheet metal and lots of other not-so-solid stuff that gets by but who knows how long? And all kinds of tiny springs and gadgets designed to do one thing or another. (If you didn't know better, you'd swear you were looking at the inside of a toy.)

Like heads that are only adequate. Heads that might work fine at first, but wear out sooner and diminish the quality of sound reproduction as they wear.

There are lots of other things, but that's basically what *not to get* in a deck.

Okay, now for a short course in what *to get.*

Exclusive Ampex dual capstan drive. No head-wearing pressure pads. Perfect tape tension control, recording or playing back.

Exclusive Ampex rigid block head suspension. Most accurate head and tape guidance system ever devised. Solid.

Exclusive Ampex deep gap heads. Far superior to any other heads on the market. Last as much as 10 times longer. There's simply no comparison.

So much for the "general" advantages of Ampex decks. Ready to nitpick about *specific* features on *specific* machines? Go ahead. Pick.

Pick the Ampex 755 for example. (This is the one for "professional" nitpickers.) Sound-on-sound, sound-with-sound, echo, pause control, tape monitor. Three separate Ampex deep gap heads.

Or, pick the 1455. For lazier nitpickers, because it has automatic two-second threading and automatic reverse. Plus sound-with-sound, pause control and tape monitor. Four separate deep gap heads.

One more thing you should get on your next deck, whichever one you choose: the exclusive Ampex nameplate on the unit. Just big enough to let everybody know you've got the best. (Who says a nitpicker can't be a name-dropper too?)

So, pick, pick, pick. And you'll pick Ampex. Most straight-thinking nitpickers do, you know.

AMPEX

AMPEX CORPORATION
CONSUMER EQUIPMENT DIVISION
2201 LUNT AVENUE
ELK GROVE, ILLINOIS 60077

Model 755

Model 1455

A deck for nitpickers.

And a deck for lazy nitpickers.

CIRCLE NO. 124 ON READER SERVICE CARD

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Triggered Sweep Makes The Difference

With The Type S54 Solid-State Oscilloscope

A true waveform measurement system, with the implied control, range, and accuracy; and designed for the service industry.

- Full triggering capability with AUTO or LEVEL selective modes plus TV frame or line capability.
- Bandwidth is DC to 10 MHz.
- Deflection factor is 0.1 V/cm.
- X10 gain increases deflection factor to 10 mV/cm, DC to 4 MHz.
- Vertical attenuator and Horizontal timing accurate within 5%.
- 6 cm x 10 cm illuminated graticule.

Type S54 . . . . **$350**
U.S. Sales Price FOB Beaverton, Oregon 97005

Or The Type D52 Double-Beam Oscilloscope

A unique measurement package for applications requiring analysis between two time-related signals. The instrument combines two separate vertical channels, a calibrated time base, and full triggered sweep capabilities with a low price of $360.

- Full level selective triggering has internal source from either channel plus TV frame and line capability.
- Bandwidth is DC to 6 MHz.
- Deflection factor is 0.1 V/cm.
- X10 gain increases deflection factor to 10 mV/cm at DC to 1 MHz.
- Vertical attenuator and Horizontal timing accurate within 5%.

Type D52 . . . . **$360**
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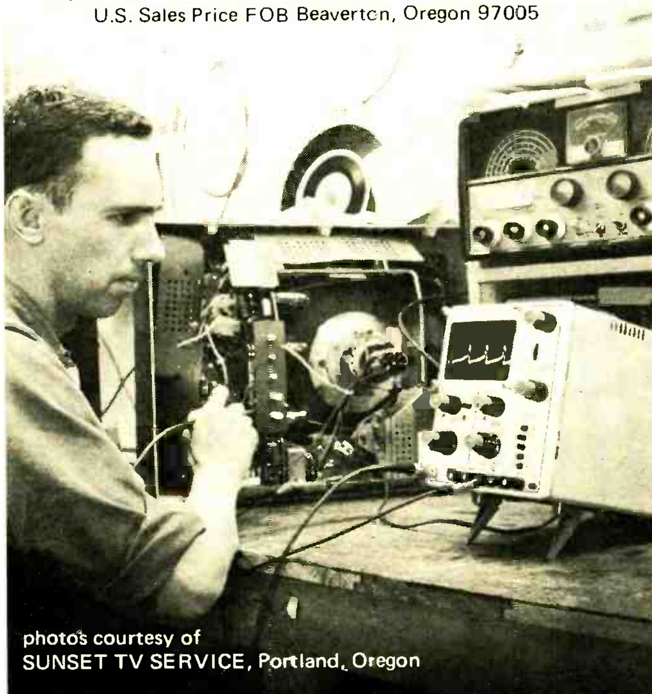

photos courtesy of
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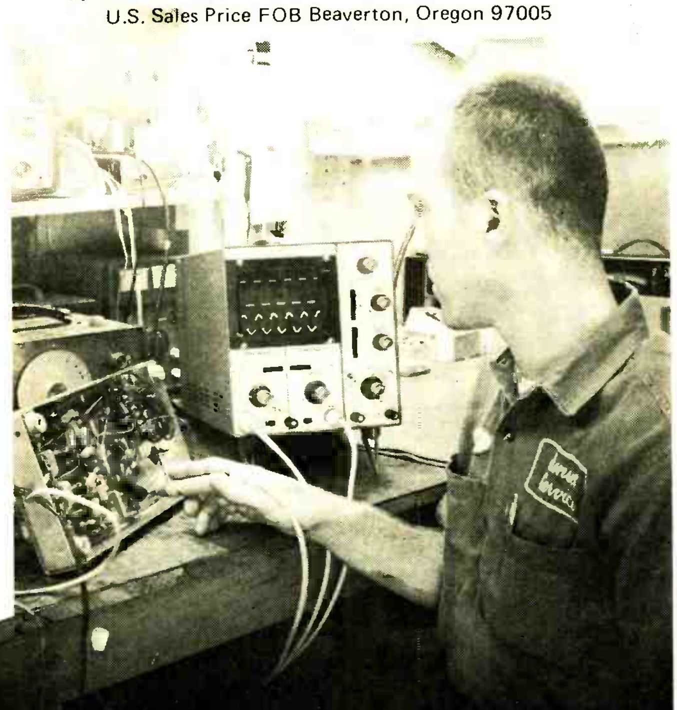

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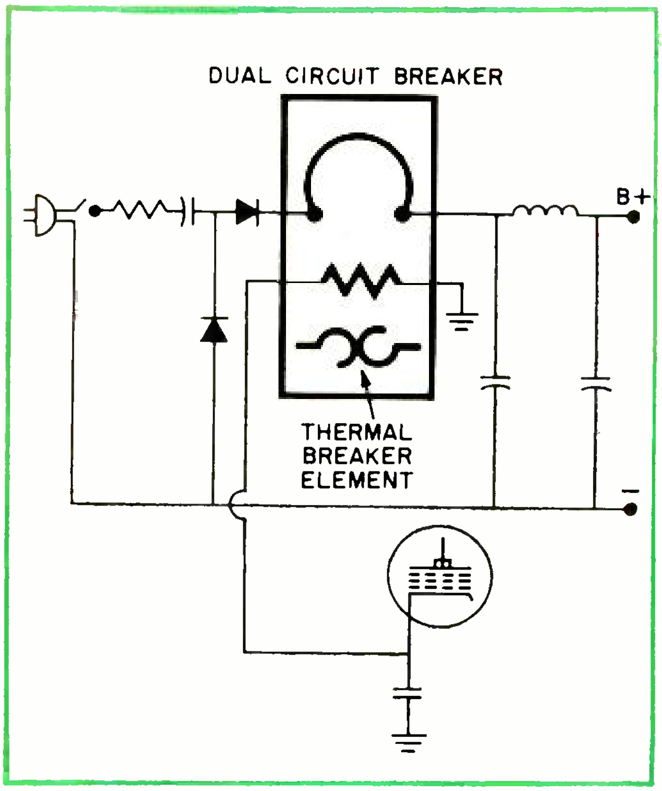
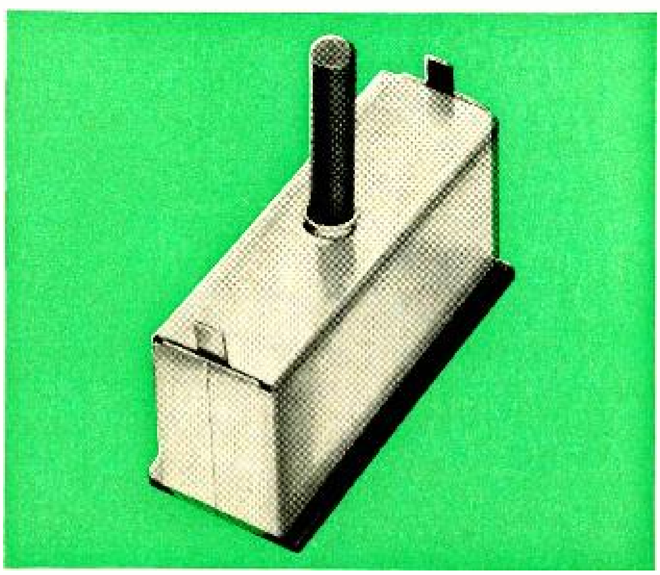
CIRCLE NO. 200 ON READER SERVICE CARD

New circuit breakers for color TV



Typical hook-up for dual circuit breaker



Dual circuit breaker

Practically all the new color TV sets have a new kind of dual circuit breaker in them which you may not have run into before. Here's the story.

Remember back when black-and-white television used two fuses—one in the power supply input, and one in the horizontal output circuit? Next, in the interest of economy, the fuse in the horizontal output was eliminated. Then the designers switched to re-settable breakers, in the B+ line.

Along came color. Overload protection became necessary, because the horizontal circuits are more complicated, and more expensive components including the flyback transformer could be knocked out by a defect in the horizontal circuit.

The answer: a dual breaker which pops out from excess current in *either* the B+ or the horizontal output . . . in a single breaker case. It has two electrically isolated but thermally connected circuits, either of which can cause the B+ contacts to open.

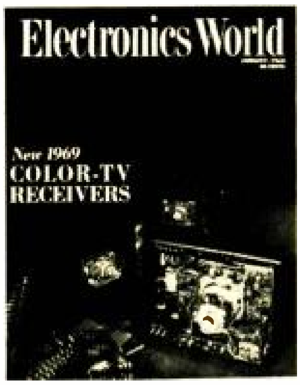
The diagram shows a basic hook-up for the breaker. The thermal breaker element goes directly in the B+ line. A resistor inside the breaker, usually about 1.3 ohms, is connected between the cathode of the horizontal output stage and ground. This resistor is located so it will heat up the thermal breaker element.

Along comes an overload in the B+. The thermal element pops the contacts open, in the usual manner. When there's excessive current in the horizontal output, the heating of the breaker's resistor has the same effect as a B+ overload, opening the contacts and removing voltage from the circuit.

Tip No. 1: breakers can fail because they get repeatedly reset into a fault. Check for gassy tubes and leaky capacitors before you replace the breaker, or you'll have the whole job to do over.

Tip No. 2: always replace with a Mallory breaker. We have three different dual breaker ratings in our line. They will replace the dual breakers in all existing color set applications. All are made to original equipment specifications. Your nearby Mallory distributor can supply you off the shelf. See him soon, or write to Mallory Distributor Products Company, a division of P. R. Mallory & Co. Inc., Indianapolis, Indiana 46206.

REMEMBER TO ASK—*"What else needs fixing?"*



THIS MONTH'S COVER ties in with our lead story on "Color-TV for 1969" by Forest Belt. One of the trends for the new models is the appearance of a number of smaller color sets with pictures of 15-in or less. Typical of these are the three 14-inchers shown. The receiver at the bottom right is the RCA Model EL-424. We have removed the back cover to show the unusually compact construction required to get the size down. The receiver at the left is Zenith's Model Z3508W, while the set in the right background is Sylvania's Model CB-34W. On the picture tubes of these two receivers we have simulated closed-circuit TV displays showing two other rear views of the RCA set. . . . Photo by Dirone-Denner.

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MONTHLY FEATURES

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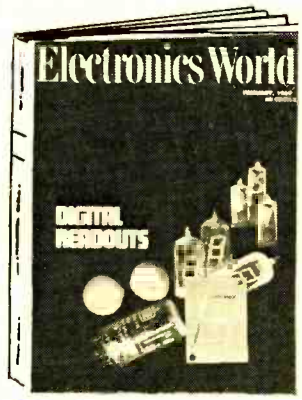
COMING NEXT MONTH



SPECIAL FEATURE ARTICLE:

DIGITAL READOUTS

Automation has changed the way we look at things. Only a few years ago, it was cheaper and easier to interpret data from a meter deflection. Today, information is available in digital form and so the trend is to digital readouts. This article discusses the advantages and disadvantages of a number of the most popular types, and includes a table where the characteristics and cost of devices made by Tung-Sol, IEE, Dialco, Burroughs, Raytheon, and others, are compared.

STEREO VS CONCERT HALL
Most home music systems are better than some of the earlier professional models. Yet, they fall far short of "live" listening quality. Article points out some of the limitations of stereo reproduction.

CHROMA ALIGNMENT
Alignment of the chroma section of a color-TV receiver is one job which even expert technicians fear. There are so many different circuits and methods. In this article, Forest Belt takes the high-mindedness out of the procedures and brings chroma alignment down to earth.

GEOMAGNETIC OBSERVATORIES
The earth's magnetic field is of prime importance to geophysical scientists, and not so surprisingly, the military is interested too. In this article, some of the techniques and equipment scientists use to measure geomagnetic fields are covered.

THE "REGVERTER"
Most mobile electronics equipment has to use power-conversion devices. Some converters are huge, yet are only mediocre regulators. The "Regverter" is a solid-state circuit which combines reliability and efficiency with small size.

All these and many more interesting and informative articles will be yours in the February issue of ELECTRONICS WORLD . . . on sale January 16th.

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Radio & Television news

By FOREST H. BELT/Contributing Editor

Keeping Good Technicians

It still looks like a long time before there will be enough service technicians to go around. Half the shop owners we talk with tell us how hard it is to find and keep able technical help. They all seem to wonder what the reasons are.

The Service Committee of EIA sums up the problem in the word "motivation." At last fall's Conference the Committee decided the biggest job lies in selling young people and their parents on the dignity, challenge, and reward of consumer-electronics service work. The place to start, they say, is in the high schools and colleges—letting teachers know what a vast market there is for this kind of trained manpower.

Yet, how well does the service industry motivate these youngsters afterward? In many localities it offers low salaries, no fringe benefits, long hours, and dirty shops in which to work. How can we expect clean-cut young fellows to find anything glamorous or challenging in a business that, taken all around, shows less than average pride in itself? We can't—and therein lies one key to the motivation that is needed.

Dr. Victor Howard, consultant in personnel management, has this to say about it. "Motivation is a pyramid of values an employee wants and needs. Physiological needs are at the base followed by safety or security needs; then social needs, ego needs and, finally, the need for self-fulfillment."

In more specific terms, here is what it takes to motivate young service technicians: a comfortable, clean, well-lighted place to work; safe, sturdy, trustworthy tools and equipment to work with; training in how to work safely; satisfactory wages sufficient to permit family security and a reasonable social standard; disability insurance and pension plans that relieve them of uneasiness and worry that saps useful energy; self-respect—which could best be evidenced by a firm conviction among those already in the servicing business that it's a rewarding career; and advanced training to satisfy the willingness—indeed, the insistence—of today's young people to learn more and more about whatever interests them.

These are the things it takes to find and keep good technicians. All of them are available and are already being provided by many business-minded service-shop operators. Without these, the independent service industry has little hope of attracting the kind of young men it needs to keep it alive and independent.

Warranties Simplified?

The wording is maybe . . . but for the service dealer there is little change. What the major electronics manufacturers are doing is shortening the long-winded way warranties have been written. Of course, it may help servicers to spell out clearly that warranty "service, labor, and transportation charges . . . are the purchaser's responsibility." Buyers may eventually quit expecting free labor under extended warranties.

This simplification, however, is not what government (and private) consumer protectionists are really after. Ostensibly, they want a warranty that covers everything—so the buyer pays nothing for repairs that become necessary during the warranty period. If you read between the lines though, and listen carefully to what they say, you come to realize that they are actually promoting a lifetime warranty—one that covers the entire useful life of an appliance.

That's virtually a throw-away philosophy. Buy something, use it, and the manufacturer covers any repairs it needs until the time comes to get another. Then just throw it away and buy another. With most items, if there were any servicing at all, it would be done only by a manufacturer-operated servicing facility.

One step in that direction has already been taken. It's called "exchange warranty." If an appliance goes bad in warranty, take it to a center and get another free. That doesn't go on forever but it does eliminate servicing through a certain period. The 2-year exchange plan on *Motorola*'s Quasar modules is similar, but so far it requires a technician to know which module to exchange. Still another angle on the same theme is part of almost all leasing plans. A user merely leases the equipment, with all maintenance furnished by the leasing company. When the time comes for a new unit, the user merely signs a new lease. Payments are made once a month, and no repair bills, ever.

Simpler warranties, if not overdone, could improve industry-customer relations. It's important, however, to examine the deeper implications. They might not all be good.

What 1969 Will Bring

With every new year, industry sages predict what they think will happen during the ensuing 12 months. Columnists get that urge too; so here is what I expect in 1969.

So much hinges on the economy in general. With a new President, a different party, we can be sure we'll see a changed approach to the seeming impossible task of maintaining a boom while cooling it. This boom has a lot of momentum, and won't cool much for awhile, even if peace is really achieved in Viet Nam. The consumer electronics industry is affected in a roundabout way, of course, through higher or lower wages brought on by war and defense spending.

The boom will likely last till after midyear, even in spite of attempts to slow it down. Spending for home electronics will keep climbing at present rates, at least. If no further attempt is made to curb consumer spending, the second quarter of 1969 could become a record-breaker. Here are just a few specific examples:

Color-TV in 1969. Color-TV, having failed to spurt significantly near the end of 1968, may wait until mid- or late next year to climb again. Color sets now outsell black-and-white, but the next surge in sales won't occur until the newness of solid-state wears off. After more transistor chassis have appeared (probably in the spring lines) the public will lose its wariness. Then look for a sharp upturn in sales.

Hi-Fi in 1969. Hi-fi, still waiting for its next "big" innovation, will increase at about the same rate it is now—slowly, but steadily. There's no sign of anything startling to come, certainly not before late in the year. You'll hear a couple of good new ideas early in the spring but they won't start any new fads.

Auto Stereo. Speaking of fads, this one is building a record of striking growth. An awful lot of 1969 cars will have auto stereos installed at the factory. Some will be combination systems—both cartridge tape and stereo-FM. The dominant cartridge system is 8-track continuous loop. But there's rumbling that suggests more cassettes are usurping the automobile market. They won't sideline much 8-track business but a lot of the natural increase in this field will go in the cassette direction. The chief encroachment will be in the used-car after-market. Cassette machines and tapes are less expensive than 8-track. Stereo cassettes with higher fidelity, played on machines with better heads, are only around the corner—and that will alter the emphasis. Look for more companies in the business and for auto stereo to be the fastest-growing segment of consumer electronics in 1969. It'll probably take till 1970 for this particular mini-boom to slow down.

Electronic Music in 1969. Here's one more home-entertainment product to watch in 1969. Any real growth at all will amount to a boom since the field is hardly scratched. I don't mean the amplified-instrument business, but "synthetic" electronic music. So far this has been mainly a lab or university curiosity, although it has gained some acceptance in *avant-garde* circles. It produces some of the strangest and wildest sounds you've ever heard, and some of the most charming. The "instruments" now sell in the neighborhood of $3,000. The possibilities are enticing, though. Look for a less expensive version for home and junior band use.

Color-TV X-ray Radiation

Back to the here-and-now. Almost after any need for it, at least for color-TV, there is a radiation law. It squeaked through Congress in October. But that's nowhere near the end of the matter. Even though most color sets now use circuits that can't cause the h.v.-regulator radiation problem that kicked off the x-radiation uproar. The Department of Health, Education and Welfare (HEW) still must set standards. The lack of such standards makes a fiasco of the law in most respects. Color set manufacturers must, at their own expense, remedy any radiation defect that occurs. (That's what *G-E* did, anyway.) The funny part is that there's no way—under the new law—to decide if there is a radiation defect. Even more to the point, there is still no evidence that the soft x-rays do any harm anyway. So the law enjoins HEW to sponsor research to find out if they do—but to set standards whether or not they do. This seems like a strange tail-wag-the-dog law that developed from "scare" publicity and pressure. The bill does apply to other electronic equipment but it is virtually pointless for the equipment that triggered the whole thing.

Solid-State (Almost) Color-TV Display

In a laboratory in Tokyo, a Japanese professor found a way to draw a new type of optical fiber at very low cost. One practical use he recently demonstrated is for a flat color-TV screen. The fibers are arranged so that colors appear in lines instead of in dot triads. However, the optical fibers do not produce the colors themselves. They are merely connected to red, green and blue filters over three monochrome CRT's. The various color signals are applied to the tubes separately and carried to the viewing surface by the fibers. So we don't have a non-CRT color-TV display yet, but this kind of research helps keep the fires stirred. ▲

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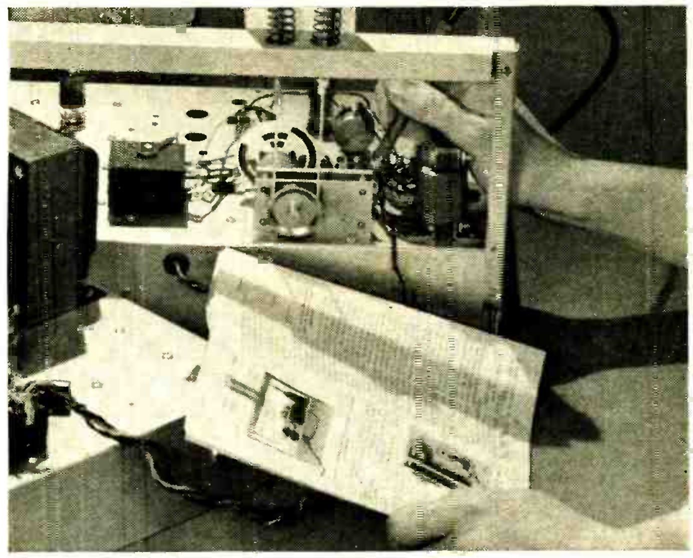

Reading is a necessary part of any training program, but it takes a great deal of stamina to wade through a 300-page technical textbook. Every NRI course is condensed into "bite-size" texts that are simple, direct, well-illustrated, averaging an easily-digested 40 pages. These are "programmed" with NRI training equipment you build, experiments you perform, to bring to life the fundamental laws of electronics, the theory, the training of your choice. You are always kept well supplied with these books, NRI does not require you to "pay as you go."

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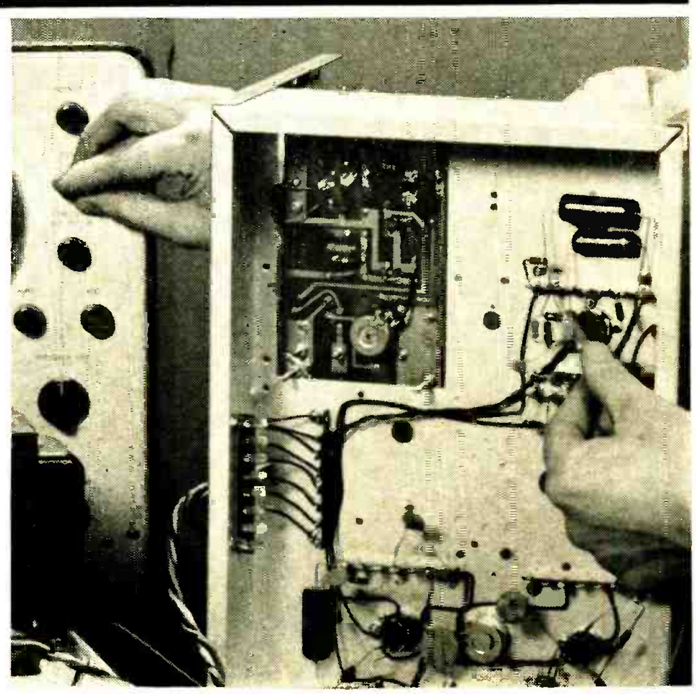

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Reflections on the news

Electronics Growth . . .

has slowed and the industry expects this downward trend to continue to midyear. The reason, according to *Electronics Industry Association's* president, Mark Shepherd, Jr., is that "uncertainties in the general economy had turned business conditions 'sluggish.' "

Apparently, these "uncertainties" revolve around speculation of the direction which President-elect Richard M. Nixon will want (or be forced) to take as to Viet Nam, tax-surcharge, and general government spending. It is safe to assume, we believe, that there will be little change in the Vietnamese situation because Nixon's Asian policy is not expected to be very different from that of LBJ. Thus, defense expenditures (DOD) probably will rise another \$3 to \$5 billion over the fiscal '68 request.

Generally, most areas of electronic industries—consumer products, industrial electronics, government electronics, replacement parts, etc.—show some slight growth. The estimated total sales in 1968 (millions of dollars) were about \$23.600; in 1969 the total expected sales are only \$21.600.

Software . . .

is often the least-thought-about but perhaps most expensive and time consuming—as well as troublesome—part of a computer operation. De-bugging a computer program may take months of tedious work with trial runs and sample calculations repeated over and over again. And after all of this, one tiny programming error can easily shut down a huge multimillion-dollar computer thereby making the entire system useless.

According to Murphy's Law, "when there's a possibility of something going wrong, it will," and this is exactly what happened during the recent national elections. Two giant *IBM* System 360 Model 40 computers suddenly began spewing false data—reporting wrong vote tallies and percentages for the wrong candidates—forcing a switch to a slower, back-up, vote-tallying system. However, the director of the News Election Service said the computers were not to blame and that the difficulty was traced to programming. It seems that more than 10.000 hours were required to develop the program and other computer instructions but, nevertheless, a simple numerical error concerning the number of precincts reporting caused the confusion.

Programming has been called an exacting art. Instructions in symbolic form are fed via a typewriter, tape, or other similar machine, into the computer; from that point, the action becomes complicated. The data is stored in the computer's memory banks until required. Then, after passing through a series of addresses and shifts, the instructions are picked up and the calculations made.

Lasers . . .

may be a more efficient and rapid method of detecting and tracing air pollutants than existing methods which require substantial time and manpower.

For some time, lasers have been used experimentally to detect clear air turbulence. The technique is based on the premise that laser light is reflected by miniscule particles (pollutants) swirling around in clear air storms. This same premise will be used in an air pollution detection study by the *General Electric Space Sciences Laboratory* under the auspices of the Appalachian Regional Commission (Pennsylvania Chamber of Commerce). Under the program, *G-E* will build a trailer-mounted laser device capable of remotely detecting the accumulation and motion of various types of air pollutants within a radius of five miles.

An Electron Microscope . . .

twenty times more powerful than conventional 100.000-volt instruments, is "on-line" at *U. S. Steel Corp.*'s research laboratory in Monroeville, Pa. The new million-volt unit, which was designed and built by *RCA*, can resolve structures down to their atomic dimensions. Thus, it should be able to detect particles of only two-angstrom size, or approximately 1/250,000,000th of an inch diameter.

Why is such a powerful tool needed? Well, metallurgists will use it to confirm old theories and postulate new ones on the fine structure of materials, to explain strength, fatigue, electrical and electronic properties, phase transformations and chemical reactions. In short, they may be able to use it to develop new materials more fitting to the space age. Biologists see the instrument as useful in studying disease-produc-

ing viruses and bacteria; and (through observation of the beginning of certain life-functions) in finding the causes of some now-incurable diseases.

Although the *U. S. Steel* microscope is extremely complex, it is highly automated and can be operated by one man. It contains three television systems, each employing small transistorized cameras to provide personnel safety and instrument versatility. Two TV systems are trained on meters and other points so that the operation can be monitored without exposing the microscopist to radiation. The third system is used for image intensification. In this way, the strength of the electron beam can be reduced as much as 50 times to diminish the effects of heat and radiation on the specimen.

Flat-Faced Display Devices . . .

that could replace a cathode ray tube have been high on the priority list of military and commercial instrument manufacturers but, so far, designers have been unable to come up with a practical working model. A matrix of light-emitting diodes could do the job but the problem has been interfacing each diode with buffer circuits which could individually turn each on or off. *General Electric's Electronics Laboratory* thinks it has the problem solved. Instead of adding control or buffer circuits to the matrix, they use a monolithic IC which also contains a light-emitting gallium-arsenide diode. Thus, they have a miniscule component which contains its own logic, memory, and light.

Not all the problems have been erased by this technique, however. The chips are limited in size—about an inch at a density of 400 dots per inch—and the gallium-arsenide phosphide gives off an infrared light. Thus, a special electroluminescent panel is needed for viewing.

Since Artificial Heart . . .

research has shifted into high gear, scientists are speeding up their search for sources to power them. Thus, bio-electric power supplies, which use chemical reactions inside the human body to generate power, are receiving more than passing scientific interest. In the January, 1968 issue of EW, we discussed the development at the *University of Pennsylvania* of a biological fuel cell, and in the March issue we talked about how platinum electrodes imbedded in the heart could be used to obtain voltage outputs of .25 volt or more. Now, space scientists at *G.E.'s Re-entry Systems Division* have developed a technique of implanting zinc and platinum electrodes within the body to produce 50 microamps at 0.8 volt. They claim no biological damage from galvanic chemical reactions, and a rabbit used in the tests has been generating power for a transmitter implanted in its body for over nine months.

Some Thoughts . . .

about things going on. Have you heard that *RCA* has developed a contraceptive device that can be inspected electronically? The intra-uterine device is a plastic ring approximately three-quarters inch in diameter. Inside are electrical components and a flexible wire. When in proper position, the device gives off one signal—and another when it's distorted or displaced. . . . A Connecticut-er, Luther Simjian, has patented a method of transmitting messages while simultaneously translating them into one or more foreign languages. The system is called Teletrans. Here's how it works: a sensor automatically scans a taped or typewritten message and records it, matching the words to code characters on a revolving drum; then it transmits the recorded code by wire or radio. The code for a word in English is also the key to the foreign language equivalent. When the coded message is decoded at the receiver, the operator controls the output language by inserting appropriate discs. The inventor of this new system claims a thousand word-and-figure vocabulary. . . . *Sylvania's Ultronic Systems* subsidiary will assist the brokerage firm of *Paine, Webber, Jackson & Curtis* in a six-to-eight-month study of the firm's information network and recommend communications requirements. The study could result in a model communications system which other large investment firms could utilize. It is expected that the stockmarkets' average daily volume will soon reach 23-million shares a day. By 1980, the daily market volume could reach 36 million shares. This points up the need for a reliable, quick-reaction communications network. . . . Automatic highways are on the way. The *Ford Motor Company* is conducting tests on an electronic vehicle control system which may be a forerunner of automatic highways. The program is one of two *Ford* studies known as "Automatic Headway Control" (AHC) and is essentially a computerized brake and throttle control unit. . . . It's possible for commercial shipping to navigate anywhere in any weather by utilizing signals from polar orbiting satellites of the U. S. Navy Navigational Satellite System. The satellites, which cross over the North and South Poles, orbit the earth every 108 minutes and broadcast their position every 2 minutes. The navigational equipment was developed by *ITT Federal Laboratories*. . . . Industry is complaining that university post-graduate programs are not enough and have taken it upon themselves to provide their upper-level engineering and technical personnel with their own brand of continuing education. ▲

The Alarmists.

Radar Sentry Alarm supervises security from every angle.

Radar Sentry Alarm covers every angle.

It works on the same principle used by the U.S. government to protect our borders. Microwaves beamed by an installation of modular units are foolproof.

Any human movement, even the slightest gesture, sets off the alarm. And what an alarm! An ear-splitting blast that would frighten anything. You can't beat it.

And there's no way to escape detection ...whether the intruder comes in from the wall, window, door or ceiling. Even if he shuts off the power, the alarm sounds.

This is the newest and completely proven system that everyone's talking about.

Take any of the set-ups pictured here.

The smallest is our model 301: its remote detector unit covers up to 5,000 square feet. Can set off an alarm that's heard half a mile away. Add up to 3 antennas for a coverage of up to 15,000 square feet. Model 5006 modular unit is 6 units in one. It will cover up to 90,000 square feet. The big one on the right, 5010, will give customized coverage of up to 150,000 square feet.

Take any of these solid state numbers, add Dialtronic automatic telephone dialer, programmed to phone the police or direct-hook-up or, in case of fire, the fire department. Or add the special Radar Sentry Alarm holdup and prowler alarm. It can be used in combination with any of these set-ups, plus the telephone alarm, without the thief's knowledge.

There's no hiding place. These units are considered the best burglar traps in the world. Solid state circuitry gives effective performance, means a minimum of false alarms and reliable operation. And the heart of the electronic system is printed on one single printed circuit module. To replace, just pull out the old one, plug in the new one, no lapse in security.

Design your own inviolable customized system with Radar Sentry Alarm and accessories. You won't be able to find a more versatile, more adaptable system...nor one that is more tamper-proof against burglars.

Get the full story on Radar Sentry Alarms. Write now for our new booklet covering all the facts.

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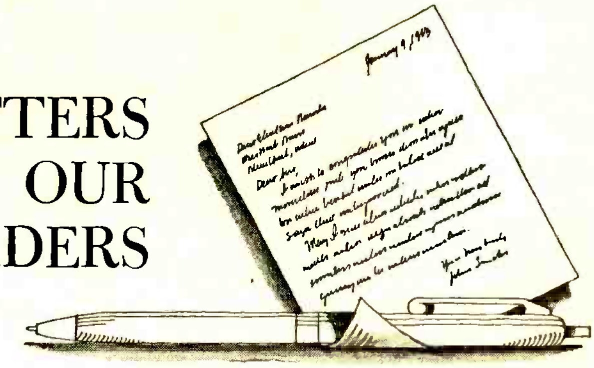
CIRCLE NO. 86 ON READER SERVICE CARD

LETTERS FROM OUR READERS



GI ENGINEERS

To the Editors:

Being a "GI Engineer" I must take issue with a statement made on the same subject in your June issue.

You say, "Engineers who are drafted into the Army as enlisted men have limited opportunities for serving in engineering-related capacities unless they go to Officer Candidate School."

Army regulations provide for a Scientific and Engineering Assistants Program for enlisted men with engineering, math, and science degrees. It has been my experience that a draftee with a technical degree will have a much better opportunity "for serving in engineering-related capacities" in the S&E Program than if he chose to go to OCS. Where the S&E loses out is in that he is still responsible for the routine "dirty work" of the enlisted man which an officer does not contend with, and also he receives an income less than one-half that which he would receive in civilian life including all "benefits."

The fate of the officer candidate is reflected in the fact that the schools now open are infantry, artillery, and engineers—the three combat specialties. In the Summer of 1967, the OCS program was closed to all but college graduates and/or enlisted men with one year military experience. In the Spring of 1968, OCS was re-opened to high-school grads mainly due to the fact that large numbers of OCS enlisted college grads were dropping out of the program. The Army claimed that these people were "improperly motivated."

It is very distressing that civilian industry generally looks down on a college grad who went through the Army as an enlisted man.

JOHN E. DUNSTAN, SP/4
White Sands Missile Range, N. M.

As mentioned in our story, the quotation and other information were taken from a report by the Engineering Manpower Commission of the Engineers Joint Council.—Editors

* * *

RARE-BLOOD CLUB

To the Editors:

Lou Goldberg, WB2SSM, has been named chairman of the Amateur Radio Div. of the National Rare Blood Club.

Mr. Goldberg, a rare blood-er, will canvass the 300,000 amateur radio operators in the United States to seek out those with rare blood and invite them to join the Club, 164 Fifth Ave., New York, N. Y. 10010. The Club is searching for the 25% of the population that has rare blood, in view of the increasing shortage of the fluid in hospitals across the country.

Rare-blood donors are not paid, nor does the recipient of rare blood pay for the blood he receives.

SAM BLAKE
New York, N. Y.

* * *

CO-OP ENGINEERS

To the Editors:

As one whose every waking hour is lived in an acute awareness of cooperative education, I was pleased to see the fine article which Mr. Greenwald and Professor Seidman wrote for ELECTRONICS WORLD magazine in August.

I offer my congratulations on your handling of the subject and for the mentions of Northeastern University.

I have passed the story on to Dean Roy Wooldridge and to each of my staff writers, whose work so often revolves around this topic.

Several of the statements you make are truly "quotable," and I would like your permission to use excerpts from your article from time to time.

PAUL F. MCNEESE, Director
Northeastern University
Boston, Mass.

We are pleased to grant reader McNeese permission to quote from the article provided ELECTRONICS WORLD *is credited as the source.—Editors*

* * *

FROM A CO-OP ENGINEER

To the Editors:

After reading the article in your August issue concerning "The Co-op Engineer," I wish to pass on information gained while participating in the co-op education program. At the time of participation I had four and a half years of experience in electronics with the military, a Second Class Radiotelephone FCC license, and a two-year degree from a local junior college.

To begin with, co-op education is not free. Tuition fees vary according to the university and the semester (work period) a student chooses to work. A student should keep lines of communication open between the co-op administrator and the employer, for the student is the first to be layed off in a work shortage.

Also, due to different interpretations of the Civil Service Rules, a student may hold different GS ratings for the same amount of education. This is unfair to the lower paid GS ratings. Prior military service does not count as longevity on student GS ratings.

In my opinion, individuals with work experience should stay in school, for the co-op program will extend their education approximately one academic year. If a student has to work, I suggest he search out his own job because there are many employers with a sympathetic ear and higher wages.

JOHN H. ALBERS, JR.
Houston, Texas

* * *

SPECIAL SECTIONS

To the Editors:

I would appreciate receiving eight reprints of the Special Section "Shielded Cables & Connectors" which appeared in your October issue. The section contains excellent articles and I wish to distribute these to the engineers and technicians in my group.

E. D. MENKES, Engineering Leader
RCA Communications Systems Div.
Camden, N. J.

To the Editors:

We would like to have for our engineering library a reprint of the Special Section "Shielded Cables & Connectors," as published in the October issue of ELECTRONICS WORLD. Please advise as to cost of your reprints in quantities.

I have found your Special Sections very useful and am accumulating them in a binder. Is there a possibility you may publish these at some time in a bound volume?

A. G. ANDREWS, Project Officer
Acres Intertel Limited
Telecommunications Consultants
Ottawa, Canada

We are not presently planning to bind our various sections into a single volume, although we do appreciate the suggestion. The following reprints are available at a cost of 25¢ each:

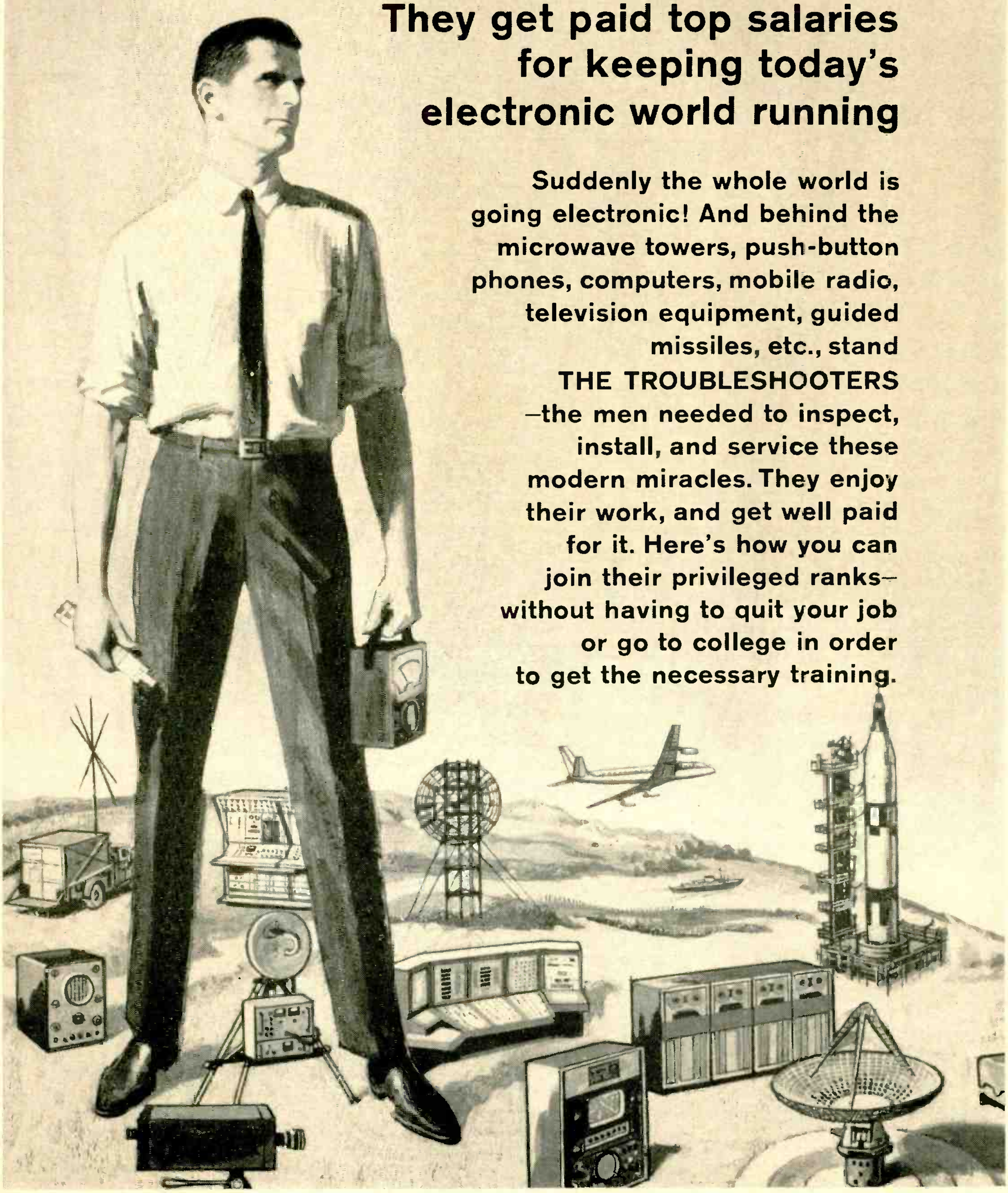
Batteries
Variable Resistors
Solid-State Diodes
Chokes & Coils
Relays
Transistors
Power Supplies
Linear Integrated Circuits
Shielded Cables & Connectors

Send orders directly to: ELECTRONICS WORLD *Editorial Offices, One Park Ave., New York, N.Y. 10016.—Editors* ▲

Join "THE TROUBLESHOOTERS"

They get paid top salaries for keeping today's electronic world running

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



JUST THINK how much in demand you would be if you could prevent a TV station from going off the air by repairing a transmitter...keep a whole assembly line moving by fixing automated production controls...prevent a bank, an airline, or your government from making serious mistakes by servicing a computer.

Today, whole industries depend on Electronics. When breakdowns or emergencies occur, someone has got to move in, take over, and keep things running. That calls for one of a new breed of technicians—The Troubleshooters.

Because they prevent expensive mistakes or delays, they get top pay—and a title to match. At Xerox and Philco, they're called Technical Representatives. At IBM they're Customer Engineers. In radio or TV, they're the Broadcast Engineers.

What do you need to break into the ranks of The Troubleshooters? You might think you need a college degree, but you don't. What you need is know-how—the kind a good TV service technician has—only lots more.

Think With Your Head, Not Your Hands

As one of The Troubleshooters, you'll have to be ready to tackle a wide variety of electronic problems. You may not be able to dismantle what you're working on—you must be able to take it apart "in your head." You'll have to know enough Electronics to understand the engineering specs, read the wiring diagrams, and calculate how the circuits should test at any given point.

Learning all this can be much simpler than you think. In fact, you can master it without setting foot in a classroom...and without giving up your job!

For over 30 years, the Cleveland Institute of Electronics has specialized in teaching Electronics at home. We've developed special techniques that make learning easy, even if you've had trouble studying before. Our AUTO-PROGRAMMED® lessons build your knowledge as easily and solidly as you'd build a brick wall—one brick at a time. And our instruction is personal. Your teacher not only grades your work, he analyzes it to make sure you are thinking correctly. And he returns it the same day received, while everything is fresh in your mind.

Always Up-To-Date

To keep up with the latest developments, our courses are constantly being revised. This year CIE students are getting new lessons in Laser Theory and Application, Microminiaturization, Single Sideband Techniques, Pulse Theory and Application, and Boolean Algebra.

In addition, there is complete material on the latest troubleshooting techniques including Tandem System, Localizing through Bracketing, Equal Likelihood and Half-Split Division, and In-circuit Transistor Checking. There are special lessons on servicing two-way mobile radio equipment, a lucrative field in which many of our students have set up their own businesses.

Your FCC License—or Your Money Back!

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And no wonder. The licensing exam is so tough that two out of three non-CIE men who take it fail. But our training is so effective that 9 out of 10 CIE graduates pass. That's why we can offer this famous warranty with confidence: If you complete a license preparation course, you get your FCC License—or your money back.

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Want to know more? Send for our 44-page catalog describing our courses and the latest opportunities in Electronics. We'll send a special book on how to get a Government FCC License. Both are free—just mail the bound-in postpaid card. If card is missing, use coupon below.

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All CIE courses are available under the new G.I. Bill. If you served on active duty since January 31, 1955, or are in service now, check box on card or coupon for G.I. Bill information.

NEW COLLEGE-LEVEL COURSE IN ELECTRONICS ENGINEERING

for men with prior experience in Electronics. Covers steady-state and transient network theory, solid state physics and circuitry pulse techniques, computer logic and mathematics through calculus. A college-level course for men already working in Electronics.

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1. Your 44-page book "How to Succeed in Electronics" describing the job opportunities in Electronics today, and how your courses can prepare me for them.
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EW-53

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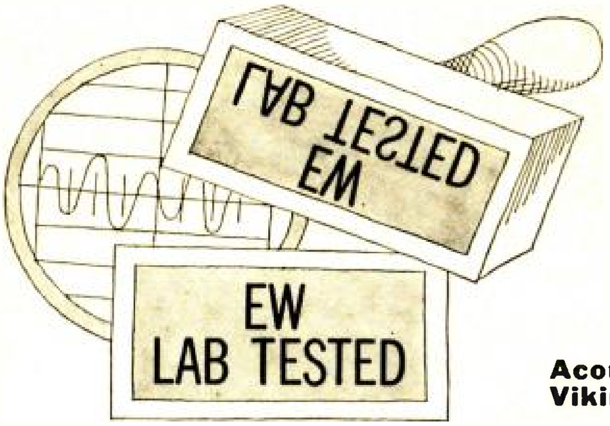


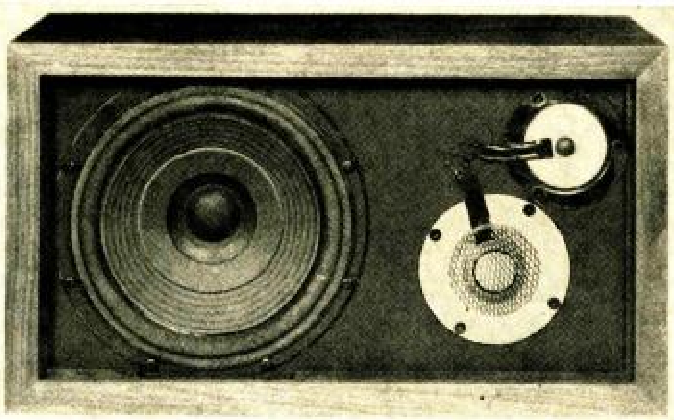
HI-FI PRODUCT REPORT

TESTED BY HIRSCH-HOUCK LABS

Acoustic Research AR-3a Speaker System
Viking 433 Tape Deck/Preamp

Acoustic Research AR-3a Speaker System

For copy of manufacturer's brochure, circle No. 1 on Reader Service Card.



THE better any product is, the harder it is to improve it significantly. This self-evident proposition did not deter *Acoustic Research* engineers when they set out to improve the very popular AR-3 speaker system. The result is the new AR-3a.

The AR-3 is the direct descendant of the AR-1, the first acoustic-suspension speaker system, which *AR* introduced in 1954. The AR-1 upset many previously held notions about how big a speaker had to be to reproduce the lowest audible frequencies. The "bookshelf"-sized *AR* speakers set new standards for low-distortion, low-frequency reproduction.

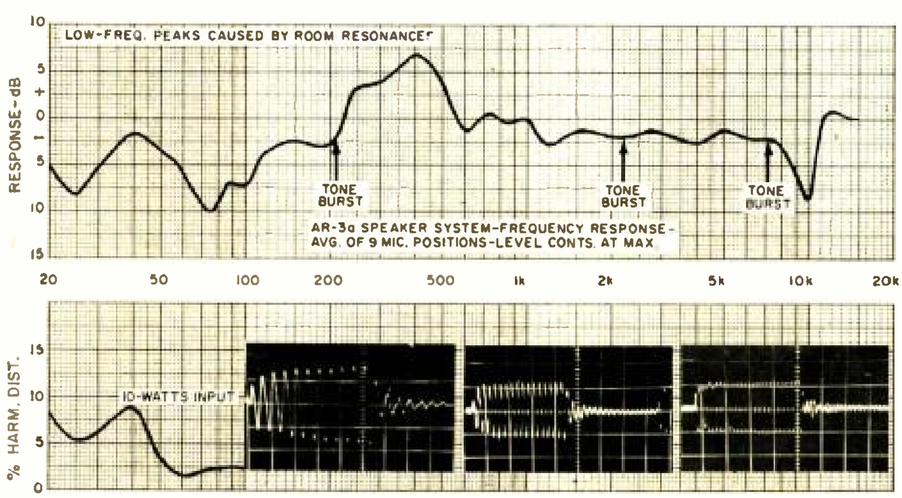
Several years ago, the company developed midrange and high-frequency drivers which complemented its remarkable woofer, and the result was the AR-3. The hemispherical-dome drivers had unusually wide dispersion and smooth frequency response. The AR-3 has enjoyed the highest reputation since its introduction. We have long considered it one of the standards by which other speakers are to be judged, and we still do.

Except for a change in grille cloth, and a subtle difference in the front molding, the new AR-3a looks like the AR-3. Its cabinet measures 25 inches by 14 inches by 11⅜ inches deep. It weighs 53 pounds and requires sturdy shelves if it is to be wall-mounted. The woofer is the same 12-inch acoustic-suspension driver used in the AR-3, but the crossover to the midrange now takes place at 575 Hz instead of 1000 Hz, as in the AR-3. The new midrange hemispherical-dome driver operates between 575 and 5000 Hz, and a similar, but smaller, driver takes over above 5000 Hz. In the AR-3, the transition between midrange and tweeter occurs at 7500 Hz.

The new midrange and high-frequency drivers have smaller voice-coil (and dome) diameters: 1½ inches and ¾ inch, respectively, compared to 2 inches and 1⅜ inches in the AR-3. Constructed with new diaphragm materials and suspensions, and using copper instead of aluminum wire in their voice coils, the new midrange and tweeter, compared to those of the AR-3, have superior power-handling ability and distortion characteristics. The smaller domes on the mid-range and tweeter are also responsible for the improvement in the dispersion characteristics, compared to the already excellent AR-3.

We have seen *AR's* frequency-response curves showing the response of each driver of the AR-3a measured individually in an anechoic chamber. They are impressively flat and smooth. It is to be expected that our "live-room" measurements of the complete system would show greater deviations because of room effects, and they do. However, even taking our data at face value, the over-all response was +6.5, −10 dB from 20-15,000 Hz. This is the best speaker frequency-response curve we have ever measured using our present test set-up.

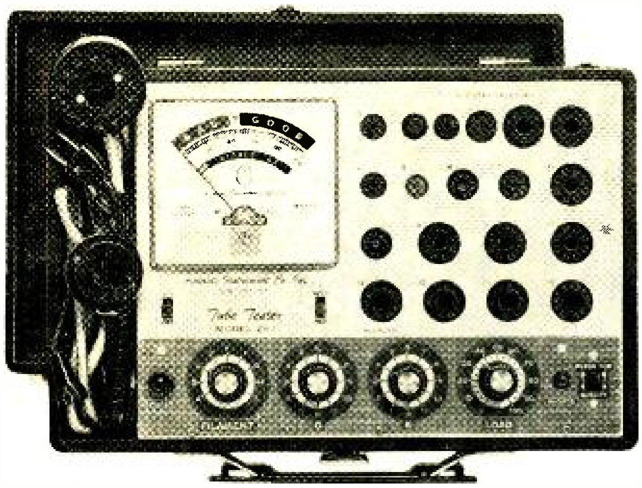
Even more significant to us was the flatness of the output between 550 and 15,000 Hz. Except for a single sharp dip of about 5 dB at 10,000 Hz, which was probably caused by room or test-microphone phasing effects, the total variation was only ±1.5 dB over this entire frequency range. Since this curve represents the average of nine microphone positions in a more-or-less normal listening room, it indicates an out-



(*Continued on page* 78)

The New 1969 Improved Model 257 **A REVOLUTIONARY NEW**

TUBE TESTING OUTFIT



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

ANNOUNCING... for the first time

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

COMPLETE WITH ALL ADAPTERS AND ACCESSORIES, NO "EXTRAS"

STANDARD TUBES:

- ✓ Tests the new Novars, Nuvistors, 10 Pins, Magnovals, Compactrons and Decals.
- ✓ More than 2,500 tube listings.
- ✓ Tests each section of multi-section tubes individually for shorts, leakage and Cathode emission.
- ✓ Ultra sensitive circuit will indicate leakage up to 5 Megohms.
- ✓ Employs new improved 4½" dual scale meter with a unique sealed damping chamber to assure accurate, vibration-less readings.
- ✓ Complete set of tube straighteners mounted on front panel.

BLACK AND WHITE PICTURE TUBES:

- ✓ Single cable used for testing all Black and White Picture Tubes with deflection angles 50 to 114 degrees.
- ✓ The Model 257 tests all Black and White Picture Tubes for emission, inter-element shorts and leakage.

COLOR PICTURE TUBES:

- ✓ The Red, Green and Blue Color guns are tested individually for cathode emission quality, and each gun is tested separately for shorts or leakage between control grid, cathode and heater. Employment of a newly perfected dual socket cable enables accomplishments of all tests in the shortest possible time.

The Model 257 is housed in a handsome, sturdy, portable case. Comes complete with all adapters and accessories, ready to plug in and use. No "extras" to buy. Only **$47.50**

NOTICE

We have been producing radio, TV and electronic test equipment since 1935, which means we were making Tube Testers at a time when there were relatively few tubes on the market, 'way before the advent of TV. The model 257 employs every design improvement and every technique we have learned over an uninterrupted production period of 32 years.

Accurate Instrument Co., Inc.

SEND NO MONEY WITH ORDER
PAY POSTMAN NOTHING ON DELIVERY

Try it for 10 days before you buy. If completely satisfied then send $10.00 and pay the balance at the rate of $10.00 per month until the total price of $47.50 (plus P.P., handling and budget charge) is paid. If not completely satisfied, return to us, no explanation necessary.

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Please rush me one Model 257. If satisfactory I agree to pay $10.00 within 10 days and balance at rate of $10.00 per month until total price of $47.50 (plus P.P., handling and budget charge) is paid. If not satisfactory, I may return for cancellation of account.

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☐ Save Money! Check here and enclose $47.50 with this coupon and we will pay all shipping charges. You still retain the privilege of returning after 10 day trial for full refund.

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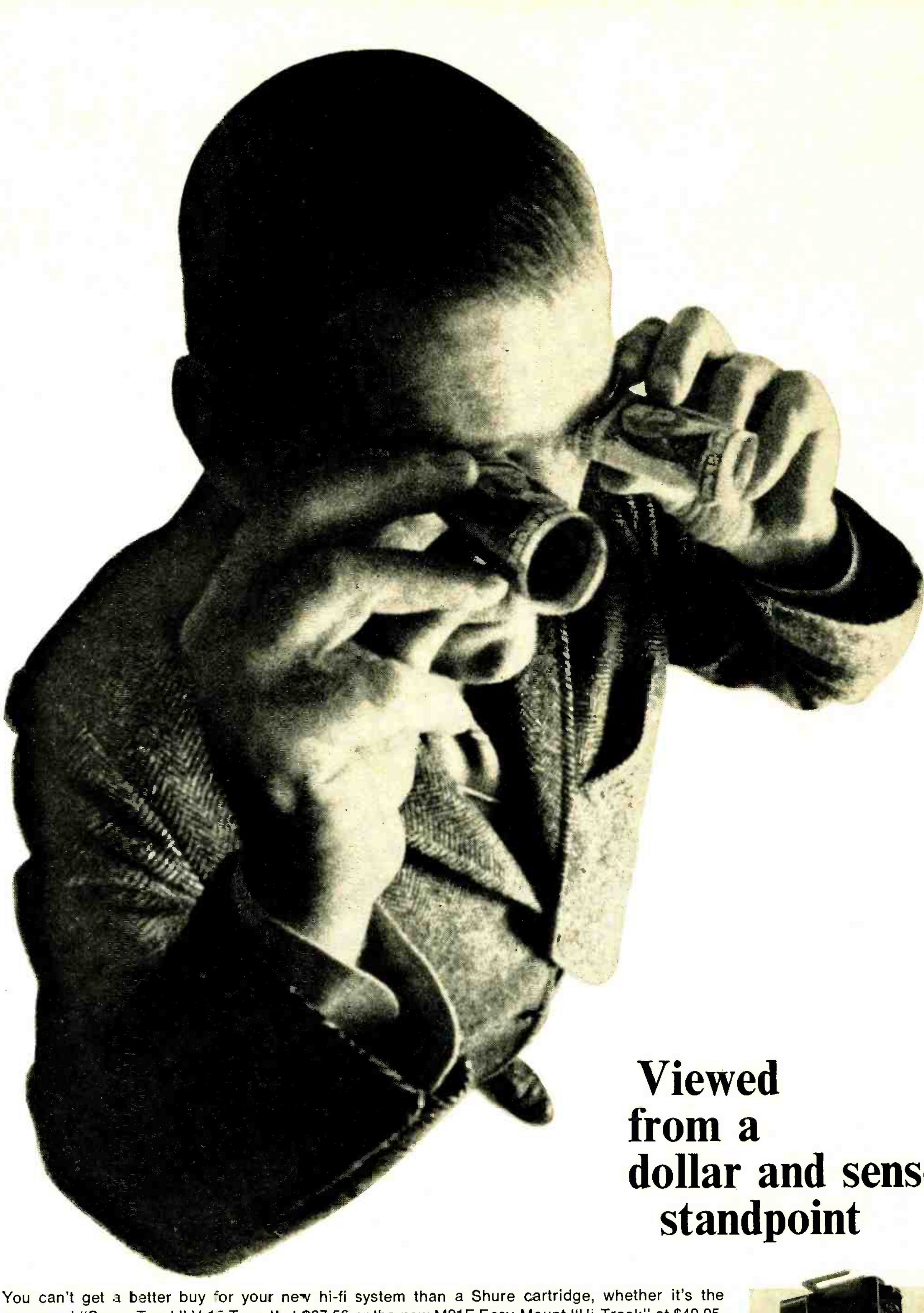


Viewed from a dollar and sense standpoint

You can't get a better buy for your new hi-fi system than a Shure cartridge, whether it's the renowned "Super Track" V-15 Type II at $67.50 or the *new* M91E Easy-Mount "Hi-Track" at $49.95, made in the tradition of all fine Shure cartridges. If you're new to hi-fi, benefit from the published opinions of experts the world over: the **Shure V-15 Type II** Super Track makes a decidedly hearable difference. If you want to spend less, the M91E is right for you. You can always "trade-up" to a V-15 Type II at a later date. Shure Brothers, Inc., 222 Hartrey Avenue, Evanston, Illinois 60204.

NEW! M91E Hi-Track Elliptical Cartridge with optimized design parameters for trackability second only to the incomparable V-15 Type II. Bi-radial .0002" x .0007" diamond stylus. 20-20,000 Hz. Channel Separation: more than 25 db @ 1 KHz. Tracking force range ¾ to 1½ grams. Trackability specifications @ 1 gram: 20 cm/sec @ 400 Hz.; 28 cm/sec @ 1 KHz.; 25 cm/sec @ 5 KHz.; 18 cm/sec @ 10 KHz. $49.95.

CIRCLE NO. 95 ON READER SERVICE CARD

RCA's Harlequin 14-in portable color set.

COLOR-TV for 1969

By FOREST H. BELT/Contributing Editor

There will be more transistors and IC's in the new models, and most makers are offering smaller picture tube sizes. Users will also find more sets with quick warmup and automatic-fine-tuning features. Here's a complete roundup of new sets and their innovations.

The Admiral 4017P 14-in color portable.

WITH all the improvements that have been added to color-TV sets in the past couple of years, you'd think there would be few changes in the new sets for 1969. That's not the case, however. Quite a bit has changed, and—as always in this fast-paced branch of consumer electronics—design engineers have outdone themselves and each other in developing new attractions for the latest lines.

Some trends of last year continue: fine-tuning aids to make it easier to tune color stations; more transistors to take the place of tubes; and a few integrated circuits to take over new functions. None of the 1968 innovations has been abandoned.

But 1969 color models are starting a few trends of their own. One of the most noticeable, and probably the most important to future sales, is the trend toward smaller-screen portables. A dozen or so manufacturers now have portable color sets in 15-inch or smaller screen sizes. Prices, as would be expected, are lower than for consoles. Yet, prices haven't dropped enough to create any stampede by prospective buyers. The little *General Electric* 11-inch portable still holds the distinction of being the lowest-priced color set available, selling at less than $200. Other portable prices range between that and around $400, but their popularity is nevertheless rising.

Oddly enough, bargain-priced portable color receivers are not making the big splash that was expected in the "first-set" market. A significant number are going as a second set in families that already own a console color model. This is unusual, considering that first-set color-TV has barely scratched its market. (Fewer than 30% of U.S. homes have color-TV.)

At the more expensive end of the color-price spectrum, sales remain respectably high. Buyers want fancy features and nice furniture. The newest all-transistor and hybrid sets, which usually sell for more than comparable tube models, are in demand.

There was some worry during early 1968 that public uneasiness about x-rays from color sets might spoil some sales. It may have, slightly. But, by the time the 1969 models reached the retailers, there was little evidence of hesitancy in buying—at least not for that reason. Furthermore, in many 1969 models, manufacturers have taken steps to eliminate even the possibility of x-rays; nearly half the models we checked have no shunt-type high-voltage regulator tube—the usual source of possible x-rays. The tiny amounts that can be generated by faulty h.v. rectifiers and picture tubes have been proven insignificant.

Another trend, noticeable at least in color sets built in this country, is some form of quick-warmup circuit. Transistor black-and-white (and color) receivers show a picture almost instantly after being turned on; many set-buyers now like that feature in any set they buy. We counted ten manufacturers who offer fast-warmup on at least one of their models; some include it on all.

There are other "little things" to help pull 1969 color-TV sales up to the 8-million-plus expectation. *Sylvania,* for example, has put the transistors in its hybrid receivers into sockets instead of soldering them to circuit boards; the result is easier servicing. Another *Sylvania* sales feature is called Color Minder. It consists of installing the color, tint, brightness, and contrast knobs so they all point straight up when set properly; that way, they can be easily reset if someone misadjusts them.

Probably the greatest tool for 1969 color sales is an extended warranty, particularly on the costly picture tube. *Admiral* led the way (and still does at press time) with a 3-year picture-tube warranty. Practically all set-makers now offer a 2-year warranty on the color picture tube. A few have elaborate prorating schemes for easing the cost burden on a customer who is unfortunate enough to have a picture tube go bad. One prorating plan runs for 8 years. The customer pays for the plan at the outset, but it does make a new picture tube less expensive than the near-$200 one ordinarily costs.

One criticism of these extended warranties comes from service technicians. They complain that the set-owner is seldom told that, even though the replacement picture tube or other part comes free or at some reduced price, the set-owner must pay the usual service and repair installation charges. A good many manufacturers are taking steps to educate customers to this. Others include such charges in their warranties, and pay the service technician themselves.

The color-TV market is growing at a steady clip, whatever blandishments are responsible. Every reader needs to know more about these features that make modern color sets better, safer, more attractive, and more acceptable. In the next few pages, you can see what these features are and how they work. Then you can decide for yourself which ones are the most worthwhile or desirable.

The Right-Now Picture

Turn on a transistor radio and sound comes on instantly; there's no warmup time. The same is true of most transistor TV sets. If you've seen one of the 1968-model *Motorola* transistor color receivers, you know that the sound comes on instantly, followed in 3 or 4 seconds by the picture. Since transistors require no warmup, most of the circuits operate instantly. However, the picture-tube heater must warm up before a raster can be seen; a quick-heating picture tube can handle that.

Even fast-warmup tubes haven't proved the answer for tube-type color receivers. Yet, customers want the instant viewing they're becoming accustomed to. So, designers worked out a way to keep tube filaments partly heated all the time, even when the set is "off." When the owner turns the set on, the tubes warm up completely and are ready to work in a couple of seconds.

The method is not new. In fact, neither is the idea. *Westinghouse* introduced its Instant-On feature a number of years ago. However, only this year, has the idea been applied widely to color receivers of both tube and hybrid (tube-and-transistor) design.

The basic method consists of applying reduced voltage to all tube heaters at all times, even though the set switch is "off." Turning on the switch causes full voltage to be applied to the tubes and also activates the "B+" supply. The entire set comes on almost instantly—within 8 seconds in the slowest. Sound is usually a little faster, sometimes preceding the picture by 5 or 6 seconds.

Exactly how the system works in a 1969 *Westinghouse*

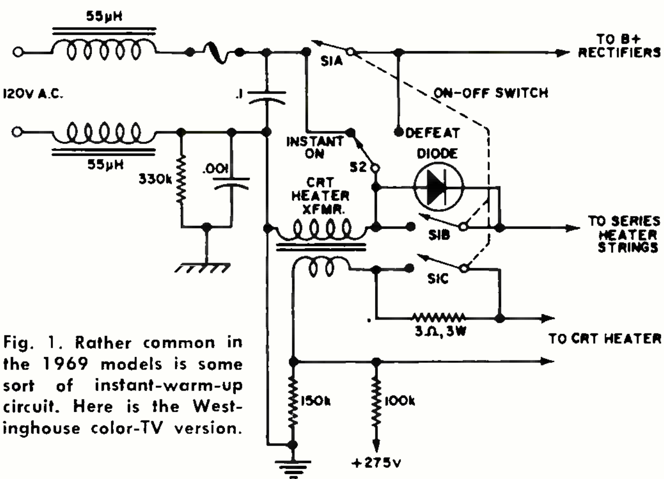


Fig. 1. Rather common in the 1969 models is some sort of instant-warm-up circuit. Here is the Westinghouse color-TV version.

chassis is diagrammed in Fig. 1. A single-pole, double-throw switch on the rear of the chassis allows the set-owner to choose Instant-On or ordinary operation. That's S2 in the diagram, and it is shown in its Instant-On position. The silicon diode in series with the heater strings is a half-wave rectifier for the a.c. line voltage that is applied. Voltage is applied even when the "on-off" switch (S1) is open. Since there is no filter capacitor, the diode is very inefficient. The r.m.s. or effective voltage applied to the filament string is only about half the r.m.s. value of the line voltage. However, that is enough to keep the tube heaters fairly warm.

The picture-tube heater, meanwhile, is also getting partial voltage. Full line voltage is applied to the heater transformer, but the secondary voltage is reduced by the 3-ohm, 3-watt resistor. (The other two resistors are merely for CRT protection.)

As you can see, the "B+" rectifiers get no voltage until switch S1 is turned on. That's a three-section switch. Section *A* applies power to the "B+" rectifiers, and plate voltage is developed throughout the receiver. Section *B* simultaneously shorts across the diode, allowing full voltage to reach the heater strings. Section *C* shorts out the CRT-heater dropping resistor, and normal heater voltage is applied. Within 3 or 4 seconds, the whole set is operative.

Most instant-picture systems have a means for defeating their action. In this *Westinghouse* version, moving S2 to the Defeat position is what it takes. Section *A* of S1 is no longer bypassed, and the action of the other two sections becomes

MANUFACTURER	CHASSIS	CRT SIZE[1]	DESIGN[2]	IC's
ADMIRAL	4H12	23	tube	—
	6H10,9H10	18,20	tube	—
	K10-2A	14	7/25[2]	—
ANDREA	VCX-325-1 to 6	23	hybrid[6]	sound sect. & remote control
	VCX-325-7	23	hybrid	sound sect. & remote control
CONAR (kit)	600	18	tube	—
DELMONICO	150	[illegible]	17/14[2]	—
	151	[illegible]	tube	—
	7208	14	9/26[2]	—
DUMONT	120926,28	23	tube	a. f. t.
ELECTROHOME	C5	23	tube	—
EMERSON	120921,23,24	18,21,23	tube	a. f. t.
GENERAL ELECTRIC	HC	10	tube	—
	KE	18,20,23	tube	—
HEATH (kit)	GR-180	18	tube	—
	GR-227	20	tube	—
	GR-681	23	tube	a. f. t.; remote rec'r.
HITACHI	CNA-24T	18	tube	—
	CNA-1900T	18	tube	—
MAGNAVOX	T924	18,20	tube	—
	T931,33	23	tube	—
	T932	15	tube	—
MOTOROLA	TS-915	23	trans.	sound sect.
	TS-921	20,23	tube	—
	TS-924	14	tube	—
OLYMPIC	CTC-30,31	22,23	tube	—
	CT911	18	tube	—
PACKARD-BELL	CQ-962	23	17/9[2]	sound i. f.
	CQ-964	23	tube	—
	CQ-966,8	23	17/10	sound i. f.
	CR-424	14	11/33[2]	—
	CR-634,36	18	tube	—
	CR-932	23	tube	—
PANASONIC	CT-21	12	10/25[2]	—
	CT-62,63	15	10/29	—
	CT-92	[illegible]	tube	—
PHILCO-FORD	19FT20	[illegible]	19/17[2]	—
	19KT40	[illegible]	hybrid[6]	color osc.
	19QT85	21,23	hybrid	—
RCA	CTC-22	14	tube	—
	CTC-28	23	tube	a. f. t.
	CTC-31	20,23	tube	—
	CTC-36	18	tube	—
	CTC-38	21,23	17/8[2]	a.f.t.
	CTC40	23	trans.	a.f.t.,sound
SETCHELL-CARLSON	U806,7	18,23	tube	—
	U809	14	7/25[2]	—
	U810	18	hybrid	—
	2700	23	tube	—
SHARP	CJ-45P	15	tube	—
	CN-32TA	18	tube	—
SYLVANIA	D08	23	tube	—
	D10/09	23	17/14[2]	sound i. f.
	D11-1-2	14	hybrid	—
	D12/13	23	12/23	sound i. f.
TOSHIBA	C2/C3	11	12/15[2]	—
	C4/C5	15	20/11	—
WESTINGHOUSE	V2655	18,23	tube	—
	V2656	23	24/11[2]	—
ZENITH	15Y6C15	14	hybrid	—
	16Z7C19	18	hybrid	—
	16Z7C50	20,23	hybrid	a. f. t.
	20Y1C50	20,23	tube	—

Notes: 1. Viewable diagonal inches; 2. Some hybrids show how many tubes/transistors; 3. All u.h.f. tuners are transistor; 4. auto. =automatic; 5. lo = lo level, hi = high level, D =

1969 COLOR–TV CHASSIS

FINE-TUNE AID	V.H.F. TUNER[3]	REMOTE CONTROL	QUICK WARM-UP	DEGAUSSING[4]	H.V. REG.	NO. VIDEO I.F.'s.	NO. CHROMA B'PASS	DEMOD.[5]	COLOR-DIFF. AMPS.
a.f.t.	tube	7-function	Instant Play	auto.	shunt	3	2	X-Z hi	–
a.f.t.	tube	7-function	Instant Play	auto.	pulse	3	2	X-Z hi	–
–	trans.	–	–	auto.	pulse	3	2	R-Y, B-Y	yes
eye	tube	7-function	–	auto.	n.a.	3	2	X-Z lo	yes
eye	tube[7]	7-function	–	auto.	n.a.	3	2	X-Z lo	yes
–	tube	–	–	none	shunt	2	1	R-Y, B-Y	G only
–	tube	–	–	auto.	shunt	3	2	X-Z hi	–
–	tube	–	–	auto.	shunt	3	2	X-Z lo	yes
–	tube	–	–	auto.	pulse	3	2	X-Z D	yes
a.f.t.	tube	–	Quick-On	auto.	shunt	3	2	X-Z lo	yes
a.f.t.[8]	tube	–	Insta-Vu	auto.	pulse	3	2	R-Y, B-Y	yes
a.f.t.	tube	–	Quick-On	auto.	pulse	3	2	X-Z lo	yes
–	tube	–	–	none	pulse	3	1	R-Y, B-Y D	yes
a.f.t.	tube	–	Insta-Color	auto.	shunt	3	1	X-Z D	yes
–	tube	6-function	–	auto.	shunt	3	2	X-Z lo	yes
–	tube	6-function	–	auto.	shunt	3	2	X-Z lo	yes
a.f.t.	tube	6-function	–	auto.	shunt	3	2	X-Z lo	yes
–	tube	–	–	auto.	shunt	3	1	X-Z lo	yes
–	tube	–	–	auto.	shunt	3	1	R-G-B	yes
a.f.t.	tube	4-function	Quick-Picture	auto.	pulse	3	1	R-Y, B-Y	G only
a.f.t.	tube	6-function	Quick-Picture	auto.	shunt	3	1	X-Z lo	yes
–	tube	–	–	auto.	pulse	3	2	R-B-G D	yes
FTI/FTL[9]	trans.	7-function	yes	auto.	pulse	3	2	R-B-G D	yes[10]
FTI/FTL	tube	4-function	–	auto.[12]	pulse	3	2	X-Z hi	–
–	tube	–	–	auto.	pulse	3	2	X-Z D	yes
eye	tube	–	Rapid-On	auto.	shunt (30) pulse (31)	3	1	X-Z lo	yes
–	tube	–	–	auto.	shunt	3	2	X-Z hi	–
–	tube	–	–	manual	shunt	3	2	X-Z lo	yes
–	tube	–	–	manual	shunt	3	2	X-Z lo	yes
a.f.t.	tube	3-function	–	manual	shunt	3	2	X-Z lo	yes
–	trans.	–	–	auto	shunt	4	2	X-Z D	11
–	tube	3-function	–	auto.[12]	pulse	3	1	X-Z lo	yes
–	tube	–	–	manual	pulse	3	2	X-Z lo	yes
light	trans.	–	yes	auto.	pulse	3	2	X-Z D	11
light	trans.	–	–	auto.[12]	pulse	3	2	X-Z D	11
light	tube	–	–	auto.[12]	pulse	3	1	X-Z lo	yes
–	trans.	–	–	manual	shunt	3	2	R-B-G	yes
eye	trans.	–	–	na.	n.a.	n.a.	n.a.	n.a.	n.a.
13	trans.	8-function	–	auto.	pulse	3	2	X-Z lo	yes
–	tube	–	–	auto.	pulse	2	1	X-Z lo	yes
a.f.t.	tube	8-function	–	auto.	shunt	3	1	X-Z lo	yes
–	tube	–	–	auto.	shunt	2	2	X-Z lo	yes
–	tube	5-function	–	auto.	pulse	2	1	X-Z lo	yes
a.f.t.	hybrid	7-function	–	auto.	shunt	3	2	X-Z D	yes
a.f.t.	trans.	–	yes	n.a.	pulse	3	3	R-B-G	yes[10]
light & a.f.t.	tube	–	–	manual	shunt	3	1	X-Z lo	yes
–	trans.	–	–	manual	pulse	4	2	X-Z D	yes
light	tube	–	–	manual	shunt	4	2	X-Z D	yes
light	tube	–	–	manual	shunt	3	1	X-Z lo	yes
–	tube	–	–	auto.	pulse	3	2	X-Z D	yes
–	tube	–	–	auto.	shunt	3	1	X-Z D	yes
–	tube	–	–	auto.	shunt	3	2	X-Z lo	yes
a.f.t.	tube	yes	–	auto.	shunt	3	2	X-Z lo	yes
–	tube	–	–	auto.	pulse	3	2	X-Z lo	yes
a.f.t.	tube	yes	–	auto.	shunt	3	3	X-Z lo	yes
–	trans.	–	–	auto.[12]	pulse	3	2	R-G-B D	yes
–	trans.	–	–	manual	shunt	3	2	R-G-B	yes
–	tube	–	–	auto.	pulse	3	2	X-Z lo	yes
on-screen bars	tube	–	Instant-On	auto.	pulse	3	2	X-Z lo	yes
–	tube	–	–	auto.	pulse	3	3	X-Z lo	yes
–	tube	4-function	–	auto.	pulse	3	3	X-Z lo	yes
a.f.t.	tube	6-function	–	auto.	pulse	3	3	X-Z lo	yes
a.f.t.	tube	6-function	–	auto.	pulse	3	2	X-Z hi	–

diodes; 6. No tube/transistor count available; 7. Motor-driven, but push-button operated; 8. Called "Electrolock"; 9. Fine Tuning Indicator and Fine Tuning Lock; 10. Two stages for each color; 11. Has X and Z amps, plus R, G, and B amps; 12. Using thermal relay; 13. Has eye and a.f.t. (called "Autolock Channel Tuning"); n.a. = information not available.

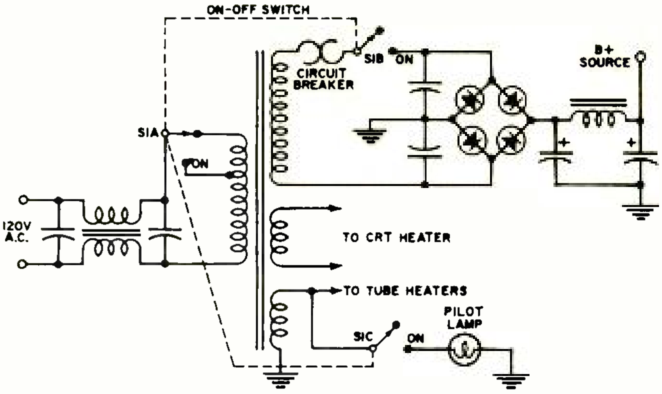


Fig. 2. This simpler version, from Electrohome, cannot be turned off completely except by pulling the plug.

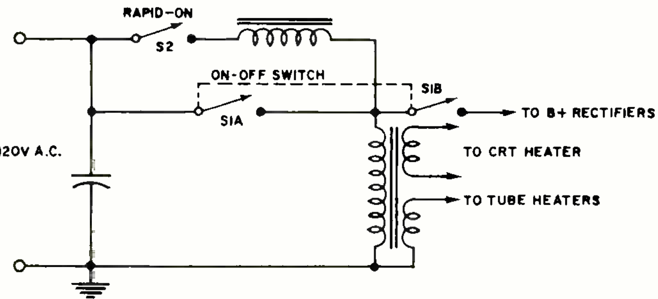


Fig. 3. Olympic quick warmup circuit is the simplest.

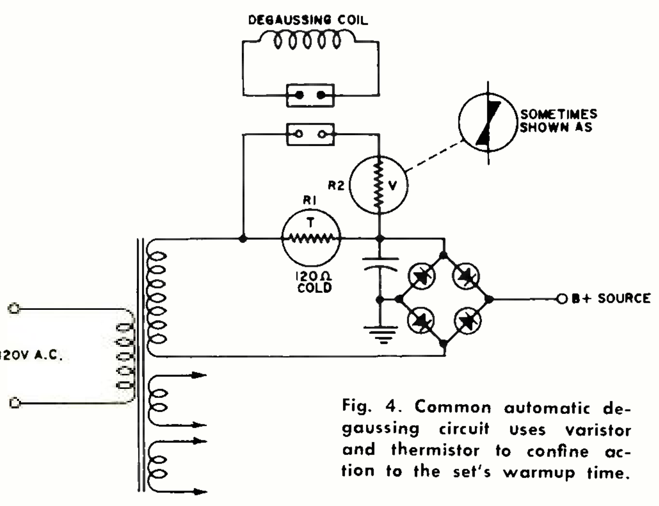


Fig. 4. Common automatic degaussing circuit uses varistor and thermistor to confine action to the set's warmup time.

irrelevant; *nothing* operates at all when S1 is open and S2 is at the Defeat position.

There are a few other special considerations in quick-warmup circuits in other sets. In *DuMont*, for example, a special quick-heating high-voltage rectifier is used. The 3CU3 or 3CN3A tube should never be replaced by one of a slower-heating type, such as a 3A3, even though they are otherwise alike.

The names of quick-warmup circuits are as similar as the principles of their operation. *Admiral* calls it Instant Play; *DuMont* has Quick-On; *Electrohome* uses Insta-Vu; *Magnavox* says Quick-Picture; *Olympic* calls it Rapid-On. *Motorola* and *RCA*, whose all-transistor color chassis have the feature inherently, don't bother to give it a name; it's just one more advantage of transistorization.

The method used in the latest *Electrohome* color chassis is different, but is easy to understand. Three-section switch S1 is shown in Fig. 2 in its "off" position. The line voltage is connected to the oversize primary winding of the power transformer, which reduces secondary voltages to about 30% below normal. Section *B* of the switch keeps plate-supply voltage from reaching the rectifier bridge, so no "B+" is developed. Tube and CRT heaters receive reduced voltages, so they're kept warm though not hot.

When the switch is turned on, section *A* connects the input voltage across the normal portion of the transformer primary, bringing all secondary voltages up to normal; the tube heaters rise to full temperature. Section *B* connects the plate-supply voltage to the rectifiers, and they develop "B+" for plates and screens throughout the set. Section *C* turns on the pilot light.

This *Electrohome* chassis has no provision for disabling the Insta-Vu circuit. The set remains partially on unless the line cord is unplugged. Some manufacturers claim an advantage to leaving the set thus warmed up at all times: it keeps moisture out, they say. It is true that constant warmth eliminates condensation that can occur in some humid climates when a set is alternately hot and cold.

Simplest of all in operation is probably the *Olympic* fast-warmup version in Fig. 3. With S2 open, operation of the set is normal. The only thing unusual is that one section of "on-off" switch S1 is used to open the "B+" circuit. With Rapid-On switch S2 closed, an inductor is placed between the line voltage and the power transformer. The voltage is reduced because of the inductor in series, and the secondary voltages applied to the CRT and tube heaters are therefore low. The tubes are kept warmed up, but not to full temperature. Then when S1 is closed to turn the set on, the inductor is bypassed, applying full voltage to the transformer. The tubes heat to full temperature. The *B* section of the switch also closes the "B+" circuit, applying plate voltages through the set. Picture and sound both come on within a very few seconds.

(Editor's Note: All quick-warmup vacuum-tube circuits will add something to the user's electric power bill, although not much. Power consumption may be about ⅕ of the set's normal full-power drain on the a.c. power line. Some users may also worry that their tubes won't last as long if they are kept warm all the time. However, the repeated thermal shock of the usual "on-off" operation may result in a shorter tube lifetime than if the heater is kept partly on at all times. Hence, tube life should not be affected one way or the other.)

Preventing CRT Magnetization

One popular feature in 1969 color sets is a degaussing circuit. Its job, of course, is to keep the CRT shadow mask from becoming magnetized and spoiling purity. Most degaussing circuits are automatic; the set-owner never bothers with them. In a very few sets, the degaussing process is done at the customer's will, manually, even though it is as simple as manipulating a special switch. The color set without built-in degaussing is a rarity this year.

The common automatic version is shown in Fig. 4. Two special resistors, *R*1 and *R*2, are the heart of the automatic action. When the receiver is turned on, the resistance of voltage-variable resistor *R*2 is very low, and that of temperature-variable resistor *R*1 is high. Alternating current flows through the degaussing coil to the "B+" rectifiers. As the set warms up, voltage across *R*2 causes its resistance to rise, which forces some more current to flow through *R*1. As *R*1 begins to heat from current flow, its value drops. This chain reaction continues for several seconds—*R*2 increasing in value and *R*1 decreasing, with each aiding the action in the other. After several seconds, practically all current flows through the now-very-low resistance of *R*1, completely bypassing the degaussing coil and the now-quite-high resistance of *R*2.

The degaussing coil is wrapped around the periphery of the color picture tube. The alternating current in it creates a varying magnetic field that erases any residual magnetism in the shadow mask. The field is collapsed rather gradually—over several seconds—by the thermistor/varistor action; by the time the raster shows up, there are no remaining fields from the degaussing coil. The set-owner is virtually unaware that anything has taken place.

This circuit is easy to check. Just short out *R1* before you turn on the set, and the set comes on normally. Then remove the short. You'll be able to see the degaussing action by the multicolor lines it makes on the raster. They should fade away in a few seconds. Of course, multicolor lines on the screen at all times means *R1* is open or is remaining at its highest ("cold") resistance.

Some color receivers use a thermal relay for automatic degaussing action. Again, the demagnetizing occurs before the raster appears, and is unnoticeable. The circuit diagram of one model is shown in Fig. 5. Some imports that use this system may put the thermal element directly across the line voltage; in the one shown here (from a *Panasonic* CT-63), the voltage drop across part of the heater string makes it possible to use a lower voltage thermal relay.

Like the degaussing system in Fig. 4, the one in Fig. 5 uses the warmup sensor to bypass or short out the degaussing coil after the set has been on several seconds. The thermal-relay contacts are normally open when the receiver is off. With the receiver on, current heats the element and closes the contacts, shorting across the degaussing coil.

This circuit can't be checked out the same way as Fig. 4, however. For this one, you have to remove the connection from one relay contact, if you want to "see" the degaussing action after the raster comes on. Don't disconnect the thermal element, since it is part of the voltage-dividing circuit for the tube heaters.

Both degaussing coils shown here are in series with the "B+" rectifiers. The chief reason for this is to keep "B+" low or nonexistent until after degaussing action has ended. This reduces the likelihood that a raster might come on while the degaussing coil is still making magnetic fields around the CRT face. Hence, the set-owner isn't bothered by weird lines that would accompany degaussing action which might be the case if a raster were visible.

One manual degaussing circuit for 1969 models is typified by the *Philco* 19FT20 chassis. The circuit is extremely simple, (Fig. 6). In the normal position, the two degaussing-switch sections (S2A and B) are closed. When the receiver is turned on, warmup and operation are perfectly normal.

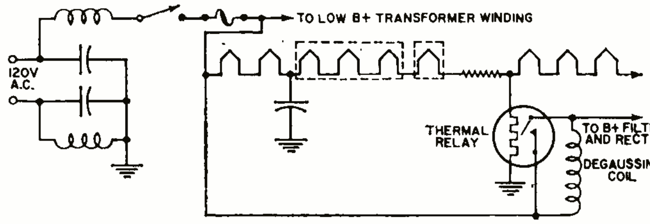


Fig. 5. Some sets use a thermal relay to cut off the degaussing action before the receiver raster comes on. Action of large B+ filter capacitor causes current to taper off gradually in degaussing coil before it is shorted.

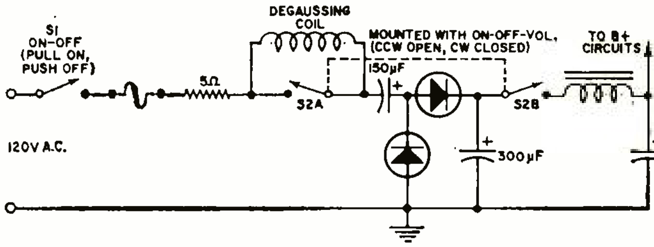


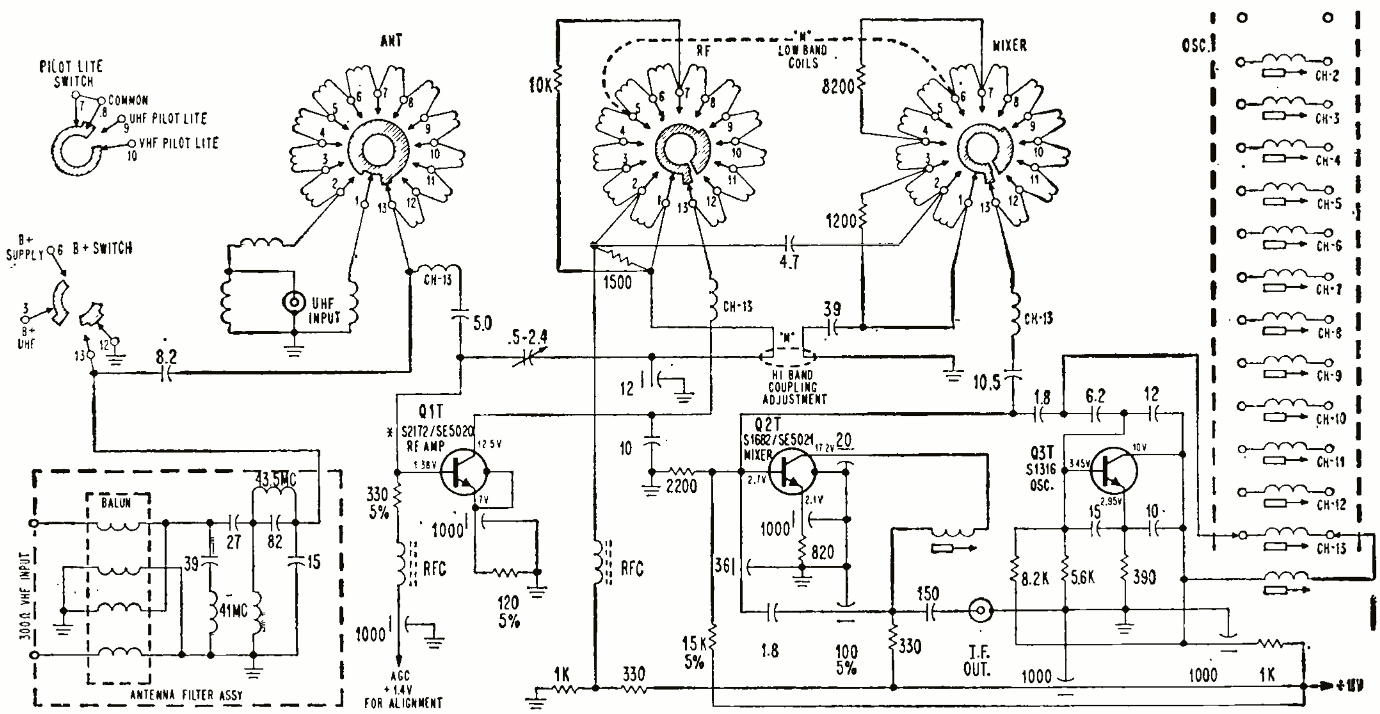
Fig. 6. Manual degaussing system employed in a Philco.

Since section S2A is closed, the degaussing coil is shorted out and there is no degaussing action.

To initiate degaussing, the volume control is turned backward (counterclockwise), with the set off. A click indicates that the two degaussing-switch sections have opened. The set is then turned on by pulling outward on the volume-control shaft. No raster comes on, because section S2B of the degaussing switch is open; no "B+" is developed. The coil degausses the CRT only for as long as it takes the voltage-doubler capacitors to charge—a few seconds.

When the volume control is rotated clockwise, the degaussing sections of switch S2 close. The coil is no longer in the circuit, and the "B+" circuit is completed.

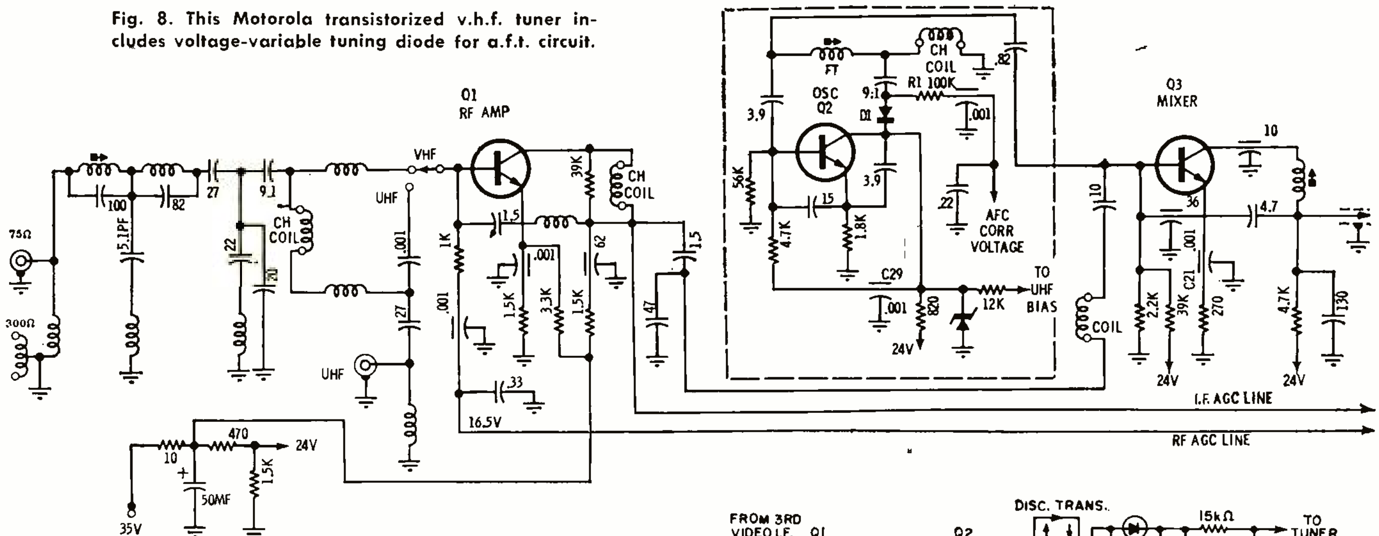
The advantage of this circuit is that the set can be degaussed again if it needs it. The owner need only turn the set off and wait a few seconds while the capacitors discharge. With heat-operated degaussing circuits, the set must be off long enough for the thermal elements to cool before another



NOTES
1. ALL SWITCHES SHOWN IN CH.13 POSITION
2. ALL ROTOR BLADES ARE SHORTING TYPE
3. ALL CAPACITORS IN PICOFARADS
4. ALL RESISTORS IN OHMS, K=1000
5. ALL SWITCH SECTIONS ARE VIEWED FROM FRONT OF TUNER
* Q1T EARLY PRODUCTION USED S1674

Fig. 7. Transistor v.h.f. tuners, such as this one employed in Philco receivers, are becoming more popular.

Fig. 8. This Motorola transistorized v.h.f. tuner includes voltage-variable tuning diode for a.f.t. circuit.



degaussing action is possible. With a very tough case of impurity, a single occasional demagnetizing might not be adequate. That's why a few sets—notably this *Philco* model, most of *Setchel Carlson's*, and one *Toshiba*—use manual degaussing instead of the more popular automatic version.

V.H.F. Tuners Go Solid-State

For several years, now, all u.h.f. tuners have been transistorized. Not so with v.h.f. tuners in color sets. Solid-state has been applied to v.h.f. tuners only in all-transistor receivers. For 1969, an impressive number of models include a transistor v.h.f. tuner. *Admiral, Packard-Bell, Panasonic, Setchell-Carlson,* and *Toshiba* each have it in at least one model. *Philco-Ford* has it for all 1969 models. The all-transistor sets from *RCA* and *Motorola* of course have transistor v.h.f. and one *RCA* model has a hybrid v.h.f. tuner that combines a transistor with a nuvistor.

Some set makers have dabbled with transistor v.h.f. before, but this is the first year a trend in this direction has developed. Most of the solid-state tuners are part of hybrid sets.

Transistor v.h.f. tuners aren't radically different from their tube counterparts. Fig. 7 is a diagram of one. This *Philco* version is a switch-type tuner, with a transistor for oscillator, one for mixer, and one for r.f. amplifier. You can see how nearly it resembles an ordinary v.h.f. tuner.

The diagram in Fig. 8 shows something a little different in transistor v.h.f. tuners. This one is from *Motorola's* all-transistor Quasar color set. What's different is that it contains circuits for automatic fine tuning (a.f.t.)—which *Motorola* calls FTL, for Fine Tuning Lock.

Connected across the channel-tuning coil in the oscillator stage is a voltage-variable tuning diode, *D*1. Whenever the tuner drifts off frequency, shifting the i.f. slightly, a correction voltage from the FTL section (elsewhere in the receiver) is applied to the tuning diode through *R*1. As the voltage changes on the anode of the tuning diode, capacitance across the channel-tuning coil varies and returns the oscillator to a frequency that produces the correct i.f. It is obvious, if you're familiar with tube-type a.f.t. tuners, that the transistor oscillator with a.f.t. works just about the same way.

Something really new is a field-effect transistor in a television tuner. *RCA* has one—a dual-gate MOSFET, no less—in the 5-transistor KRK 142 v.h.f. tuner used with the new CTC 40 all-transistor color set. This transistor can handle automatic fine tuning too; it uses one of the transistors as a tuning diode. The two gates of the MOSFET are connected together through an isolating resistor.

Toward "Just-Right" Tuning

From the looks of 1969 models, 1968 was the year of the fine-tuning aid. This year's sets have just as many, but there's been no great rush to put them on models or brands that didn't already have them.

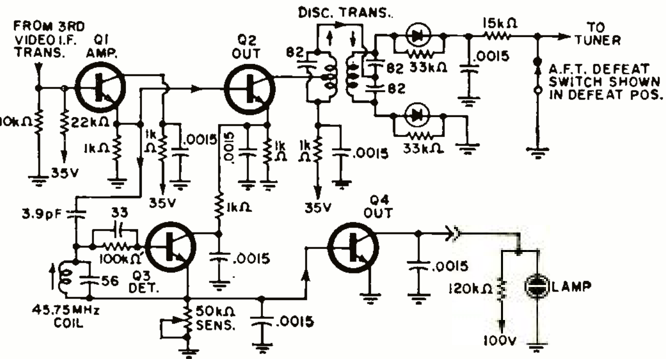


Fig. 9. Motorola's a.f.t. system, called "Fine-Tuning Lock."

You've already seen a transistor tuner with an automatic fine-tuning circuit (Fig. 8). If you're interested in where the automatic fine tuning control voltage comes from, take a look at Fig. 9. This circuit is typical, except that it also includes a tuning light.

The automatic fine tuning stage takes its sampling signal from the third video i.f. amplifier in almost all sets. The 45.75-MHz signal is amplified and applied to a discriminator of some sort (diodes in Fig. 9). If the tuner frequency has drifted, and the picture i.f. carrier is no longer exactly 45.75 MHz, a correction voltage is developed by the discriminator and applied to the tuner.

In the *Motorola* a.f.t. stage shown, a couple of extra transistors light a neon lamp if the frequency drifts beyond "reach" of the a.f.t. section.

The 1969 *Philco* has a new a.f.t. system that goes by the name of Autolock Channel Tuning, or just ACT. Whereas a tuning diode is used in the tuner of Fig. 8, the *Philco* v.h.f. tuner uses a transistor (connected base and collector, with emitter open) as the voltage-tuned element. Otherwise, the system is similar to others: the 45.75-MHz signal is amplified and applied to a discriminator. A d.c. amplifier is used to boost the control voltage—a trick used in a few other brands.

Few color-set owners realize how important precise fine tuning is. It can make the difference between watching a color show in color and watching it in monochrome. Although the rush to fine-tuning aids seems to have passed, you can expect them to continue appearing until virtually all color sets have them.

High Voltage . . . The Regulator Story

Considerable publicity was given last year to the possibility of dangerous x-rays emanating from color-TV sets. Though small doses of x-rays (*Continued on page* 66)

HOW TO ADD REMOTE SPEAKERS TO Hi-Fi STEREO SYSTEMS

By VICTOR BROCINER / Assistant to the President, H. H. Scott, Inc.

If a few simple precautions are observed, additional speakers can readily be added to either tube or transistor stereo amps.

WE HAVE become so used to the conveniences of our constant-voltage power line, into which one may plug household appliances almost at will, that it is sometimes difficult to remember that the output of a high-fidelity amplifier must be treated somewhat differently. Even in the case of the power line one has to be careful not to plug in too many appliances, or the fuse will blow. A similar precaution must be exercised when connecting multiple loudspeakers to amplifiers, with the difference that in the case of solid-state amplifiers it can be the power transistors that blow instead of the fuse. However, if a few simple precautions are observed, no problems need arise.

Why is total available power not the only thing that needs to be taken into consideration when adding speakers to a hi-fi installation? One reason is that while the power line operates at a nearly constant voltage, the output of an amplifier fluctuates over a tremendous range from moment to moment as the audio signal varies, and the limits between which the output fluctuates are also variable depending upon the setting of the volume control. This is why it is not feasible to rate the loads (the speakers) in terms of power consumed or current drawn and why the concept of impedance comes into the picture.

The impedance of a circuit is equal to the voltage across the circuit divided by the current through the circuit: $Z = E/I$. When this is rearranged as follows: $I = E/Z$, it becomes a little clearer that impedance is the current-determining element for a given applied voltage, and in the case of amplifiers it is the current drawn by the loudspeaker load that we are concerned about. The internal heating in the power devices of an amplifier increases rapidly as the current drawn from them goes up. Of course, there is a point beyond which this heat damages the device. In the case of tubes, reasonably short periods of overload may cause the plates and screens of the tubes to glow red hot, but the tubes can recover from this. With solid-state devices the allowable time for an extreme overload may be on the order of microseconds.

There is an additional difference between the behavior of tube and solid-state amplifiers that is inherent in their design. With any output device, the power output varies as the load impedance is varied. At zero impedance the power output is obviously zero, as it is at infinite impedance. As the impedance is increased from zero value, the power output increases to a maximum and then decreases. Maximum power output is delivered when the load impedance is equal to the internal impedance of the amplifier. For impedance values near this optimum, the variation in power output is relatively small.

Tube amplifiers are designed to produce maximum power into a load whose value is somewhere near the optimum impedance, and the matching is done by means of taps on an output transformer. With transistor amplifiers the internal impedance of the amplifier is so low that if a matching impedance were used to obtain maximum power, the current drawn from the transistor would be far in excess of their maximum capability. Consequently transistor amplifiers are designed to operate into impedances considerably higher than the optimum impedance; furthermore, since they are almost invariably output-transformerless, the power delivered is determined by the value of the load impedance and there is nothing one can do about it.

Suppose that a solid-state amplifier is designed to deliver its rated power into a 4-ohm load. If it is well-designed, the current drawn by this load will be such as to keep the internal heat dissipation in the output devices appreciably below their maximum. However, the safety margin is not made so great that a 2-ohm load, for example, which would draw double the current of the rated load, would be safe. Fuses do not act quickly enough to protect against the effects of extremely brief overloads. Electronic protective circuits may do so, but they add considerably to the cost of the amplifier if they are designed to provide adequate protection. Even when the danger of damage to the power transistors is small—and today's solid-state amplifiers are remarkably rugged—there is another factor that must be taken into account: distortion. Operating a solid-state amplifier into a load impedance lower than the rated value results in increased distortion—and not only at very high power; the performance is deteriorated even at ordinary listening levels. Hence, with transistor amplifiers especially, it is important to keep the load impedance equal to or greater than the rated value.

Assume now that we want to connect one or more sets of loudspeakers to a hi-fi system, with the thought of operating more than one at one time. How shall we proceed?

Amount of Power Required

When a number of speakers are operated from the same amplifier, the power output of the amplifier is shared among them. This limits the number of speakers that can be operated from a given amplifier, depending on the levels at which they are to be operated. If an amplifier is just adequate to provide the desired levels in the main listening room, it will not be able to provide full room volume in an additional room as well. On the other hand, if the remote installation is intended to provide soft background music only, the arrangement will be quite acceptable.

In making judgments on the adequacy of the power available, it should be kept in mind that doubling the power output, or increasing it by 3 dB, does not double the loudness. A 7-10 dB power increase, the exact amount depending on the nature of the program material, is required to double loudness. Looking at it the other way, halving the power results in a noticeable but not pronounced change in loudness. Halving the *loudness* involves a decrease in power of 1/5 to 1/10. Of course this information has to be applied with

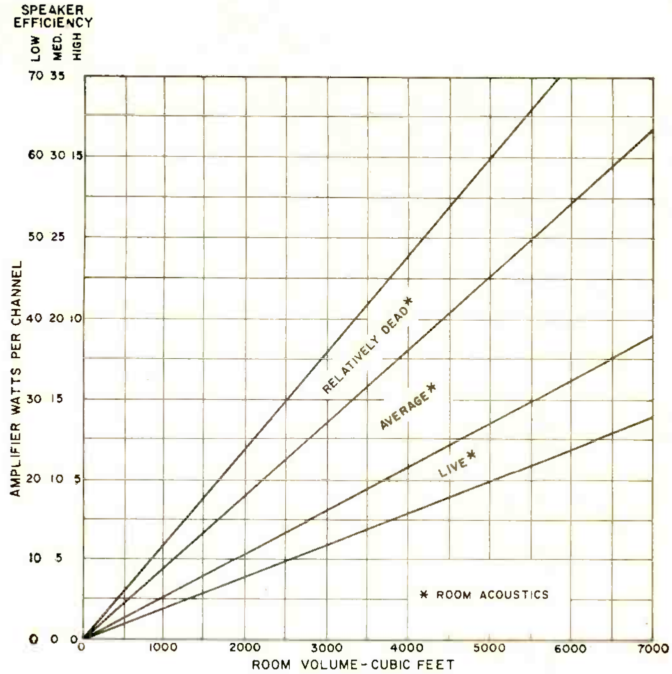


Fig. 1. Continuous power requirements for various room sizes and acoustics, for speaker systems of different efficiencies. In general, completely closed acoustic-suspension systems are fairly low in efficiency while closed and ported systems with efficient speakers and horn systems are high in efficiency. If most listening is done at very high levels, somewhat more power is needed; for listening at low background levels; somewhat lower power is required.

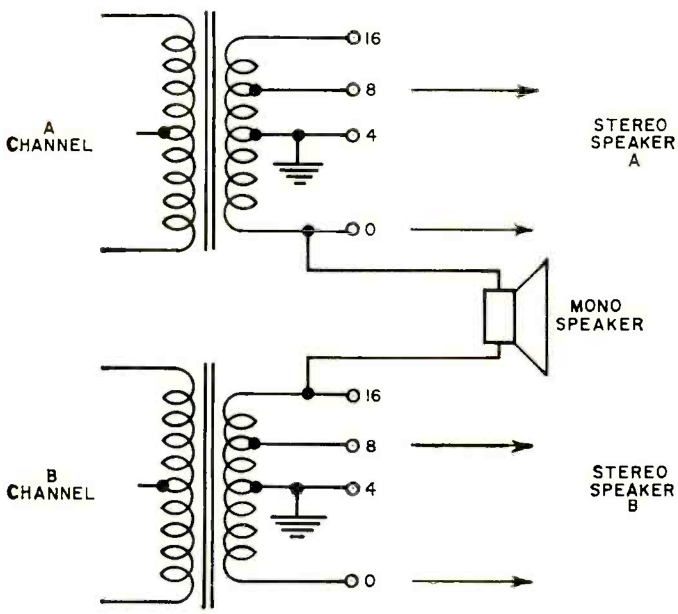


Fig. 2. Method of connecting remote mono speakers to amplifier using center-tap-grounded output transformers. Stereo speakers are connected to impedance taps having half nominal impedances of the speakers used.

a certain amount of judgment; otherwise it might well lead to the connection of 50 additional speakers, based on the argument that each speaker that is added results in an only slightly noticeable decrease in loudness!

The amount of amplifier power required in an average living room depends, among other things, on the efficiency of the loudspeakers used. A guide to power requirements is given in Fig. 1. From this chart it is easy to determine the power requirements for each speaker station, and from this to find the total power required. If all of the loudspeakers are not going to be used simultaneously at any time, the power should be determined for the combination requiring the greatest total power.

Remote Speakers: Stereo or Mono

If stereo reproduction is desired wherever additional speakers are installed, each installation requires a pair of speakers for the two stereo channels. If monophonic reproduction is desired, things are a little less simple. Connecting a speaker to only one of the channels is obviously not a good solution. It is necessary to obtain the sum of the left and right channels in some manner to recover the monophonic program content. Many amplifiers have a low-level center-channel output connection which provides such a signal. While originally intended primarily to provide a center channel for wide-spread stereo using three speakers, it is eminently suited to the purpose we have in mind. This connection provides sufficient voltage to drive a separate power amplifier for the remote speakers.

Where sufficient power is obtainable from the main amplifier, it is of course far more convenient to use an arrangement which does not require an additional power amplifier. Bridging speakers across the respective outputs of the left- and right-channel amplifiers is not a satisfactory solution because, among other things, this provides a *difference* rather than a *sum* signal. Nor is it possible to remedy this by reversing the output of one of the channels because they have a common internal ground connection.

Some tube amplifiers have their transformers' secondaries grounded at a center-tap instead of at the end of the winding. With this arrangement it is possible to connect a speaker to obtain the full monophonic signal, as illustrated in Fig. 2.

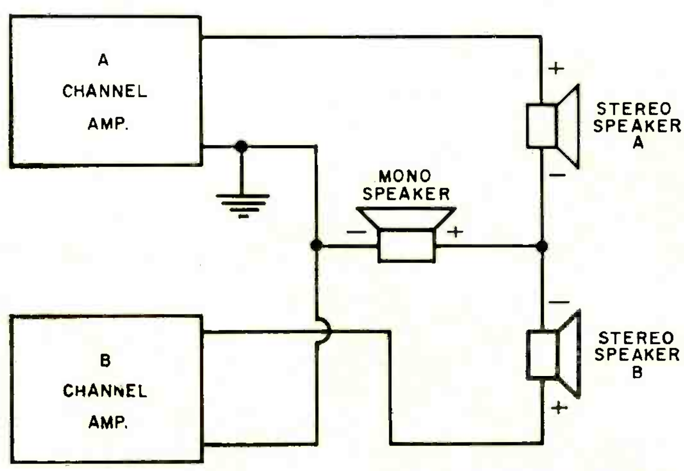
A novel system for obtaining a center channel is shown in Fig. 3. The part of the circuit illustrated, if used alone, has a detrimental effect on the separation of the stereo channels. In practice, a special input network is used ahead of the two channels of the amplifier to compensate for this.

A very simple and convenient provision for obtaining a powered monophonic channel is embodied in *H. H. Scott* amplifiers and receivers (Fig. 4A). The remote speakers are connected directly to the amplifier terminals marked "Remote" and switch S3 set to "Mono." For amplifiers not equipped with such conveniences, it is possible to use a high quality 1:1 transformer to reverse phase, as shown in Fig. 5A. For those who do not wish to go to the expense and trouble of using a transformer and are willing to tolerate a 6-dB loss in level when using a single remote 8-ohm loudspeaker, the circuit of Fig. 5B offers a simple solution.

Impedance Matching

Although the term "matching" has been used in this sec-

Fig. 3. Novel method of obtaining center mono channel. Special network ahead of amps maintains separation.



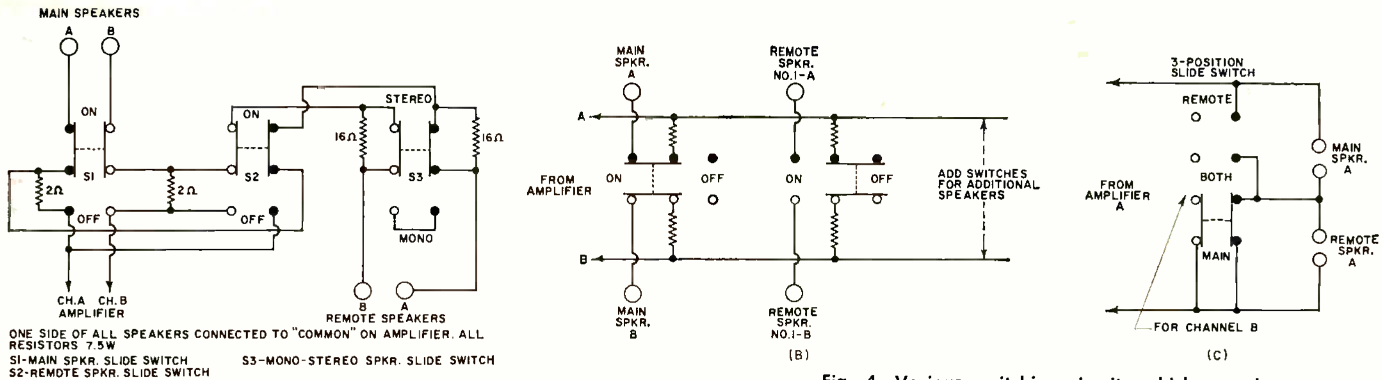


Fig. 4. Various switching circuits which may be used to operate a remote loudspeaker system.

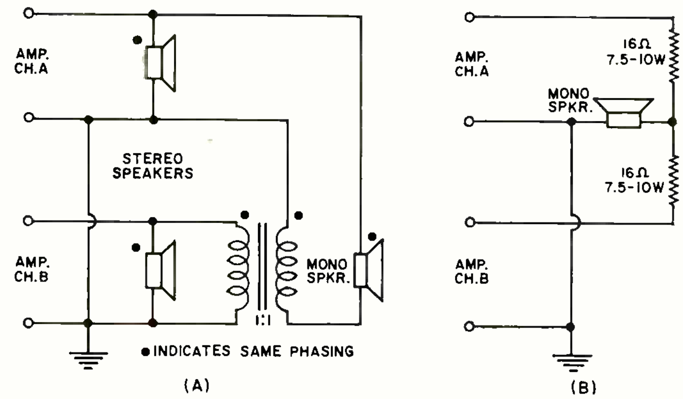


Fig. 5. (A) Using 1:1 transformer to power remote mono speaker. (B) Simple circuit but with 6-dB power loss.

tion heading in accordance with common practice, it should be pointed out that it is not really matching at all that we are concerned with, but rather the connection of the correct value of total load impedance to the amplifier. Tube amplifiers generally offer a choice of transformer taps for 4-, 8-, and 16-ohm loads. As already mentioned, this flexibility is not provided on modern solid-state amplifiers; consequently additional speakers must be connected in such a way as not to present a total load impedance of less than the minimum value specified for the amplifier being used. Since hi-fi loudspeakers are made with impedances of 4, 8, and 16 ohms, depending on the model and manufacturer, and since most solid-state amplifiers have a minimum specification of 4 ohms for load impedance: (1) up to four 16-ohm speakers may be used in parallel, (2) two 8-ohm speakers may be used in parallel, but (3) multiple 4-ohm speakers represent a problem.

If speakers of different impedances are paralleled, the resulting impedance can be found from the formula: $Z_{TOT} = Z_1Z_2/(Z_1 + Z_2)$.

When using a combination of speakers which present an unacceptably low value of impedance when paralleled, one is tempted to consider putting the speakers in series so that their impedances add. This is permissible provided the speakers are identical—and this means identical not only in impedance, but in all respects. With dissimilar speakers, interaction takes place between the two speakers, resulting in deteriorated performance for both. The same consideration also holds true, of course, for series-parallel arrangements.

To avoid the problem presented by speaker combinations that would result in too low an impedance, as in case (3) above, one can resort to a transformer. Fig. 6 shows the large number of impedance transformations that can be obtained with a 0-4-8-16-ohm transformer. A high-quality output transformer designed for tube amplifiers can be used for this purpose, provided care is taken to cut off and insulate the high-impedance primary winding connections.

Switching of Speakers

Most of today's receivers and amplifiers are provided with terminals for extra speakers and some form of front-panel switching. The more elaborate units provide switching to permit changing from the main to the remote speakers and also to operate both at the same time. A series resistor is usually switched into the circuit when both sets of speakers are in operation to permit using 4-ohm speakers for both main and remote positions. This protects the amplifier against possible overload; it also results in a loss of total power available, usually on the order of 6 dB, plus a reduction of damping factor to around 1. These effects are proportionally less with speakers of higher impedance. The decreased damping factor results in a slight exaggeration of the very deep bass with low-efficiency speakers. The loss in power in unfortunate, especially since it takes place when extra power is needed for the operation of the extra speaker system, but this is the penalty one pays for using low-impedance speakers without any provisions for matching.

If switching is not provided in the amplifier or if the switching that is present does not include operation of both sets of speakers simultaneously, the circuit of Fig. 4A can be incorporated into a separate switch box and connected between the standard amplifier output terminals and the speakers. The third switch, and associated resistors, for stereo-mono operation, may be omitted if desired. Slide switches rated at 2 amperes or more are satisfactory. If the total load presented by all the speakers that are going to be operating at the same time is no lower than the minimum value specified for the amplifier, the protective resistors may be omitted.

If more than one set of additional speakers are to be used, all of them can be wired in parallel to the "remote" terminals, unless they are to be independently controlled by switches. In this case, a series of double-pole switches, wired as shown in Fig. 4B, is (*Continued on page 71*)

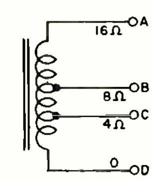
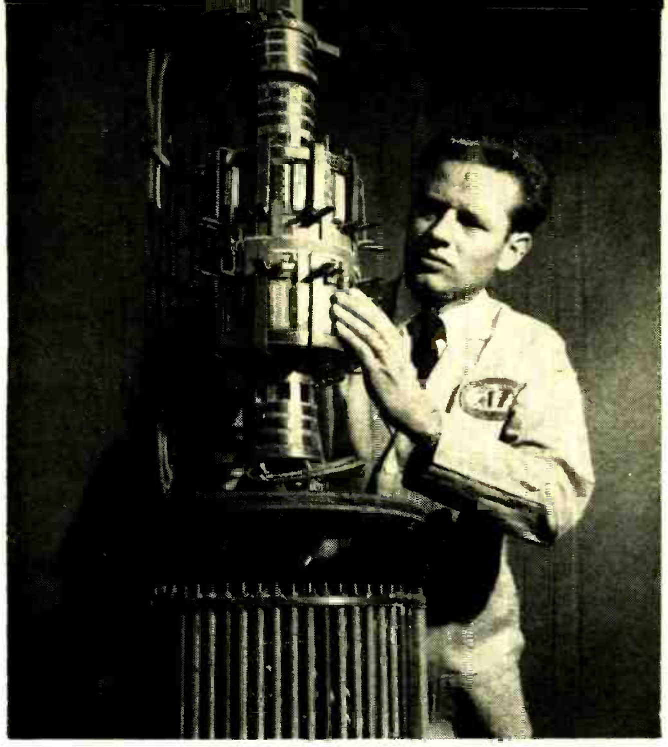


Fig. 6. Using the transformer-secondary taps for matching.

AMPLIFIER		SPEAKER(S)	
CONNECT TO	FOR LOAD VALUE	IMPEDANCE	CONNECT TO
B–D	8Ω	16Ω	A–D
B–D	"	4Ω	C–D
A–D	"	2Ω	C–D
B–D	"	1.44Ω	A–B
B–D	"	.64Ω	B–C
A–D	"	.32Ω	B–C
B–D	4Ω	8Ω	A–D
B–D	"	2Ω	C–D
A–D	"	1Ω	C–D
B–D	"	.72Ω	A–B
B–D	"	.32Ω	B–C
A–D	"	.16Ω	B–C

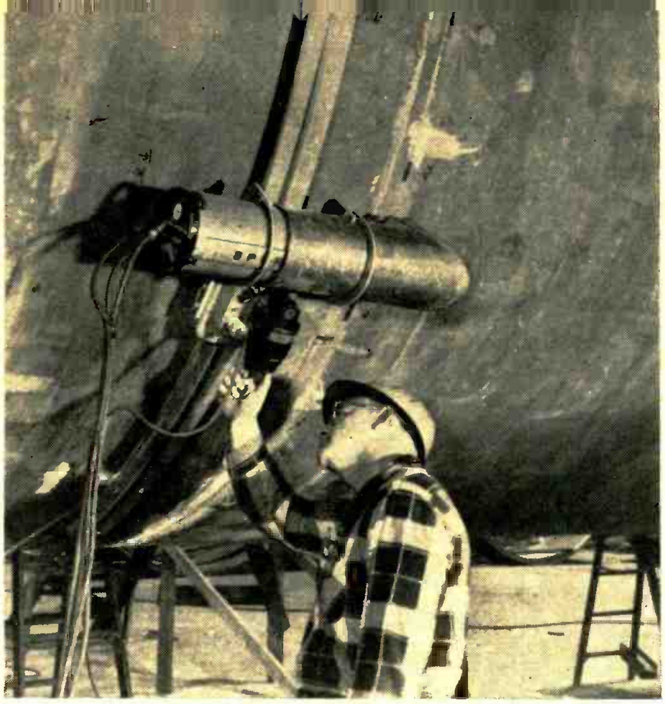


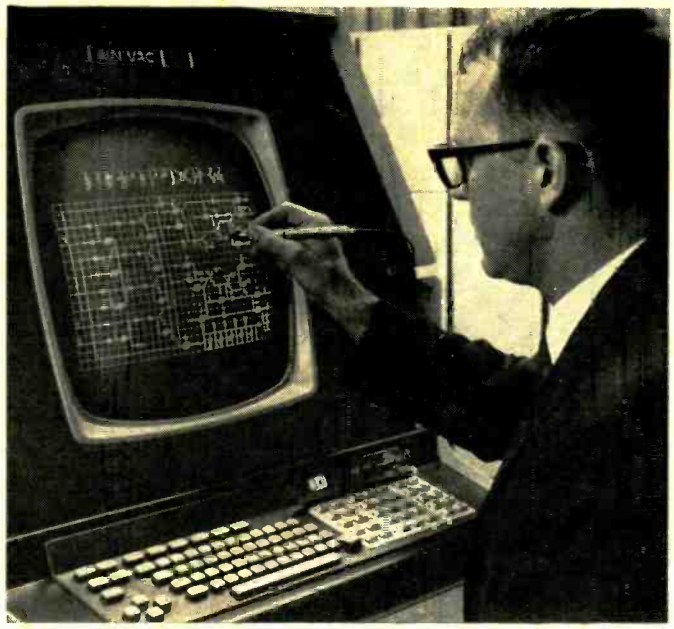
RECENT DEVELOPMENTS IN ELECTRONICS

Superconducting Power Supply. (Top left) This power supply, called a "superconducting flux pump," was developed to supply electric current to a magnetic hammer used by NASA to shape space-vehicle pressure and fuel-tank walls. The unit converts low-voltage alternating current to high direct current in its top section. The energy is then stored in an electrical coil at the bottom of the supply. The magnetic hammer does not use any moving parts but instead relies on the magnetic force produced when 20,000 amperes flow through the coil. In order to obtain this high value of current, superconducting materials are used which offer virtually no resistance to current when kept at a very low temperature. In this case, cooling is produced by using liquid helium which lowers the temperature to minus 452 degrees F. The power supply was developed by North American Rockwell.

Shore-Based Submarine Trainer. (Center) The two crewmen and officer at the left are fighting a mock sub battle with replicas of sonar, fire control, and associated communications equipment that would be installed on a sub-chasing destroyer. The shore-based electronic trainer permits students to practice tactics under realistic conditions ashore. The 2.4-million device was built for the Naval Training Device Center at Orlando, Fla. by Honeywell Marine Systems. Two other similar trainers have been in use training crews at U.S. naval bases in San Diego, Calif. and Newport, R.I. The system sets up computer-controlled engagements between two target submarines and a destroyer equipped with anti-sub rockets, and supported by two other destroyers and three aircraft. Imaginary conflicts are fought on a make-believe sea of up to 128 miles square. The progress of 12 to 16 students in detecting, tracking, and attacking can be monitored.

Phone-Line Security System. (Bottom left) The apartment-entrance security system shown here permits an occupant to dial a single digit on a conventional telephone in his apartment to unlock the building's lobby door. When a visitor picks up the lobby handset and presses the button for an apartment, a distinctive two-ring signal is heard over the resident's phone. The occupant can then talk to the visitor over the telephone and, if he decides to admit the visitor, he simply dials the digit "6" to unlock the lobby door. If the phone is being used in the apartment at the same time, then the resident hears a tone superimposed on the conversation. He can then either put his call on hold by dialing "3" or dial "6" to open the door. The new intercom system, called "Enterphone," is being installed by telephone operating companies. The system is made by Automatic Electric (Canada).

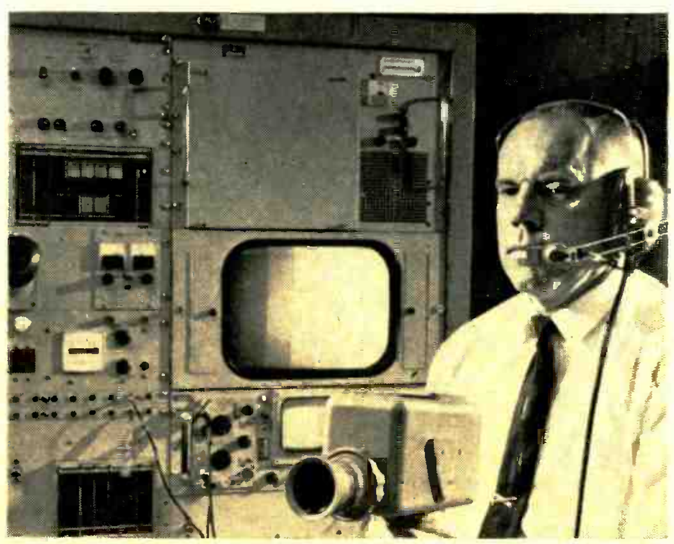




Portable X-Ray Tester. (Top left) This 160,000-volt portable x-ray unit was used to inspect the circumferential welded seams of four 247-ton aluminum heat exchangers. The x-ray head was mounted on a self-propelled carriage attached to a geared track on the 198-foot exchangers. Strip film, placed against the weld inside the shell, permitted the x-ray unit to record a continuous image while in motion. By using this technique, a 100-percent inspection of 1800 feet of welded seams was performed in near-record time. The heat exchangers are part of a system used to cryogenically liquify natural gas for shipment to other countries from a new Esso plant in Libya. X-ray unit was made by Automation Industries.

Circuit Design via Computer. (Top right) using a light pen, the engineer is designing an electronic circuit on the screen of a new graphic-display subsystem. From a number of component symbols shown in the upper part of the screen (resistors, capacitors, transformers, diodes, transistors, transformers, etc.), the designer can select those components he needs to construct the circuit on the grid shown. Featuring the first announced commercial digital-deflection technique in graphic display, the new Univac subsystem can be used for direct interconnection with a larger computer system.

Tape Cassettes Are Up and Away. (Center) The hottest product to hit the audio market in a long time is the pre-recorded tape cartridge in cassette form. With holiday sales of cassette recorders and players expected to be high, the tape-duplicating companies are working long and hard to meet the expected demand. One of the largest duplicating lines in the industry is this automated facility at Dubbings Electronics. The plant is turning out over 30 million feet of cassette tape each week and there are plans for a considerably greater output in the near future. Each multiple duplicator shown records at 16 times the speed at which the tape will be played, that is, at 30 in/s. Fourteen tapes are recorded simultaneously, or 420 minutes of program per minute.



Apollo TV Camera. (Below right) If you watched the TV pictures relayed by our Apollo astronauts recently, you saw what this little $4\frac{1}{2}$-lb TV camera can do. A technician is holding the RCA space camera in front of the ground-based scan converter which received the TV signals from the spacecraft and converted them to commercial broadcast standards for use by the TV networks. Extensive use of IC's made the small size and low power consumption (6 W) possible. Bandwidth of the system was 500 kHz, the frame rate was 10 per second, and the number of scanning lines was 320.

This is what the BART train will look like. Although an attendant will be on board, the train will be completely automatic in control and operation. The attendant will be able to override the automatic controls in an emergency.

BART: electronics aids rapid transit

By JOSEPH H. WUJEK, Jr.

The Bay Area Rapid Transit system being built in the San Francisco area may be the prototype for future mass transit. Electronics will play a key role in permitting safe, high-speed, fully automatic operation.

With the continued growth of our metropolitan regions, new emphasis is being placed upon the development of mass-transit systems. These systems must provide safe, swift, dependable, low-cost, and efficient service between the centers of employment and the outlying residential areas. Transport between the home and cultural/amusement centers is also desirable.

The automobile does not meet the requirements of mass transit in the future of our cities. Beyond the gross inefficiency and high operating cost of the automobile, we are faced with the added specter of air pollution. While the car of the future may not contribute to pollution, the auto remains a highly inefficient and dangerous mode of mass transportation. Studies have shown that a modern urban rail system can transport ten to fifteen times as many passengers per hour as can an auto-carrying, four-lane, limited-access (freeway or expressway) highway, and with a high degree of safety. Since the cost of operating a car averages about 10 cents per mile (not including parking, tunnel/bridge fees), even the most ardent "autophile" must concede the merits of an urban rail system for intra- and inter-city trips of moderate length. (The 10-cents-a-mile figure includes all operating costs; *i.e.,* fuel, maintenance, depreciation, insurance, etc.)

The problems of transportation are not alien to the electronics engineer. The April, 1968 issue of *The Proceedings of the IEEE,* in a special issue, dealt entirely with transportation. Since electrical engineers have always worked with systems, a natural extension of system theory is found in transport. In this article we will examine some of the features of the Bay Area Rapid Transit (BART) system, thought by many to be the prototype for future mass-transit systems. As we shall see, electronics plays a key role in permitting safe, high-speed operation.

The BART System

The BART system is a 1.2-billion-dollar complex that will comprise 75 miles of track in the Greater San Francisco Bay area (Fig. 1). Initial service is presently scheduled to begin in late 1970, with completion of the entire system set for early 1972. Included is a tunnel under the Bay and extensive subway operation in Oakland, Berkeley, and San Francisco. Aesthetic values have been considered in the design of surface and elevated lines, and in station architecture. There are no street crossings at grade anywhere on the entire line, thereby adding considerably to the safety of operation of the system.

In July 1963, the engineering firm of *Parsons Brinckerhoff-Tudor-Bechtel* (*PBTB*) issued specifications for functional requirements of the automatic train control (ATC) system. As consultants and test administrators of the BART system, *PBTB* operated a test track and shop facility at Concord, California for evaluation of ATC equipment. Three test cars were built and, from March 1965 to February 1966, tests were conducted. After screening of proposals, contracts were let to furnish test systems. Five companies participated in these tests: *General Electric Co., General Railway Signal Co., Westinghouse Air Brake Co., Westinghouse Electric Corp,* and *Philco-Ford Corp.*

From the comprehensive test program, the feasibility of 80-mile-per-hour operation was demonstrated. Passenger comfort is maintained with peak acceleration/deceleration of 3.3 mi/h/sec, even while maintaining train separations (headway) as short as 90 seconds. The tests also indicated:

1. That all ATC systems responded safely to their control and indication signals.
2. That speed-distance profiles can be accurately repeated run after run.
3. That deviation from any nominal speed can be regulated to within 2.2 mi/h and that this deviation is not a function of the reference speed.
4. That deviations in runtime on station-to-station runs of two to three minutes can be held to less than 20 seconds.
5. That automatic station-stops can be made to an accuracy of plus or minus 12 inches.
6. That trains can turnback (reverse direction) within six seconds.

Subsequently, *Westinghouse Electric Corp.* was the low bidder on the contract to furnish ATC equipment (Fig. 2).

BART trains will vary in size from two-car units to as many as ten cars in maximum length. Each 70-foot car will seat 72 passengers; with air-conditioning; large, tinted-glass windows; recessed lighting; and wide aisles to provide maximum comfort. The track width of 5 feet, 6 inches instead of the standard 4 feet, 8½ inches allows a spacious car interior and smoother ride.

The traction system will use 1000-volt d.c. motors, with power pickup from a third rail (Fig. 3). Since the average distance between stations is two miles, the 80 mi/h peak speed is needed to maintain an approximate average speed of 50 mi/h.

Train operation is totally automatic, with an attendant present to stop or slow the train in emergencies, make announcements, and maintain radio communications as required between the train and central control. The operator can also override to optimize train performance, such as

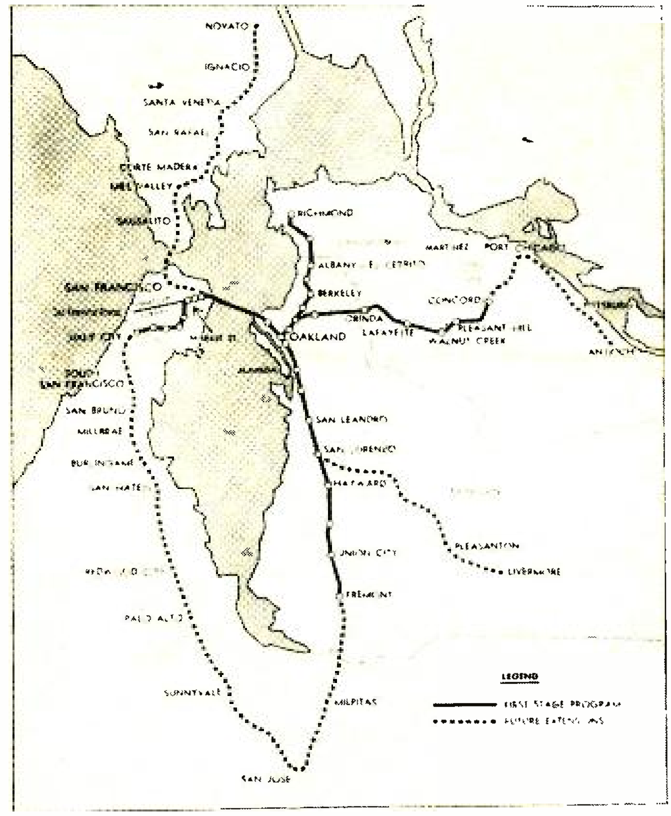


Fig. 1. Over-all map of BART system. Now nearly half completed, the $1.2 billion system will link San Francisco communities.

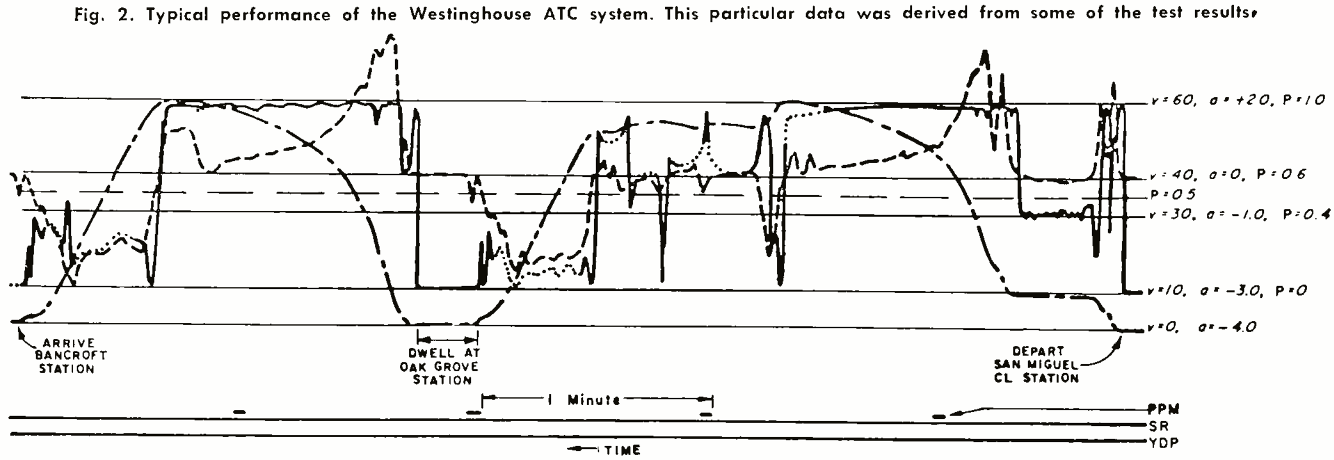
closing the doors before the scheduled interval has elapsed if there are only a few people boarding the train.

Automatic Fare-Collection System

A modern electronic system will be used to facilitate fare collection at stations. Although automatic fare-collection systems are in use in such cities as Stockholm, London, and Chicago, the BART system will include some features not found in earlier devices.

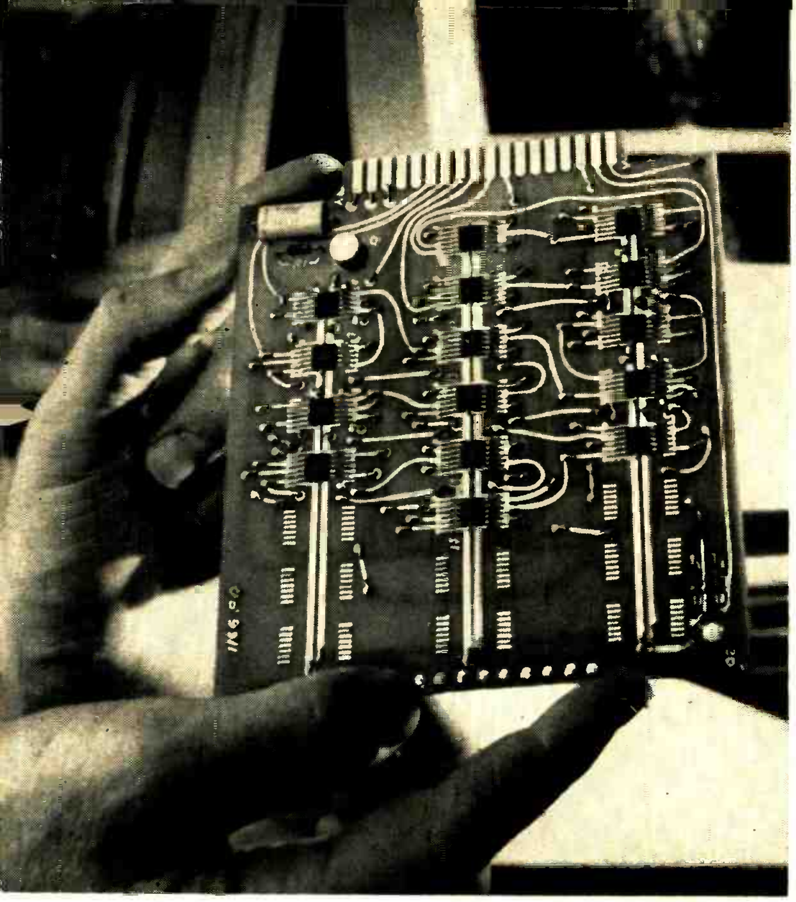
The fare-collecting system, to be built by *IBM Corp.*, will perform several distinct functions. In addition to ticket-

Fig. 2. Typical performance of the Westinghouse ATC system. This particular data was derived from some of the test results.



LEGEND

- – – – – – a = ACCELLERATION (COMPUTED AS THE DERIVATIVE OF VELOCITY)
- SR = STOP RELAY: INDICATES EMERGENCY STOP CONTROLS NOT ACTUATED
- PPM = TIME MARKERS: 1.0 MINUTE BETWEEN LEADING EDGES
- YDP = Y-DIRECTION COMMAND
- ———— P-SIGNAL = TRACTIVE EFFORT COMMAND
  P GREATER THAN 0.5 COMMANDS PROPULSION
  P LESS THAN 0.5 COMMANDS BRAKES
- .... ESTIMATED P-SIGNAL (RECORDINGS INDISTINCT)
- —— – —— v = CAR VELOCITY



This integrated-circuit logic board is one of hundreds that will be used in the automatic train control system.

vending and currency change-making, the system will automatically tabulate and subtract fares from a magnetically coded ticket. Upon insertion of the ticket, either an access gate remains open to the passenger or a signal directs him to an "Addfare" machine. The gate mechanism also prints on the ticket the amount remaining before expiration.

A special feature of the gate is the ability to remain open, with no barriers, as long as a valid ticket is presented. The "open-gate" feature thus assures a minimum of interruption in the flow of pedestrian traffic. The "Addfare" machine permits increasing the value of a magnetic ticket by depositing currency in the machine and "transferring" the currency value to the ticket.

The prime consideration in the design of the fare-collection system was "keep it simple." Careful attention was given to "human factors" engineering so as to minimize the possibility of user confusion. Directions will be given in precise, unambiguous terms on how to use the system.

Automatic Train Control (ATC) System

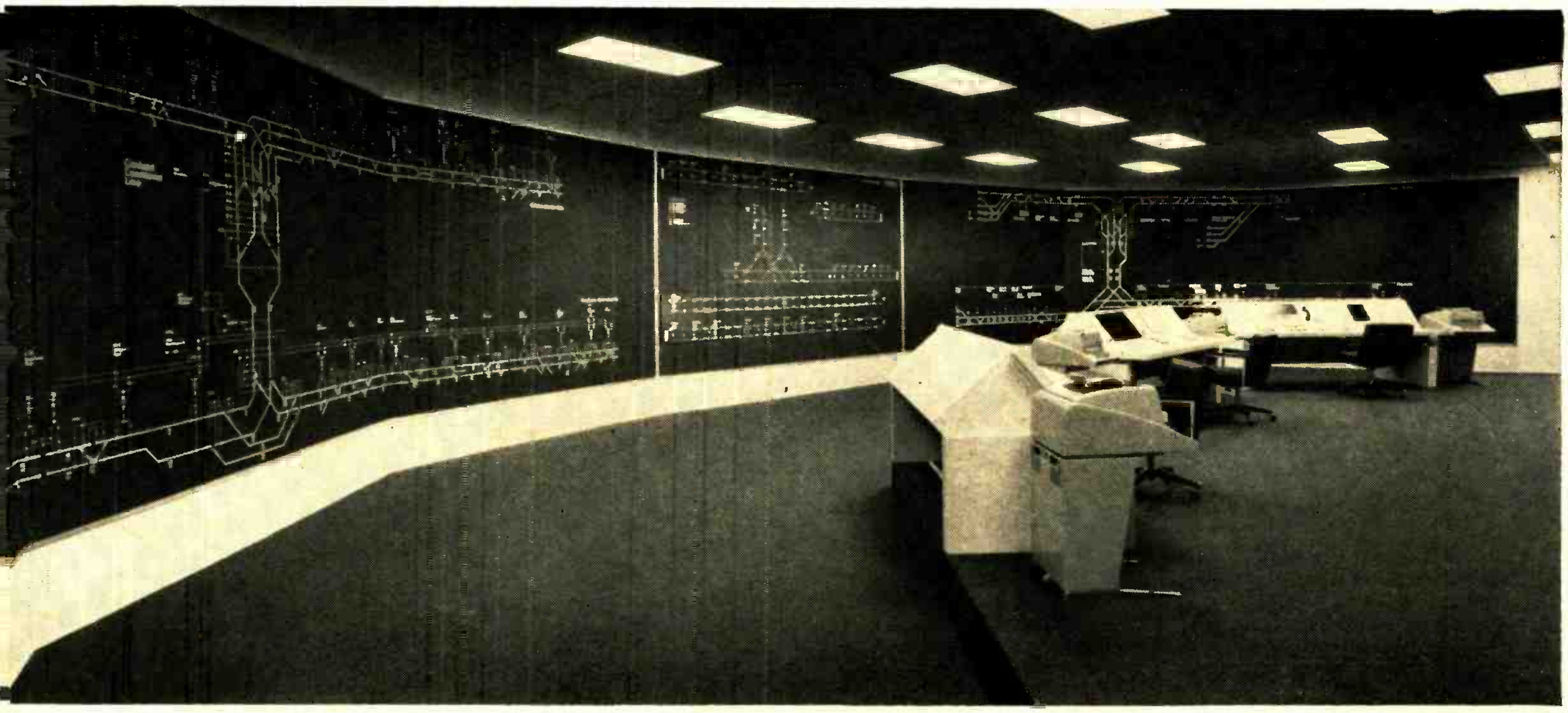
The *Westinghouse* ATC system may be considered to consist of three separate subsystems, according to function. A "fail-safe" train-spacing subsystem overrides the other two subsystems and provides anti-collision protection. In the event of equipment failure, the "fail-safe" mode always maintains proper intervals between trains.

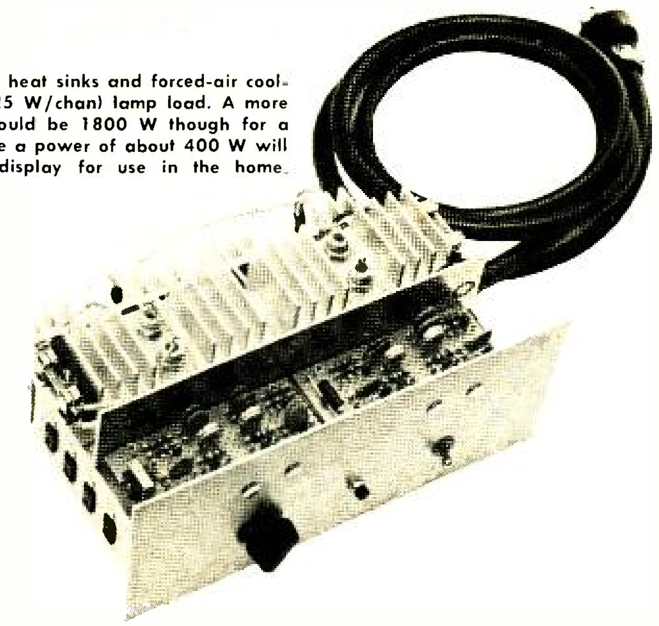
The second, a scheduling subsystem, has to do with operation of trains. This subsystem starts and stops train, opens and closes doors, and dispatches trains as the passenger load requires. The third subsystem renders BART unique among the world's rail systems. The Train Supervisory System (TSS) monitors, and continuously updates, the performance of each train on the line. While other rail systems use scheduling and train-spacing ATC, the TSS has not, at this writing, been used elsewhere.

The TSS and scheduling function is handled by a *Westinghouse* P-250 digital computer. This medium-sized machine (375,000-bit memory), originally developed for industrial process control, will examine the BART traffic and transmit coded information to on-board equipment in order to control train dynamics. A second P-250 machine will be available on standby service.

The computer can also be used as a simulator, to "play games" as it were. By simulating various traffic situations, operating conditions and load factors can be "tried", and an optimum (if it exists) operational solution deduced. Since these tests and decisions are made at computer speeds, trains need not wait for the human decision-making process. In fact, the number and rapidity of the decisions required of a system as demanding as BART could not be made by a human operator, or a team of operators. At that, the sheer physical effort involved would leave the operators fatigued and prone to dangerous errors. (*Continued on page* 84)

Full-scale mock-up of supervisory and control room. Dominated by display panels 88 feet wide and 9 feet high, the room will be located in BART's Oakland headquarters and will be the control center for the three-county transit network.





This version of the organ, using heat sinks and forced-air cooling, can operate a 2500-W (625 W/chan) lamp load. A more reasonable maximum power would be 1800 W though for a standard household circuit, while a power of about 400 W will produce a reasonably bright display for use in the home.

A New Approach to COLOR-ORGAN DESIGN

By J.M. POWELL/Engineer, TRW Inc.

Using active filters, this new color organ produces a sharper, more vivid visual display than previous designs, even at low volume levels.

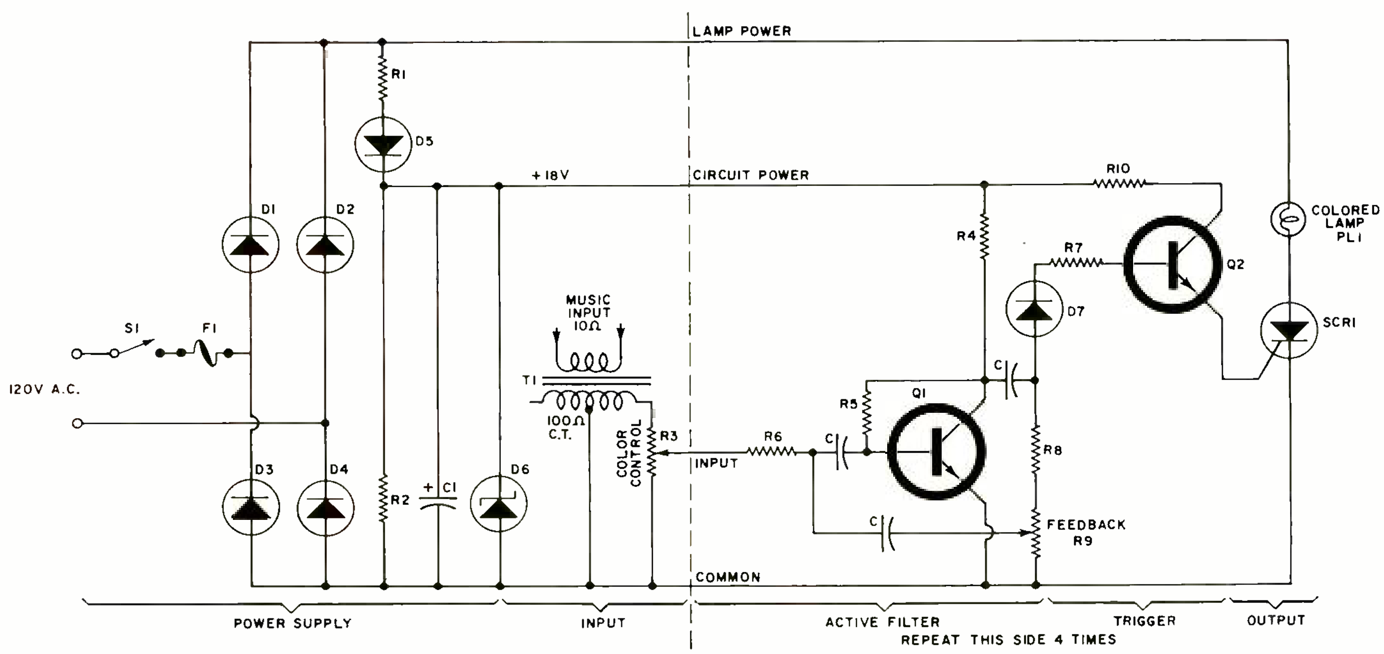
THIS article covers a distinctly different design for building a color organ, a device which is becoming more and more popular as a complement to both mono and stereo systems. While the object of such visual displays is to give sharp color response to specific tones, the limited selectivity of passive-filter systems causes color washout whenever multi-instrument recordings are played. The main feature of an active-filter design is accurate differentiation of musical tones, resulting in a brilliant and dynamic show of colors.

The active-filter color organ also operates at lower sound levels than previous designs, creating a pleasing effect with more types of music. In addition to these advantages, parts cost for this design is actually less than for a comparable passive-filter device.

The circuit is basically a full-wave unfiltered bridge driving four differently colored lamp loads through series silicon controlled rectifier (SCR) switches. A musical signal at the input terminals allows the control circuitry to turn on an SCR, and its accompanying colored lamp, when the appropriate tone and volume are reached.

The full-wave bridge-SCR lamp-driver combination is a standard arrangement and has appeared in previous articles (see "Simplified Solid-State (*Continued on page 61*)

Fig. 1. In this color organ, an active filter is used to increase selectivity. See parts list for values of feedback capacitor C.



R1—1500 ohm, 10 W res. ±10%
R2—820 ohm, 1 W res. ±10%
R3—50 ohm pot "Color Control"
C1—15 μF, 35 V elec. capacitor
D1, D2—1N3495 rectifier (Motorola)
D3, D4—1N3495R rectifier (Motorola)
D5, D7—1N4001 diode
D6—18 V zener diode (Motorola 1N4746)
T1—Interstage trans. 100 ohms c.t./10 ohms c.t. (Stancor TA-2 or equiv.)
S1—10 A toggle sw.
F1—10 A, 120 V fuse
The following parts are for a single channel. Four channels are required.
R4—3300 ohm, ½ W res. ±10%
R5—1 megohm, ½ W res. ±10%
R6—4700 ohm, ½ W res. ±10%
R7—10,000 ohm, ½ W res. ±10%
R8—2700 ohm, ½ W res. ±10%
R9—2000 ohm pot (Mallory "Trim-Pot" MTC-1)
R10—560 ohm, ½ W res. ±10%
SCR1—7.4 A SCR (General Electric C-20-B)
PL1—120 V incandescent bulb—in color (20 to 150 W total per channel)
Q1, Q2—2N3391 transistors
C—0.1 μF, 50 V capacitor (for l.f. green channel)
C—0.047 μF, 50 V capacitor (for medium-l.f. blue channel)
C—0.022 μF, 50 V capacitor (for medium-h.f. red channel)
C—0.01 μF, 50 V capacitor (for h.f. yellow channel)

Link Coupling Nomogram

By DONALD W. MOFFAT

Calculating coupling coefficient values, k_e, can be a tedious and messy mathematical process. But if the link coupling's physical length is less than the wavelength, this nomogram can do the job.

When a signal source is physically separated from the circuit it supplies, link coupling like that shown in Fig. 1 is often used to match impedances. A second transformer matches the link to the load. Although air-core radio frequency transformers are shown in the diagram, this method of coupling is equally applicable at low audio frequencies.

Link coupling would probably be used more often except that the mathematics discourages a designer from attempting to predict the over-all coupling coefficient, k_e. However, if one assumes that the length of the link is significantly less than a wavelength of the frequency being coupled, then the equations become manageable. A nomogram can then be made and k_e found without any calculations. As the length of the link approaches the wavelength, the nomogram becomes less dependable. And when the link is longer than a wavelength, this nomogram does not apply at all.

Using the Nomogram

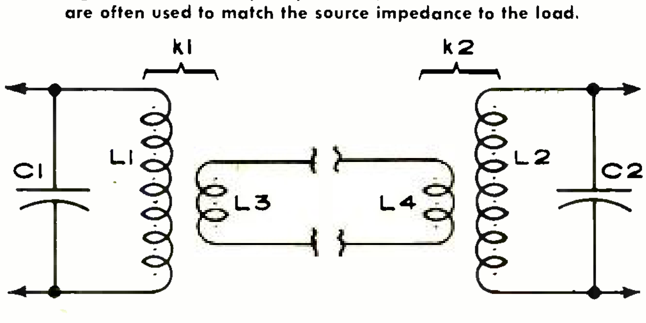
It will be helpful to first examine the curves in the upper left of the nomogram. The scale on the left and the background grid of light horizontal and vertical lines serve as guides when determining values of *Effective k*. Although only nine curves are drawn, the user should visualize an unlimited number of curves, all of the same shape, filling in the spaces.

When the instructions say to follow a curve from the vertical axis, it will often be necessary to picture a curve which starts from a given place on the axis, and follows the same shape as the others. This is shown in example.

To find k_e on the nomogram, we must know the inductances of the windings at either end of the link and the coefficients of coupling of the two transformers. The order of the five steps in the following paragraphs should be adhered to when determining k_e values.

(*a*) Locate the correct inductance values on the *L*3 and *L*4 scales and draw a straight line through these points, extending the line to cross the heavy horizontal line at the bottom of the curves.

Fig. 1. In radio-frequency circuits, air-core transformers are often used to match the source impedance to the load.



(*b*) From that point on the heavy horizontal line, draw a vertical line straight up through the curves, using the nearest vertical grid line as a guide.

(*c*) Locate the correct values of individual coefficients of coupling on the *k*1 and *k*2 scales and draw a straight line through them. Extend this line and cross the heavy vertical line that bounds the curves on the right.

(*d*) Follow the curve which also intersects at this point on the heavy vertical line, until it intersects with the vertical line drawn in Step (*b*). It may happen that one of the curves in the drawing starts at that intersection, or it may be necessary to visualize a curve which has the same shape as the others.

(*e*) From the point where the curve intersects with the line drawn in Step (*b*), proceed straight out to the k_e scale on the left. Use the nearest horizontal grid line as a guide and at the k_e scale read the effective coefficient of coupling from input to output.

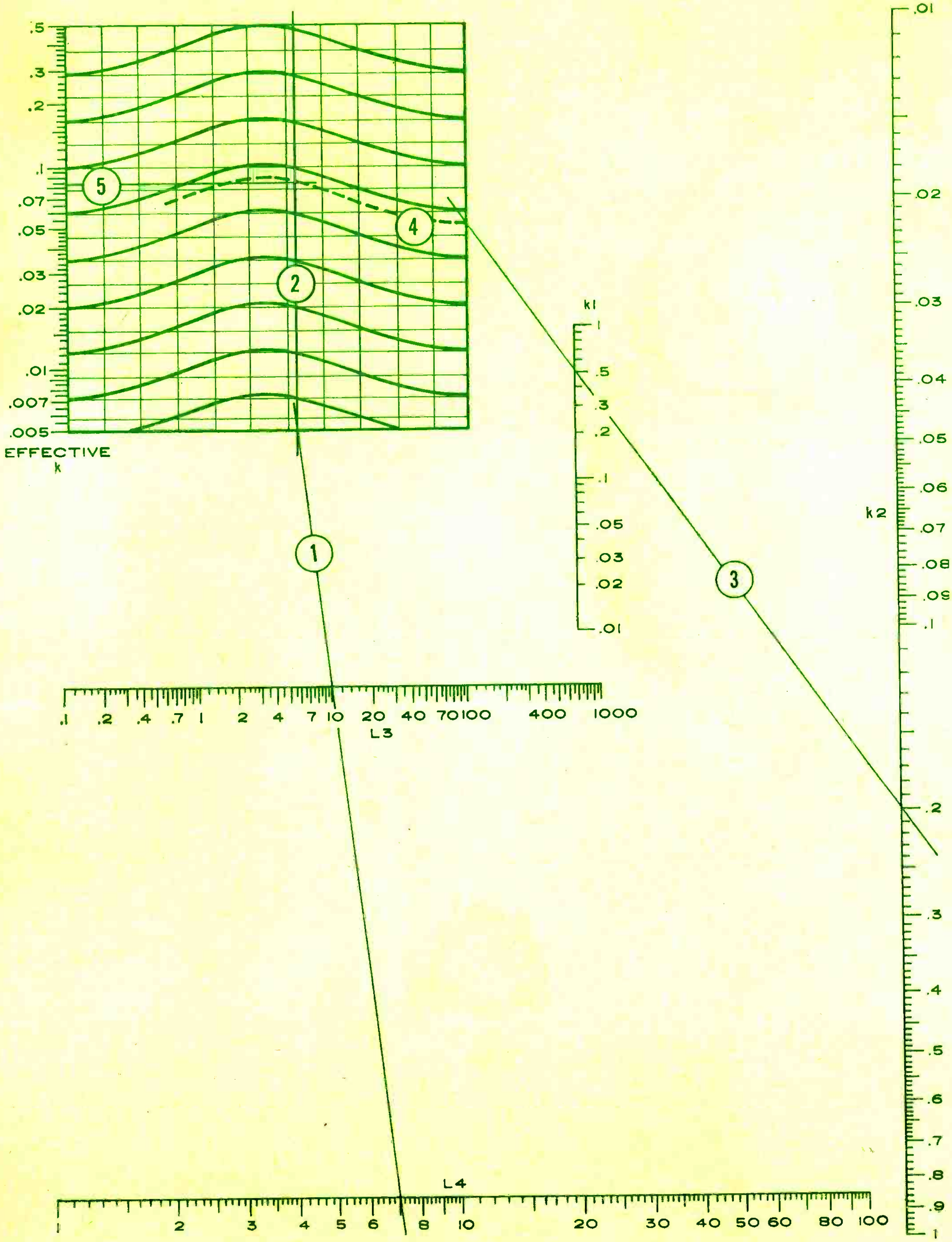
It is interesting to note that k_e increases if either of the individual coefficients of coupling is increased and, for a given combination of *k*1 and *k*2, the maximum k_e occurs when *L*3 is equal to *L*4. The value of maximum k_e (when the inductances are equal) is equal to one-half the product of the individual coefficients of coupling, so a theoretical maximum of $k_e = \frac{1}{2}$ is approached when *k*1 and *k*2 both approach unity and both inductances have the same value.

Example

Find k_e if the circuit diagram has *L*3 and *L*4 values of 10 and 7 microhenrys, respectively, and *k*1 and *k*2 values of 0.5 and 0.2. Total length of the link is significantly less than a wavelength of the frequency being coupled.

1. Draw a line from 7 on the *L*4 scale, through 10 on the *L*3 scale, to the heavy horizontal line that bounds the curves in the upper left corner.
2. Draw a line straight up from that point, parallel to the nearest vertical grid line.
3. Draw a line from 0.2 on the *k*2 scale, through 0.5 on the *k*1 scale, to the heavy vertical line that bounds the curves on their right.
4. The dotted curve shows how a curve should be visualized if a printed one does not meet the line drawn in Step 3. Follow the curve to where it intersects with the line drawn in Step 2.
5. From that intersection, use the nearest horizontal grid line as a guide and proceed straight out to the *Effective k* scale. Read the answer of $k_e = 0.084$.

Since no units are shown on the *L* scales, the user of the nomogram can supply any set of units that applies to his circuit, as long as he uses the same units on both scales. For instance, both scales can be called microhenrys, millihenrys, or even tenths of a microhenry if such values would be most useful in a particular application. ▲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L3
1 2 3 4 5 6 8 10 20 30 40 50 60 80 100
L4

Fig. 1. Classroom-studios acquaint student-teacher interns with TV techniques. Graphic art cards are used for tape identification purposes. The students operate the equipment and do the practice teaching.

TV Systems for TEACHER EDUCATION

By L. GEORGE LAWRENCE

Breakthroughs in the manufacture of small, low-priced video tape recorders have placed a superior training aid within reach of every teacher-training college.

SALESMEN know that seeing yourself as others see you often makes the difference in selling. And, although many business men have, for some time, used various means of "seeing oneself" in training their personnel, school teachers and teacher-training institutions have just begun to recognize that such a technique is a very valuable teaching aid.

Perhaps the responsibility for this new approach lies in the availability of new low-cost video tape recorders coupled with a change in the direction of academic teacher-training procedures. For example, a few years ago video tape machines cost $50,000 to $70,000; now portable video tape recorders, including camera, microphone, and other equipment can be obtained for less than $1600.

Although the new VTR's are simple to operate and low in price, they cannot be used effectively for instructional purposes unless the teacher-training objectives are clearly defined. Basically, these objectives encompass the use of television as a feedback aid. Thus the teacher intern program takes the form of "microteaching" and has these characteristics: 1. A specific teaching skill is studied by the intern. 2. The intern attempts to apply the skill in a short lesson, usually five to ten minutes in length, with four or five pupils. 3. This lesson is recorded on video tape and the intern watches a replay of the session. 4. During the replay, a supervisor or senior teacher gives the intern feedback (including constructive comments) on his performance. 5. The intern replans the lesson and reteaches it to another group of pupils. Thus, the microteaching concept—a term originated at Stanford University and encompassing the use of classroom video tape recorders—provides a teaching encounter which is scaled down in time and the number of students taught by the trainee. It is a great help in alleviating some of the complexities and trauma which often accompanies initial teaching experiences by young men and women fresh out of college.

Fig. 1 shows an introductory classroom-studio situation intended to acquaint student teachers with techniques of program preparation, use of VTR's, oral presentations.

The equipment is basic. It consists of a portable VTR, a camera with 1:5 zoom lens, a display/recording monitor, a mike with desk stand, a headset for the VTR operator, and an oscilloscope. The latter is a training aid in itself, since it shows proper video shapes when recording film by "natural" synchronization as provided by a xenon-arc projector. However, the scope is not a "must."

Any bright student, especially if he or she is technically inclined, makes an excellent recording engineer and can be taught how to operate the equipment in an hour or less. Maintenance, if and when necessary, is best performed by the equipment manufacturer's service department or by reliable, independent TV repair shops equipped for this type of work. (In specific figures, maintenance of the complete VTR package seldom exceeds $120.00 a year.)

Portability is one of the main considerations in choosing VTR sets. Many states have laws limiting the weight a woman may carry. California has set this limit at 50 pounds. However, there are several top-brand VTR's which use 1-inch and ½-inch tape and weigh 60 pounds or less, so two girls can carry the machine without much strain. The *Ampex* 5100, for example, will meet the weight requirement.

However, many schools purchase capital equipment by "bid" rather than buying outright from audio/visual equipment vendors. Thus it is possible to have (in one classroom), two or more electronically incompatible VTR's.

The trouble is that sync is injected at a different portion of the video tape; the sync track on one machine might be the sound track on the other, etc., because heads are spaced and placed differently.

However, it is not difficult to make dubbings (copies) of video tapes and transfer program material from one "oddball" machine to another. Since video signals always include standard sync pulses with the video information, it is relatively immaterial what kind of source feeds the master VTR. Dubbing connections, shown in Fig. 2, can be made by simple patchcords having BNC or u.h.f. connectors at both ends. In most cases, no intermediate processing is required. The master VTR's video and audio gain controls suffice and the video monitor and sound system provide continuous quality control while the dubbing is in progress.

The merits of dubbing, especially in a teacher-training situation, cannot be emphasized enough. It makes it easy to omit undesirable program contents by simply switching the master recorder to standby. Likewise, a tremendous amount of visuals such as pertinent film clips, film strips, slides, and transparancies, can be inserted during the dubbing process.

Electronic Injection of Visuals

Visuals raise the quality of in-class lectures by making the "message" come through stronger. In most classrooms, images on the film clips, slides, and so forth are projected onto a screen. The TV camera is pointed at the screen and its signal is fed onto the video tape. It's an inexpensive and easy process. For example, take the case of film clips. The clip, in most cases a length of 16-mm film with an optical sound track, may be inserted into a lecture to shed more light on a fairly complex topic.

Unfortunately, a common shutter-type 16-mm film projector of the incandescent type usually cannot be used with a direct video pickup because black bars appear on the monitor due to out-of-sync shutter closures, camera retrace or blanking intervals, and pull-down during critical scanning periods. Thus there may be dark, pictureless intervals.

The arrangement in Fig. 3 shows how to use a shutterless xenon-arc projector, in this case the *Bell & Howell* Model 566. Since both the television system and the "on-off" cycle of the xenon-arc lamp are automatically synchronized by the 60-Hz power line, nearly perfect sync is established. However, a critical observer, using an oscilloscope and examining the projected image directly, will observe a slight but unobjectionable flicker.

In addition, the video's geometry is not perfectly linear, but shows a slight bulge. However, due to the projector's very high light output (approximately four times higher than that of a machine with an incandescent lamp), colors reproduce exceptionally well. System saturation is avoided by placing a neutral-density filter over the projector's optics or by adjusting the VTR's video gain control. A simple audio patch, with an 8-ohm dummy load and a divider network, will transfer sound from the projector to the VTR's audio input. The recorder should be switched to "Unbalanced Line" to avoid distortion.

Transport and Installation

Properly selected VTR equipment will include a combination console/carrying case designed for easy transportation to and from off-campus classrooms. Discrete units (small VTR, 9-inch monitor, automatic camera without operating controls) weigh much less than composite packages and the small items can be stored, together with stands and cables, in a reinforced suitcase. "Boom" microphones, special lights and the like are superfluous. The average modern camera will work at ambient light levels of 50 or more footcandles. A normal passenger car, rather than a truck or station wagon, suffices for transport.

In the classroom, two mikes may be used: one a lavalier type hung around the teacher's neck; the second unit simply put on a desk to record pupils' reactions. A second person will operate the VTR. Note that the audio should be monitored by headset only to avoid feedback. Using only one mike allows good fidelity and operation at continuous high gain and there are no cords to tangle with.

The use of wireless microphones can produce some unexpected headaches. Unless the customary FM receiver is carefully insulated by an isolation transformer, sharing a common power line with the VTR can lead to serious audio interference due to noise transients from the recorder's servo system.

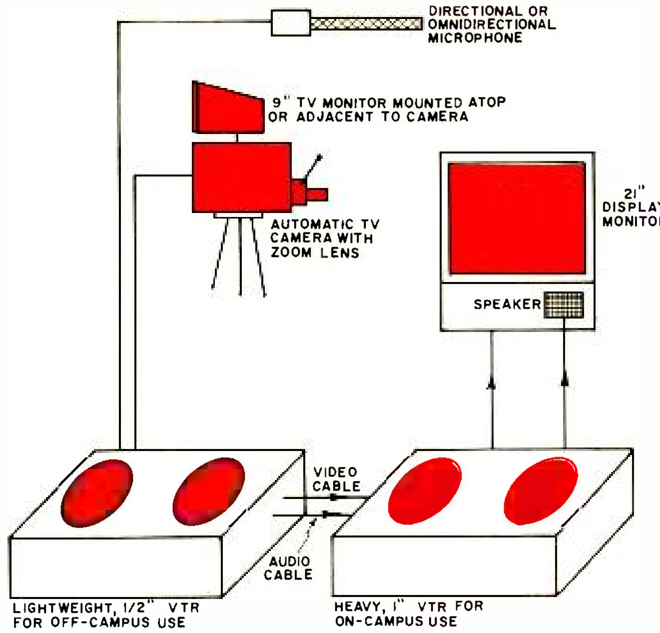


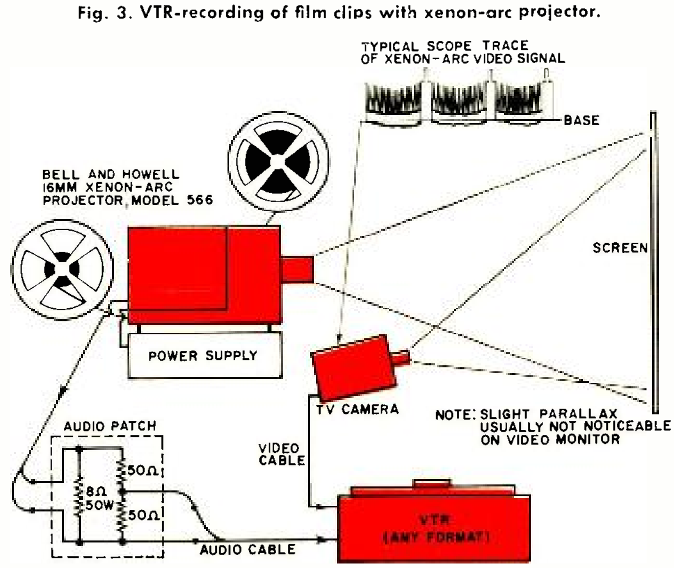
Fig. 2. Dubbing set-up for electronically incompatible VTR's.

Economy

It's possible to use inexpensive surplus computer tape for video taping. A reel of 1-inch or ½-inch tape, wound onto a 15-inch spool, gives two hours' video recording time and usually costs less than $4.00. A new video tape costs about $112.00 (two 1-hour reels, 9¾-in o.d.). Of course, the surplus tape's oxide might be more grainy and it does not have the high-quality lubricant which reduces head wear during stop-motion or standby operation (with tape gates closed). A new helical-scan head costs around $100.00, and cleaning is not difficult. However, excessive abrasion and accumulation of oxide can become a problem with the surplus computer tapes. If tape gates are opened—thus relieving pressure on the heads during standby operation—surplus tapes give excellent service.

Owing to the size of the 15-inch reel, surplus tape must be wound onto VTR-sized reels by a special mechanism. Since a hub of several inches o.d. is required, the tape may be taken to a commercial broadcaster's studio for rewinding. Usually his machine will accommodate these large reels, but even so they probably will have to be supported at both driving ends to maintain even winding. Tape wound in this manner should be rewound, with the school's VTR, to

Fig. 3. VTR-recording of film clips with xenon-arc projector.



smooth out possible folds. Alternately, two suitable hub inserts can be constructed and the reels wound on a "film editor" with long spindles. It will also afford bulk-spooling from supply reels.

Special Production Aids

Generally, a student teacher is a dedicated person who hopes to produce a lesson of high quality. Since his material is prepared for self-criticism and/or evaluation by superiors, some arrangement should be made to give him or her a hand with graphics.

Use of graphics is shown in Fig. 1. A professional polish is imparted to a video taped experimental lecture by starting the program in this manner: 1. Test pattern with music. 2. Title Card (information on the card shown reads "CSCSB Television, The Language Arts, 1968"). 3. Theme Card (the example reads "Program Contents, Introduction, Film, Native Speakers"). 4. Program Details (the example, partially covered by a Colortran door, reads "Exercises in Spanish").

These principal cards can be modified to include name of student teacher, time and place of lecture, supervisor, etc. In this setup, all graphics and insertions were prepared by one student teacher—the young lady working as recording engineer. It serves to illustrate, perhaps, that one highly talented individual can cut staff requirements to an absolute minimum.

High-quality title cards and similar items can be prepared with a Leroy set. If very large letters are required, they can be traced on black construction paper using a paper stencil and cut out with small scissors. These "signatures", as they are called, must have a lettering large enough to accommodate the optics and pickup characteristics of the TV camera's vidicon. A critical size is two (2) inches, depending upon color and field of the paper background. Resolution, the ability to discern differences between characters, will suffer if letters are smaller than ½ inch.

TV as a Behavioral Study Aid

The weakness of current theories on learning and adaptation may be traced to the fact that an objective conception of human behavior is still incomplete. Only in a very limited area, mainly in the case of automatic responses by trainable organisms, was it possible to obtain more insight. I.P. Pavlov's work with dogs and B.F. Skinner's efforts with pigeons stand out in this regard. The task of translating these behavioral profiles to humans remains, notably in a way that would promote the learning process in a young child.

Television transponders, a basic model of which was evolved by the author and shown in Fig. 4, afford rapid presentation and modification of stimulus codes as presented to an experimental specimen—a pigeon in this case. The method features the standard elements of "reinforcement by rewards" if specific responses to stimulus patterns are obtained. Typically, the pigeon is taught to peck the key of a food-release mechanism when a desired task has been performed. It is by virtue of these and related methods that a naive animal can be trained to respond to images, correct letters on electronic diodes, or—if the experimenter is patient enough—guide a vehicular system by aiming at reference symbols or comparing coinciding images. The training situation is severe and specific: Self-criticism is made effective by withholding food, acceptable behavior patterns are rewarded at once. But here as in orthodox teaching situations dealing with children, the degree to which public manifestations survive, the extent to which private or quasi-unmotivated stimulus takes over, is never too certain. But systems of this type demonstrate to both student teachers and psychologists that learning experiences are based upon a regimen of reinforcements and rewards.

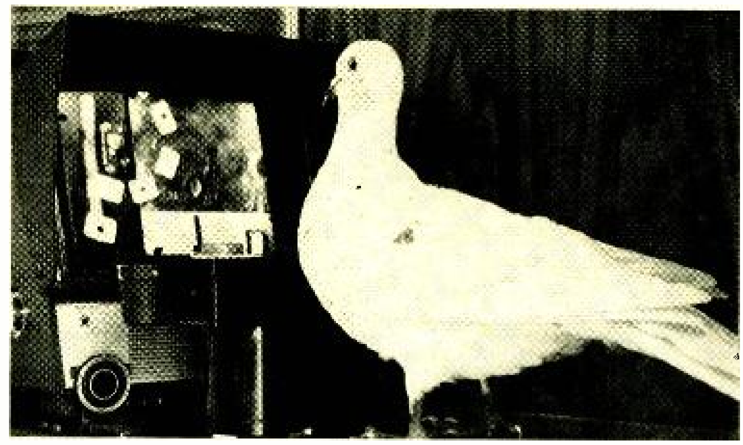


Fig. 4. This TV transponding assembly is used to study the behavioral patterns and learning processes of pigeons.

Technically, the model system shown in Fig. 5 is composed of a high-resolution TV display, a transponding key in front of the screen, a video camera with random interlace, and a prompter. A specific train of cues is provided by the prompting device, alternately displaying a set of changing patterns to the animal. Although background information may be changed at will, cues remain the same. The bird's pecking of the transponder key upon presentation of cue information, regardless of attendant distractions, is rewarded immediately. There is no physical punishment as it is not conducive to truly effective learning. The television system, by its very nature, allows superimposition of images, rapid roll, geometrical distortions, and other program modifications impossible to achieve with traditional methods of image display.

In conclusion, effective communication is the key to successful teaching. One of the greatest hazards in communication is the illusion that it has been achieved when, in reality, there has been no intellectual interaction. TV forms an acceptable and useful bridge. ▲

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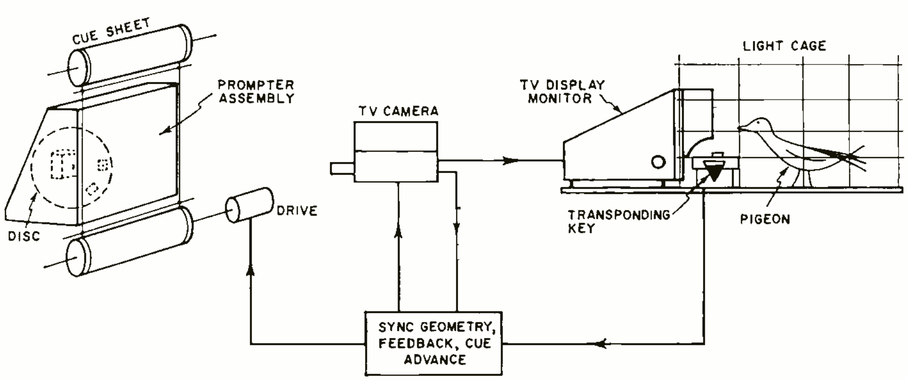
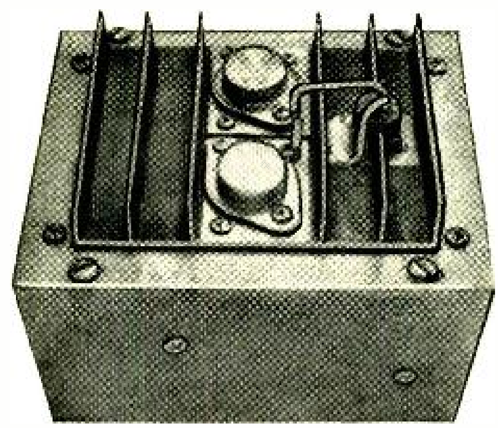


Fig. 5. Details of the TV transponder system assembly. The various components making up system are described in text.

Unique Capacitor-Discharge



Authors' system was built into a 4" x 5" x 5" utility box which, with suitable brackets, was mounted on engine firewall. The two inverter transistors, Q1 and Q2, along with SCR1 are mounted on heat sink outside of utility box.

Ignition System

By CHARLES C. MORRIS & R. D. MORTON

A proven system using a pair of SCR's and a UJT oscillator trigger circuit that does away with problems of poor high-speed performance cause by point-bounce triggering.

ONE of the three major auto ignition systems, the capacitor-discharge type is rapidly gaining in popularity. Engineers, designers, and experimenters from hobbyists to race drivers and manufacturers are turning towards these "CD" systems as the near ultimate in internal combustion engine ignition.

The circuit presented here is the result of many hours of designing and testing a 12-volt, negative-ground CD system which operates exceptionally well under many and varied conditions. Some of the tests and their results will be discussed later. While this system is not the cheapest to construct, it is not the most expensive either. Because of several unique design features, the additional ten dollars or so it costs is outweighed by improved performance and reliability, not to mention reduced tune-up and component costs. Many of the bugs found in other CD circuits have been eliminated in this design.

The most widely used ignition system is the conventional, or Kettering, system. It can be manufactured economically and is reliable as long as it is serviced periodically. From the user's standpoint, the system is not so economical since points, plugs, and capacitors must be replaced more frequently. If this is not done, fuel economy drops rapidly, engine performance deteriorates, or malfunctions show up. A typical ignition tune-up will cost anywhere from $10 to $20 using new components, and should be done about every 10,000 to 15,000 miles. Conventional systems also have certain inherent drawbacks, such as "point bounce" and spark voltage drop-off at higher driving speeds.

A better, but somewhat controversial, ignition system made its appearance several years ago. This is the transistorized ignition. This system offered improved performance and economy in several areas, particularly in increased point life and general engine performance. The main advantage of these systems was that the heavy circuit currents could be switched by a transistor, thus bypassing the points and greatly reducing point wear. The points are only used to switch the transistor on and off. Through the use of specially wound ignition coils, high-speed voltage drop was improved and plug life was increased. Most of the controversy arose from claims of greater fuel economy, "lifetime" components, and engine performance improvements. Probably most of these claims are valid, and many tests have verified some of these improvements.

About the same time that transistor ignition circuits were being evaluated, a third system made its debut. This was the capacitor-discharge ignition and it appears to be the most promising. CD ignition is similar to transistor ignition in several ways, but offers significant improvements. We have found these improvements to be in the areas of still longer component life, engine starting, high-speed driving, acceleration, and power pickup. Large increases in fuel economy were not obtained nor were they expected. Since fuel economy depends on many factors besides ignition, it is questionable whether or not claims of 20% or better increases are valid. Increases of 1 to 3 mi/gal and possibly up to 5 mi/gal could be achieved. In most of the cars we tested, the "old" ignition components were left in the engine. Only cleaning and regapping were done where necessary. One car alone has been driven over 15,000 miles since installation and the combined mileage of all vehicles has exceeded 50,000 miles with no point or plug malfunction.

Generally, CD ignition offers the following advantages over other types:

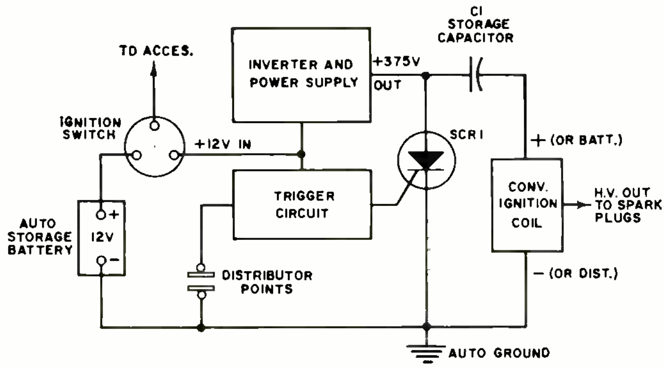


Fig. 1. Block diagram of basic SCR CD ignition system.

1. The points are replaced by a high-current semiconductor in the circuit.
2. Due to faster circuit rise times, maximum spark-plug energy can be stored for delivery to the combustion chamber over a wider range of engine speeds.
3. Higher spark voltage helps to clean plug electrodes and can help the plugs fire more efficiently, even through carbon and other fouling deposits.
4. If properly designed, point bounce or "floating" can be eliminated—a cause of multiple firing or misfiring.
5. Over-all engine performance improves.

One of the biggest problems facing the designer of a CD system is to make the proper engine cylinder fire at the right time. Of the many circuits tried and discussed, misfire or multiple firing seemed to be the main drawback, especially at speeds of 50 mi/h and higher. Most SCR's used in present CD systems are sensitive enough to be triggered by point bounce, or floating, unless sufficient blocking or filtering circuitry is used. Ideally the SCR only wants to see the original "timed" opening of the points for correct cylinder firing to take place.

Another serious problem lies in designing the high-voltage power supply so that it will deliver maximum energy fast enough to follow various engine speeds. Many circuits have been designed around power-supply transformers that simply cannot meet this criterion. Anything less can only result in reduced performance. The power-supply transformer in the circuit to be described was tailor-made to suit circuit demands far in excess of those actually encountered. At 60 mi/h, a V-8 engine has a firing time of a little more than 2 milliseconds from one cylinder to the next. This circuit is designed to deliver maximum energy to its storage capacitor within about 1 millisecond.

The two most unusual features of this design are the power-supply and SCR-firing circuits. Both design problems mentioned before have been solved satisfactorily to insure good system reliability and performance.

Fig. 1 is a block diagram of the SCR ignition system. The power supply steps up the car battery voltage from 12 volts to about 375 V d.c. and charges the energy storage capacitor, *C*1. When the engine firing cycle comes up, the SCR is triggered into conduction by the opening of the distributor points. The storage capacitor is then shorted to ground through the ignition coil. Induced energy pickup by the coil's secondary winding is then delivered to the spark plugs. The collapsing field in the coil turns the SCR off again and the system begins charging for the next firing cycle.

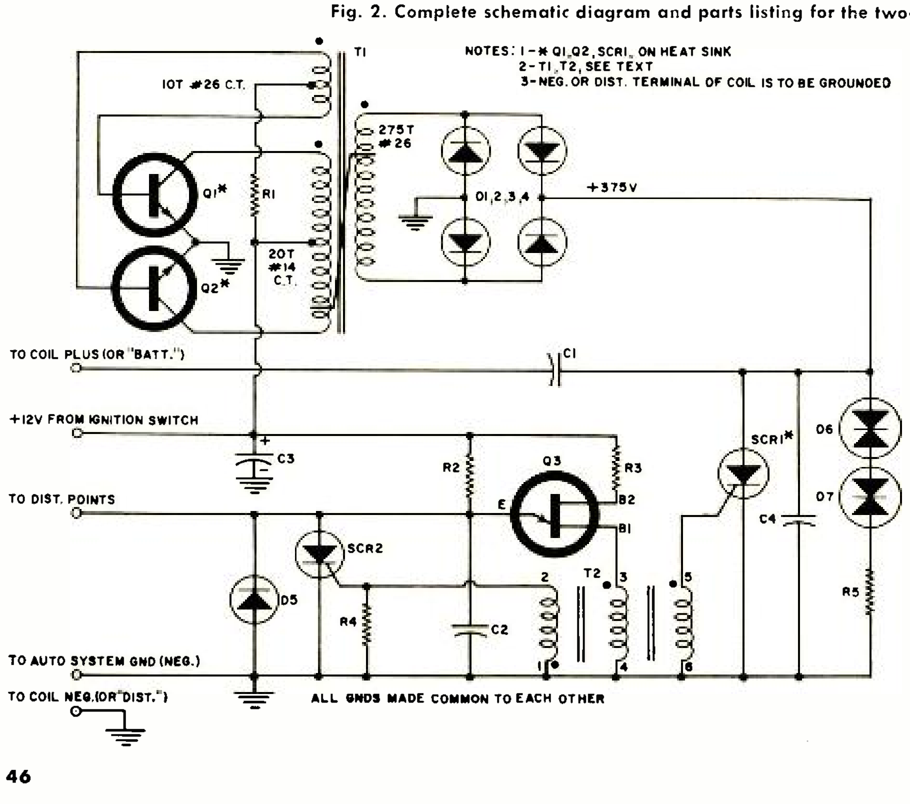
Circuit Operation

Fig. 2 is the schematic diagram of the CD ignition system. Basically, the power supply is a conventional d.c.-to-a.c. inverter, which also includes a diode bridge rectifier which converts the a.c. to about 375 V d.c. The back-to-back diodes *D*6, *D*7 in series with load resistor *R*5, serve as a constant supply load and provide some amount of regulation. Diodes *D*6, *D*7 are actually contact protectors having the ability to break down like zener diodes when certain voltage levels are exceeded. These particular diodes are less expensive than zeners and work very well in this application.

The power-supply transformer, *T*1, is home-made, simply because of economics and because no exact commercial equivalent was available. It was also necessary to tailor it to meet specific circuit parameters. Operating frequency of the supply is about 10 kHz. This higher operating frequency aids in faster restarting of the inverter after heavy system loads are placed upon it. These loads tend to keep the inverter from oscillating, and fast restart is necessary for higher circuit performance.

Silicon controlled rectifier *SCR*1 is a conventional type, selected for its higher current rating in order to increase

Fig. 2. Complete schematic diagram and parts listing for the two-SCR CD system.



R1—200 ohm, 5 W res.
R2, R4—1000 ohm, ½ W res. ±5%
R3—100 ohm, ½ W res. ±5%
R5—33,000 ohm, 5 W res.
C1—1.0 μF, 600 V metallized film capacitor
C2—0.1 μF, 200 V Mylar capacitor
C3—100 μF, 15 V elec. capacitor
C4—0.005 μF, 1000 V disc ceramic capacitor
D1, D2, D3, D4, D5—1N4005 600 V p.i.v., 1 A silicon diode (Motorola)
D6, D7—S5V5P suppressor diode (International Rectifier) (Can also use ITT 8A5PA5, 130 V a.c., 200 mA diodes; Sarkes Tarzian S-490 or S-871 diodes. Alternatively, three 1N4764, 100 V, 1 W zeners connected in series with anodes toward "B+" can be used.)
SCR1—400 V, 25 A silicon controlled rectifier (General Electric C30D) (The Motorola MCR-2604-6 or 2N4156, 400 V, 8A SCR units have been used in some CD systems with good results and are recommended for cost savings.)
SCR2—200 V, 0.6 A silicon controlled rectifier (General Electric C6B)
T1—Inverter trans. wound on Ferroxcube core, K3-005-01-3E (see text) (Can also use Indiana General core CF117, H material.)
T2—Pulse trans. 15 mH, 1:1:1 (Pulse Engineering No. PE2225 or equiv.) or wound on Ferroxcube core 266T125-4C4 or Indiana General core CF102, H material (see text). Pulse Engineering Co., 560 Robert Ave., Santa Clara, California. (Can also use Sprague 11Z13 pulse transformer. If terminal identification differs, maintain phasing shown by dots on diagram.)
Q1, Q2—2N3235 transistor (Westinghouse)
Q3—2N2646 unijunction transistor (General Electric)

circuit reliability. However, an 8-amp unit has been in operation in two of the systems without malfunction. Normally, *SCR*1 is in a state of nonconduction, allowing an "open" to exist in the series circuit formed by *SCR*1, the ignition-coil primary, *C*1, and ground. It is at this time that the power supply begins charging *C*1 and the first engine firing cycle is coming up. When the distributor points open, *SCR*1 is triggered into its state of conduction, closing the series circuit.

Two things then happen simultaneously: *SCR*1 puts a short across the power supply which stops the inverter oscillator and prevents further charging of *C*1, and *C*1 is discharged to ground through the primary of the ignition coil. The induced current and high voltage in the coil's secondary winding then feeds the spark plug to be fired. As soon as the field in the ignition coil begins to collapse, a voltage reversal is applied across *SCR*1, driving it back into a state of nonconduction. The power-supply short is also removed, allowing the inverter oscillator to restart and begin charging *C*1 again in time for the next firing cycle. This sequence repeats itself as each engine cylinder is ready to be fired. Capacitor *C*4 helps eliminate any self-oscillations that might occur within *SCR*1, sometimes caused by too rapid an application of high voltage across the SCR.

Probably the most unique feature of this system is the triggering circuit. A standard UJT relaxation oscillator has been modified to provide one-shot operation. When the distributor points open, *C*2 is charged through *R*2 to the threshold voltage of *Q*3. When this threshold voltage is reached, *C*2 then discharges through *Q*3 and the primary winding (3, 4) of pulse transformer *T*2 to ground. It will be noted that *T*2 has two secondary windings. One secondary winding (5, 6), which is connected in-phase with the primary winding, provides a trigger pulse to the gate of *SCR*1. Some degree of isolation is also obtained. The other secondary winding (1, 2) is connected in reverse-phase to the gate of *SCR*2, providing a trigger pulse due to the field collapse in *T*2. The function of *SCR*2 is to simulate the closing of the distributor points after one pulse, preventing multiple triggering, or firing, of *SCR*1. *SCR*2 is an inexpensive 1-2 amp unit. Diode *D*5 prevents early triggering, or firing, of *SCR*2. When the distributor points actually do close, the holding current of *SCR*2 is bypassed to ground, arming the circuit for the next opening cycle of the points.

Resistor *R*3 provides the bias for *Q*3, and *R*2 and *C*2 provide the timing and trigger energy for the combination of *Q*3 and *T*2. While in many ignition circuits, especially conventional and in some transistorized, the distributor points are used to interrupt rather higher current; in this circuit they are used only to short out a capacitor which prevents unwanted oscillation of Q3. From the circuit it is obvious that the maximum current carried by the points is only about 12 milliamps due to *R*2. This low current helps prolong point life.

Point cleanliness is not as important to proper circuit operation as some authors claim. This circuit was tested with up to 150 ohms series resistance added in the point circuit before the unit malfunctioned. This is considerably more resistance than that encountered in contacts or normal amounts of dirt contaminating the points. Although no malfunctions have been caused by low point current, periodic cleaning and proper adjustment would still be in order.

Construction Techniques

Good construction techniques were followed in building the system. Layout is not critical. The components were mounted and wired within a 4″ × 5″ × 5″ utility box (see photo) which, with suitable brackets, can be mounted on the engine firewall. The enclosed box keeps out dirt and moisture. A finned heat sink was used for mounting transistors *Q*1 and *Q*2 and *SCR*1. These components must be insulated from each other and from ground. Mounting kits containing insulated hardware are satisfactory. If a commercial heat sink is used, a special mounting location will have to be fabricated to mount *SCR*1. This can be done by cutting out a portion of one fin and drilling a suitable hole for *SCR*1's mounting stud. Be sure to allow for stud-mounting hardware. *SCR*1 can be mounted by using mica washers and a hole bushing. A light coat of silicone grease may be applied to all mounting surfaces on *Q*1, *Q*2, *SCR*1, and the heat sink to improve heat-transfer characteristics. When the mounting is completed, check for shorts between leads, cases, and ground—using an ohmmeter.

Inverter transformer *T*1 is a special hand-wound unit. As mentioned, commercial transformers are expensive and probably would need to be modified to meet certain circuit criteria. The three windings for *T*1 are made on an insulated toroid core. All windings are wound in the same direction (see Fig. 3A). Mark the beginning and end of each winding so they can be identified later for proper phasing and hookup as shown in Fig. 2.

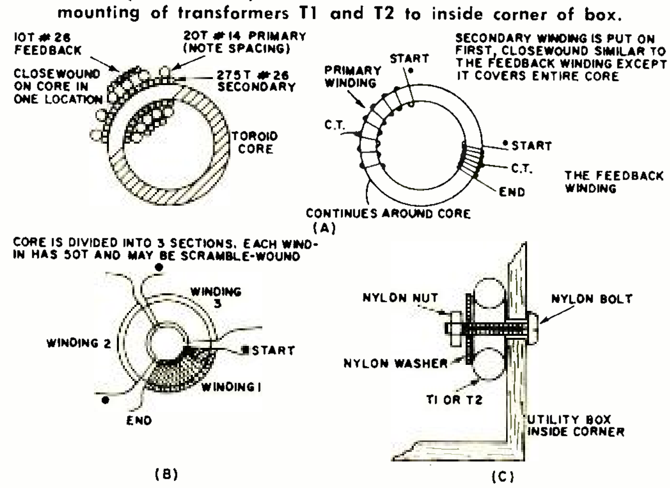
The high-voltage, or secondary, winding is put on the core first, and consists of 275 turns of #26 enameled copper wire. An easy way to wind this section is to make a long bobbin out of a tongue depressor, forking both ends. Then wind about 60 feet of the #26 wire onto the bobbin and pass bobbin, wire, and all in and out of the core center as you wind the 275 turns. Wind the wire to fill up the circumference of the core. With this winding finished, wrap a layer of insulating tape over it and identify the start and finish leads. Leave the leads about 8 inches long.

The primary winding is put on the core next, over the winding just completed. This winding is the one that connects to the collectors of *Q*1 and *Q*2. The winding consists of 20 turns of #14 enameled copper wire and is center-tapped. This winding is put onto the core more easily by hand threading since it is so stiff. Wrap the turns fairly tight so that the wire will not take up all of the inner core space; then again wrap the wire uniformly around the core circumference. Wind this in the same direction as the secondary winding and leave about 8 inches of lead length, including the center-tap. Identify the start and finish leads.

The last to be placed onto the core is the feedback winding connected to the bases of *Q*1 and *Q*2. This winding consists of 10 turns of #26 enameled copper wire and is also center-tapped. The winding can be closewound anywhere away from the other winding leads. It may be placed directly over the primary winding just completed and wound in the same direction. Leave 8-inch leads and identify each lead. After all windings are complete, the core may be wrapped securely with insulating tape.

The completed transformer is then mounted to an inside wall of the utility box, preferably near where the transistors,

Fig. 3. (A) Cross-section view of T1 and portion of windings along with over-all pictorial view (right) of T1 with secondary winding not shown. (B) Construction of T2 if commercially available pulse transformer is not used. (C) The mounting of transformers T1 and T2 to inside corner of box.



Q1 and Q2, will be mounted. The transformer is mounted using a ¼-20 nylon bolt and nut with a large nylon or fiber flat washer. Do not use conductive hardware to mount either this transformer or T2, discussed later. One note concerning these transformer windings is that due to the high efficiency and flux distribution in the toroid cores, winding position and spacing are not critical. None of the transformers we made failed to perform as desired.

Although T2 is a commercial unit, it too can be hand-wound, further reducing construction costs. We wound one of these units and bench-tested it. The performance seemed to be all right, but some experimentation might be necessary to insure proper circuit operation. T2 consists of three identical windings wound on a small toroid core. If the core is not insulated, paint it with coil dope prior to winding. Each winding consists of 50 turns of #28 enameled copper wire. Divide the core into three equal sections and scramble-wind each winding to fill one core section. The windings can be put on the core using a smaller bobbin, and must be wound in the same direction. Again, carefully identify each start and finish lead, as improper phasing when wiring will cause circuit malfunction. When complete, the transformer can be painted with coil dope to help hold the windings in place. Follow the mounting procedure as discussed for T1.

As seen in Fig. 2, there are some large dots near one lead of various windings. These are phasing dots and indicate the connecting point for transformer "start" winding leads. Note that T2 has one winding connected in opposite phase with respect to its other windings. Occasionally trouble can be encountered with starting failures in power-supply inverter oscillators. One cause of this can be the use of transistors (Q1 and Q2) that are too nearly matched. The best remedy is to replace one of the transistors. A more frequent reason is improper phasing of either the primary or feedback windings of T1. While we never experienced any of these difficulties, they are possible. If wiring and construction are done properly, the cure is to try reversing either the primary or feedback winding connections to allow for proper oscillations.

The remaining components are mounted and wired on a phenolic or other suitable board, sized to fit inside the utility box. This board can be anchored to the box walls using small right-angle brackets. Capacitor C1 may have to be mounted elsewhere due to its large physical size. One way is to mount it to a box wall using a plastic cable clamp. The diodes, SCR2, and Q3 were mounted by their own leads and soldered into place. Avoid using transistor sockets for these components since vibration and road shock could loosen connections. When soldering these components, always heat sink each lead with long-nose pliers or the like. All of the board-mounted components can be soldered to either standard terminal lugs or to special lugs that may be designed for multi-hole circuit-board material such as Vector boards and lugs. Again, layout is not critical, although the components for the triggering circuit should not be placed right next to high-voltage circuits or T1.

No. 14 hookup wire was used for all of the primary power-supply and 12-volt input circuits, as well as for all external wiring to the car. No. 20 hookup wire can be used for the remaining circuitry. The four leads going externally from the CD unit may be terminated at a suitable plug.

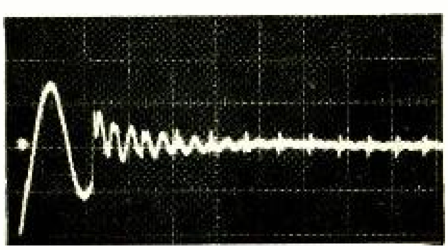
Installation

After the CD unit is finished, it can be mounted within the engine compartment of the car. A preferable spot is on the firewall, away from exhaust manifolds and where moisture is not apt to be around or on the unit. Although all of the semiconductors are silicon types which can operate over a wide temperature range, it is still good practice to allow for free air movement around the mounting location.

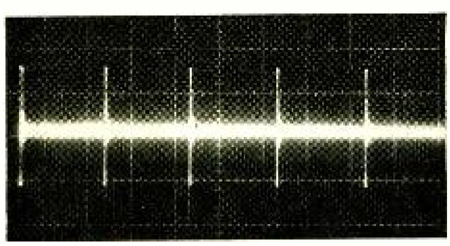
After mounting, the external wiring is completed between the CD unit and the ignition switch, coil, and distributor. A switching or plug arrangement can be devised which would allow for simple restoration of the conventional ignition should the CD system ever fail. (Details on this were given in the article "Universal Wiring for Automotive Ignition Systems" in the August 1967 issue of this magazine.) If such a circuit is used, it should be installed under the hood so as to eliminate long leads and circuit losses. In general, all leads should be kept short and made with clean, tight connections. Finally, run a #14 ground wire from the CD unit circuit ground directly to the auto system ground.

Many cars with 12-volt electrical systems use a ballast resistor between the ignition switch and ignition-coil input. As far as we know, these resistors are of two types. One type is an externally mounted body type, usually ceramic, that mounts somewhere under the hood. The second type is a resistance wire built into the dashboard wiring harness. While testing the CD unit, try it with this resistor connected in its normal manner. The positive 12-volt lead going to the CD unit would be the same lead normally connected to the ignition coil positive terminal. If trouble is encountered then there is probably too much voltage drop across the ballast resistor. You should then connect the 12-volt source lead from either the ignition switch terminal or the switch side of the ballast resistor, whichever is easier. Remember to include restoration of the ballast circuit in any switching circuitry if such is used.

In the past, considerable emphasis has been placed on readjustments of such things as points, timing, plug gap, and plug heat range. Our recommenda- (*Continued on page* 56)



A



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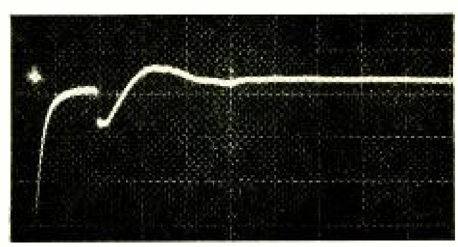

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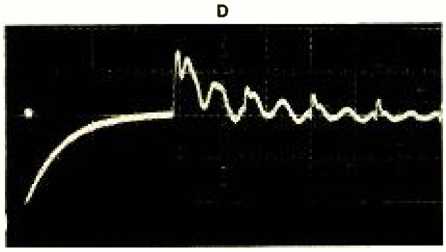

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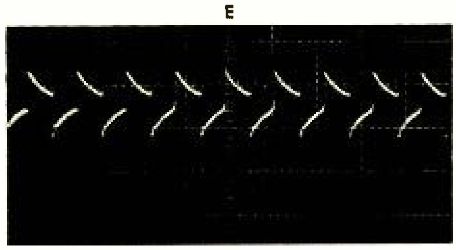
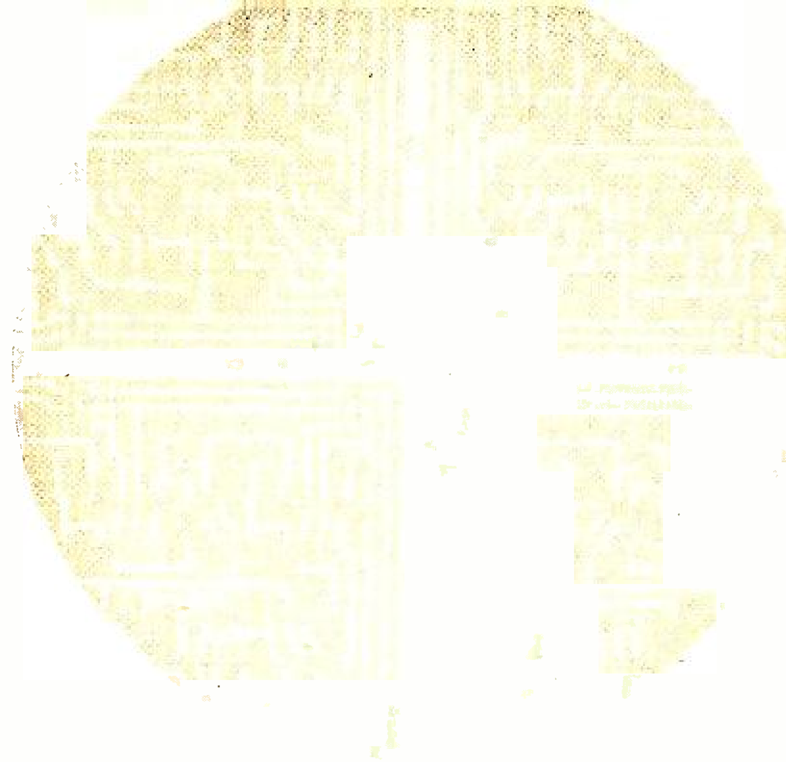


Fig. 4. (A) Single pulse across ignition-coil primary at about 2500 r/min. Rise time (<10 μs) is measured between dot at left center and lower left starting point of the trace. (B) Series of pulses across coil at same speed. (C) Single trigger pulse applied to the gate of SCR1. (D) D.c. power-supply pulse to charge C1. (E) Power-supply inverter oscillator waveform at Q1, Q2 base. The frequency is approximately 10,000 Hz.



IC frequency dividers & counters

PART 2

By DONALD L. STEINBACH/ Research Engineer
Lockheed Missiles and Space Co.

Complete frequency divider and counter systems. Synchronous dividers for division ratios from two through ten are given, along with a simple decade counter using inexpensive, readily available integrated circuits.

PART 1 of this article discussed in some detail the characteristics of a family of IC flip-flops, gates, and buffers. In this part we extend this information to complete frequency divider and counter systems.

Logic Elements in Dividers and Counters

The frequency dividers and counters described in this article are made up of one or more JK FF's (flip-flops) interconnected in such a way that as each CP (clock pulse) arrives at the divider input one or more of the FF's in the divider change state. This is accomplished by "forcing" the FF's to particular states by use of the S and C inputs and/or appropriate selection of the source for input T. In some cases gates are used to derive signals for S and C that do not already exist somewhere in the divider. Buffers are used as required to increase drive levels and/or provide isolation from external circuitry.

The frequency divider has a division ratio *n* if its output waveform passes through *one* complete cycle as its input waveform passes through *n* complete cycles. The number of FF's required in a particular divider is determined by the desired division ratio. The highest possible division ratio for a given number of FF's is 2^x where *x* is the number of FF's in the divider. Thus, one FF is needed to divide by two; two FF's are needed to divide by three or four; three FF's are needed to divide by five, six, seven, or eight, etc.

The signal input connected to T (pin 2 of the particular IC discussed last month in Part 1) of each FF in the divider will be either the incoming CP or the output of a preceding FF. If T of each FF is connected to the incoming CP, the divider is a *synchronous* divider. If the incoming CP is connected to T of the first FF only, and T of the second FF is connected to the output (Q or Q) of the first FF, etc., then the divider is called an *asynchronous* divider.

The FF propagation delays in the asynchronous divider are cumulative and the time between CP's must be sufficient to allow each FF in the divider string to change state. In general, no more than about six 9923 JK FF's should be used in any one asynchronous divider intended to operate at an input frequency of 2 MHz. All FF's in the synchronous divider are triggered simultaneously and the time delay between the CP and the resulting change in divider output is equal to the propagation delay time of one FF rather than the combined propagation delays of a string of FF's. Synchronous dividers should always be used when the divider input and output waveforms must be in synchronism.

Fig. 1. These are the before and after flip-flop states that exist for all possible input/output combinations.

BEFORE CLOCK PULSE			AFTER CLOCK PULSE
LEVELS AT CONTROL INPUTS		FLIP-FLOP STATE	FLIP-FLOP STATE
S	C	Q	Q
1	0	0	1
0	1	0	0
0	0	0	1
1	1	0	0
1	0	1	1
0	1	1	0
0	0	1	0
1	1	1	1

ONE FLIP-FLOP

STATE	F F 1
1	0
2	1

TWO FLIP-FLOPS

STATE	F F 1	F F 2
1	0	0
2	1	0
3	0	1
4	1	1

THREE FLIP-FLOPS

STATE	F F 1	F F 2	F F 3
1	0	0	0
2	1	0	0
3	0	1	0
4	1	1	0
5	0	0	1
6	1	0	1
7	0	1	1
8	1	1	1

FOUR FLIP-FLOPS

STATE	F F 1	F F 2	F F 3	F F 4
1	0	0	0	0
2	1	0	0	0
3	0	1	0	0
4	1	1	0	0
5	0	0	1	0
6	1	0	1	0
7	0	1	1	0
8	1	1	1	0
9	0	0	0	1
10	1	0	0	1
11	0	1	0	1
12	1	1	0	1
13	0	0	1	1
14	1	0	1	1
15	0	1	1	1
16	1	1	1	1

Fig. 2. All possible states of divider with up to 4 FF's.

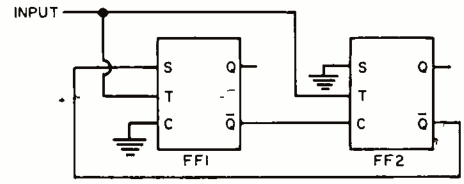
The control inputs S and C (pins 1 and 3 respectively) of a particular FF are connected to ground (0 level), $+V_{CC}$ (1 level), or the outputs of other FF's either directly or *via* gates. The level applied to S, the level applied to C, and the "present" FF state determine the state of the FF after the next CP or 1-to-0 transition of a preceding FF. Fig. 1 is an expanded version of the truth table in Fig. 7 of Part 1. It lists all possible combinations of S, C, and JK FF states that might exist *before* the arrival of a CP and gives the FF state that will then result *after* the arrival of the CP. Keep in mind that a CP is simply a 1-to-0 transition at T (pin 2) and that the state of the FF is the level at Q (pin 7).

If Preset (pin 6) of all the 9923 FF's in a divider are connected together, all of the FF's will be forced to the 0 state (output Q at the 0 level) when this "preset line" is momentarily connected to V_{CC} (+3.6 V d.c.). This technique provides a convenient starting point for the dividing action both in the operating circuit and on paper.

It is customary to define the instantaneous state of the divider as the states of the FF's in the divider written in some logical order. Thus, if the divider is made up of four FF's labeled FF1, FF2, FF3, and FF4, and FF states are 1, 0, 1, and 1, respectively, then the state of the divider is 1011. Since each FF has two states (1 and 0), the number of possible divider states is 2^x where x is the number of FF's in the divider. All possible states of a divider having 1, 2, 3, or 4 FF's are tabulated in Fig. 2.

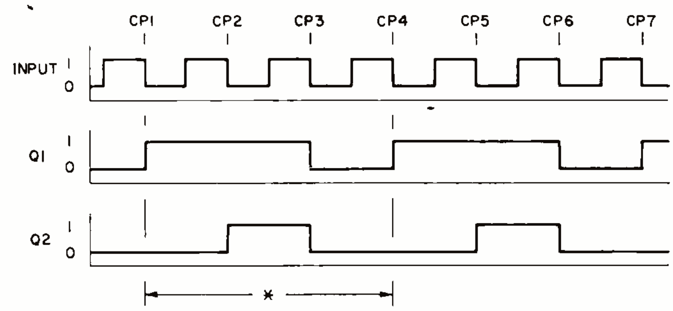
Circuit waveforms for the more complex dividers are determined from a *state table*. The state table is a CP-by-CP tabulation of the levels at S, C, and Q of every FF in the divider. It is most convenient to assume that the divider starts from the Preset state (*i.e.*, all Q's at 0). The levels of each FF S and C input are then determined from the divider schematic. Knowing S, C, and Q, the FF states after the first CP may then be determined from Fig. 1. The "new" S and C levels are determined and the FF states after the second CP are determined. This process is continued until the state table begins to repeat itself, indicating that one complete division cycle has occurred.

The completed state table should be compared with Fig. 2 to determine which (if any) of the possible divider states in Fig. 2 do not appear in the state table. Additional state tables are then constructed using each of these "unused"



STATE TABLE

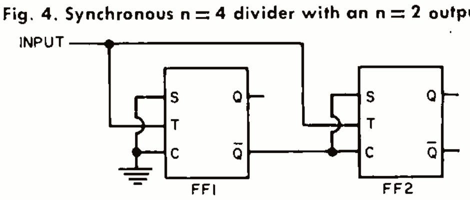
AFTER	S1	C1	Q1	S2	C2	Q2	
PRESET	1	0	0	0	1	0	
CP1	1	0	1	0	0	0	
CP2	0	0	1	0	0	1	
CP3	1	0	0	0	1	0	(SAME AS PRESET)
U1	0	0	0	0	1	1	
U1+1	1	0	1	0	0	0	(SAME AS CP1)



* IS FIRST COMPLETE DIVISION CYCLE

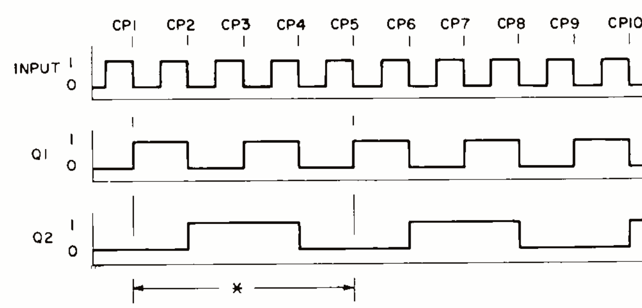
Fig. 3. Circuit and operation of synchronous n = 3 divider.

Fig. 4. Synchronous n = 4 divider with an n = 2 output.



STATE TABLE

AFTER	S1	C1	Q1	S2	C2	Q2	
PRESET	0	0	0	1	1	0	
CP1	0	0	1	0	0	0	
CP2	0	0	0	1	1	1	
CP3	0	0	1	0	0	1	
CP4	0	0	0	1	1	0	(SAME AS PRESET)



* IS FIRST COMPLETE DIVISION CYCLE

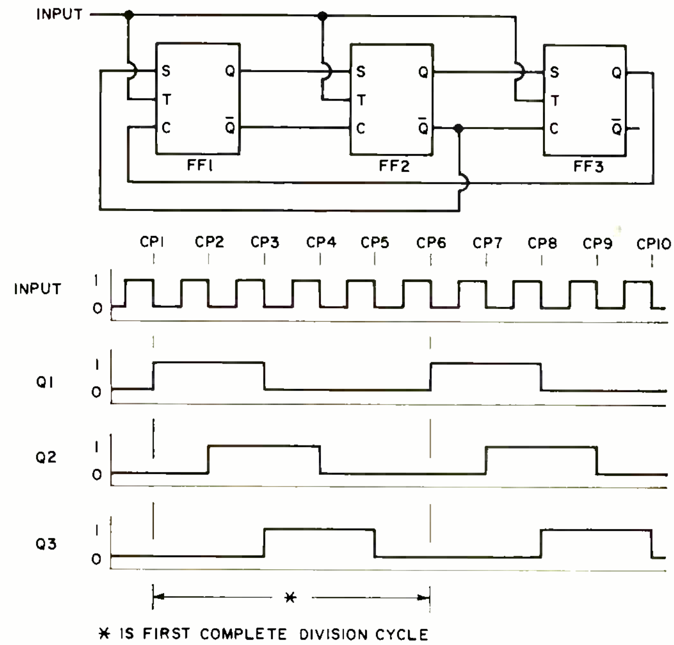


Fig. 5. Circuit and operation of synchronous n = 5 divider.

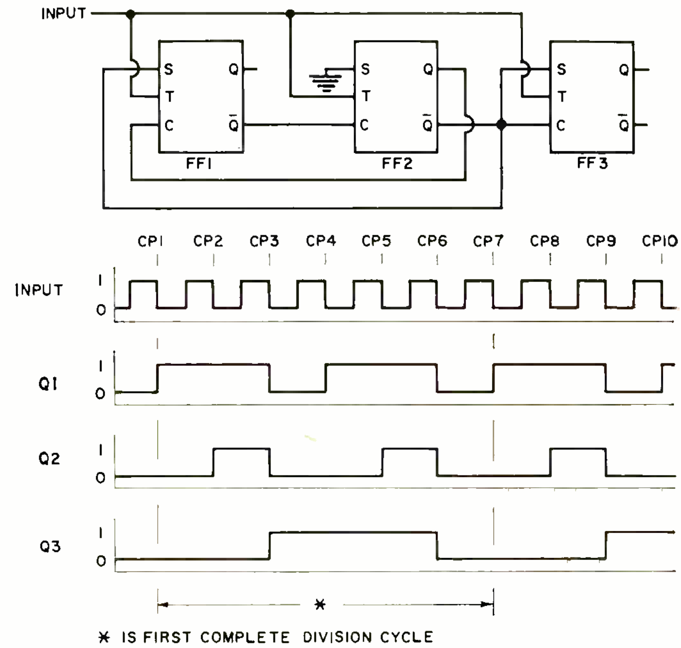


Fig. 6. Circuit and operation of synchronous n = 6 divider.

divider states as the initial starting point in order to determine if the divider will recover and divide by the desired ratio. If it does not, two courses of action are available: redesign the divider, or make provisions for Presetting the divider.

There may be more than one circuit that will yield a particular division ratio. The circuit finally chosen will usually be the one that uses the fewest components or provides the most desirable output waveform for the particular application. It frequently happens that more than one division ratio can be obtained from a single divider. For example, a divide-by-ten circuit may be able to simultaneously deliver a divide-by-two or divide-by-five output from some point in the circuit.

The circuits to follow are drawn using the logic symbols of the IC devices. Refer to Fig. 8 in Part 1 for the actual *Fairchild* IC pin numbers. Although not shown, pin 4 of each IC is grounded and pin 8 of each IC is connected to V_{cc} (+3.6 V d.c.). If the Preset feature of the JK FF's is employed, then connect pin 6 of each of the FF's together and connect this to V_{cc} through a normally open momentary switch.

Either Q or $\bar{Q}$ of any FF in the divider may be chosen as the divider output(s). For a given FF, the more lightly loaded of the two output terminals is usually used, although this is not mandatory as long as the output drive factor of the FF is not exceeded.

In the figures that follow, the input signal is drawn as a square wave only for purposes of illustration. The input waveform may be of any shape as long as the fall-time is small enough to be accepted by the FF's as a clock pulse. The area marked "first complete division cycle" is the waveform that will repeat with every n clock pulse.

Dividing by Two

The simplest possible frequency divider is an n=2 divider made from a single JK FF. If the S and C inputs are both (permanently) at 0, the FF changes state with each CP. If the FF is initially in the 0 state, it will change to the 1 state when the first CP arrives. When the second CP arrives, the FF returns to the 0 state. On the third CP, the FF changes back to the 1 state, completing the output cycle. The FF state alternates with each consecutive CP and the output frequency is one-half the input frequency—or the output waveform period is twice the input waveform period.

Dividing by Three

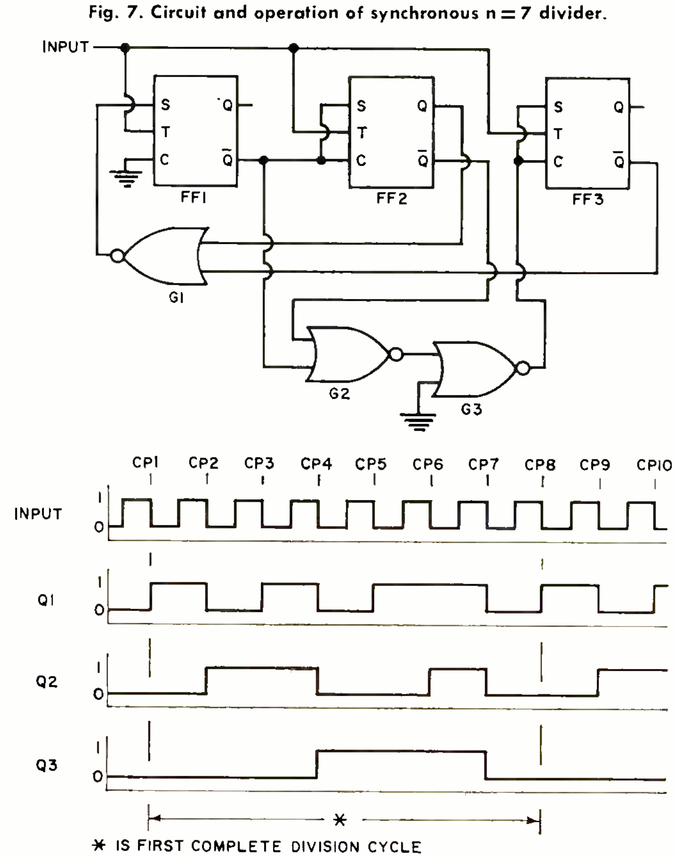
Then n=3 divider in Fig. 3 is a synchronous divider: the CP is applied simultaneously to the T input of both FF's. The input load factor is 10 since each FF has an input load factor of 5.

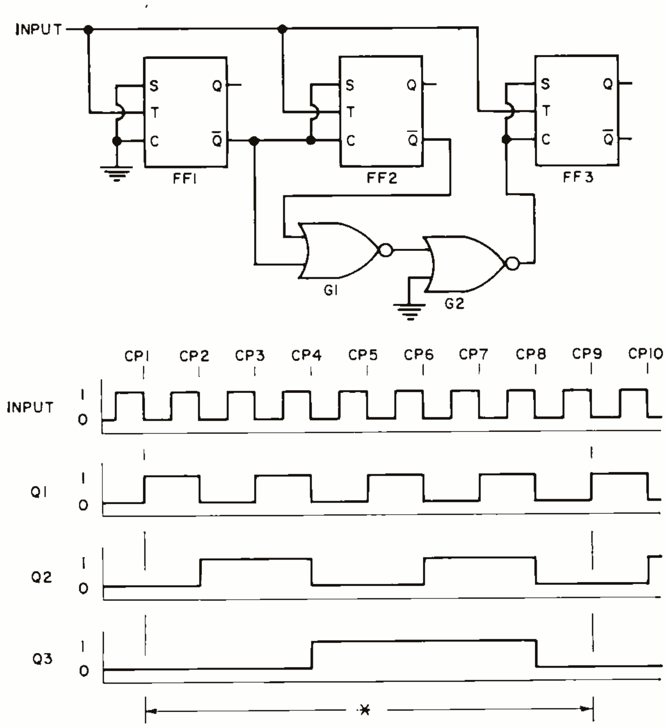
The state table for the divider of Fig. 3 is constructed as follows:

a. After Preset, Q1 (output Q of FF1) and Q2 (output Q of FF2) are both 0. These 0's are entered in the Q1 and Q2 columns on the Preset line of the table.

b. Now that Q1 and Q2 are known, all of the S and C levels may be determined directly from the divider sche-

Fig. 7. Circuit and operation of synchronous n = 7 divider.





* IS FIRST COMPLETE DIVISION CYCLE

Fig. 8. Synchronous n = 8 divider with synchronous n = 2,4 outputs.

matic: $S1=Q\bar{2}=1$; $C1=0$; $S2=0$; and $C2=\bar{Q}1=1$. These levels are entered in their appropriate columns on the Preset line of the table.

c. The levels entered on the Preset line of the table are the levels at S, C, and Q that now exist *before* the arrival of the first CP. The levels at Q1 and Q2 *after* the arrival of the first CP are obtained directly from Fig. 1: Q1=1 and Q2=0. These levels for Q1 and Q2 are entered on the CP1 line of the table.

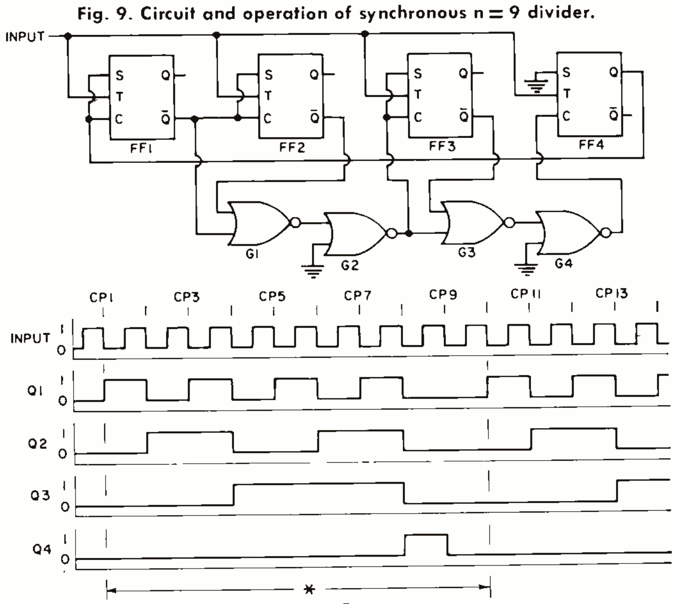
d. Now that Q1 and Q2 after CP1 are known, the S and C levels after CP1 are determined: $S1=Q\bar{2}=1$; $C1=0$; $S2=0$; and $C2=\bar{Q}1=0$. These levels are entered in their appropriate columns on the CP1 line of the table.

e. Continuing in this manner, after CP2: Q1=1; and Q2=1. Also, S1=0; C1=0; S2=0; and C2=0.

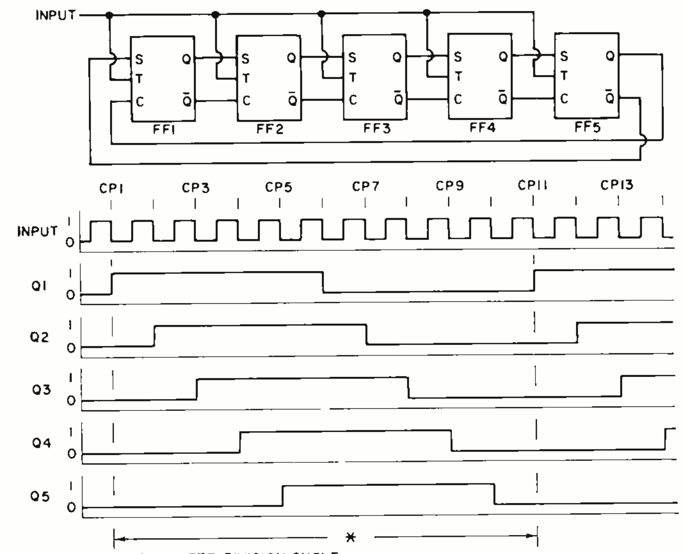
f. After CP3:Q1=0 and Q2=0. Also S1=1; C1=0; S2=0; and C2=1. This divider state is identical to the Preset state; therefore, the cycle will be repetitive.

If a CP4 line were added to the table, it would look ex-

Fig. 9. Circuit and operation of synchronous n = 9 divider.



* IS FIRST COMPLETE DIVISION CYCLE



* FIRST COMPLETE DIVISION CYCLE

Fig. 10. Arrangement employed for synchronous n = 10 divider with its counting sequence chosen for easy decoding.

actly the same as the CP1 line; a CP5 line would be the same as the CP2 line; a CP6 line would be the same as the CP3 line, a CP7 line would be the same as the CP1 line, etc. The waveforms in Fig. 3 are constructed directly from the information in the state table.

The three states of the divider are 00, 10, and 11. Comparing these states with Fig. 2 reveals that the 01 state is missing from the divider operating sequence. A state table using an initial state (U1) of 01 demonstrates that the divider will perform exactly the same as when the initial state is 00; the divider state one CP after the initial state is the same in both cases and the waveforms are identical.

Bear in mind that if the Preset function is used as explained earlier, this evaluation of the divider recovery from an "unused" state is unnecessary. It is explained in this section only to demonstrate the technique.

Dividing by Four

The simplest means of dividing by four is to divide by two twice. The output of the first divider is at one-half the input frequency and is connected to the input of the second divider. The second divider divides the output frequency of the first divider by two and the resulting output frequency is one-fourth the input frequency to the first divider. Simultaneous $n=2$ and $n=4$ outputs may be obtained from this divider. The $n=2$ output is synchronous, but the $n=4$ output is asynchronous since it is delayed from the input CP by the sum of the propagation delays of both flip-flops.

The synchronous divider in Fig. 4 also provides simultaneous $n=2$ and $n=4$ outputs. The synchronous $n=4$ output is obtained at the expense of slightly increased circuit complexity and a larger input load factor.

Dividing by Five, Six, Seven, Eight & Nine

Fig. 5 is a $n=5$ divider. All outputs are synchronous and have the same waveshape, but are time-displaced from one another. The circuit will recover from its unused states so the use of the Preset function is optional.

Fig. 6 is a simple synchronous $n=6$ divider. In addition to the $n=6$ output from FF3, $n=3$ ouputs are available from either FF1 or FF2. The divider has two unused states and will recover from either. A division ratio of six may also be obtained by dividing by two and then by three (or *vice versa*).

A synchronous $n=7$ divider appears in Fig. 7. The divider has one unused state and will recover on the next

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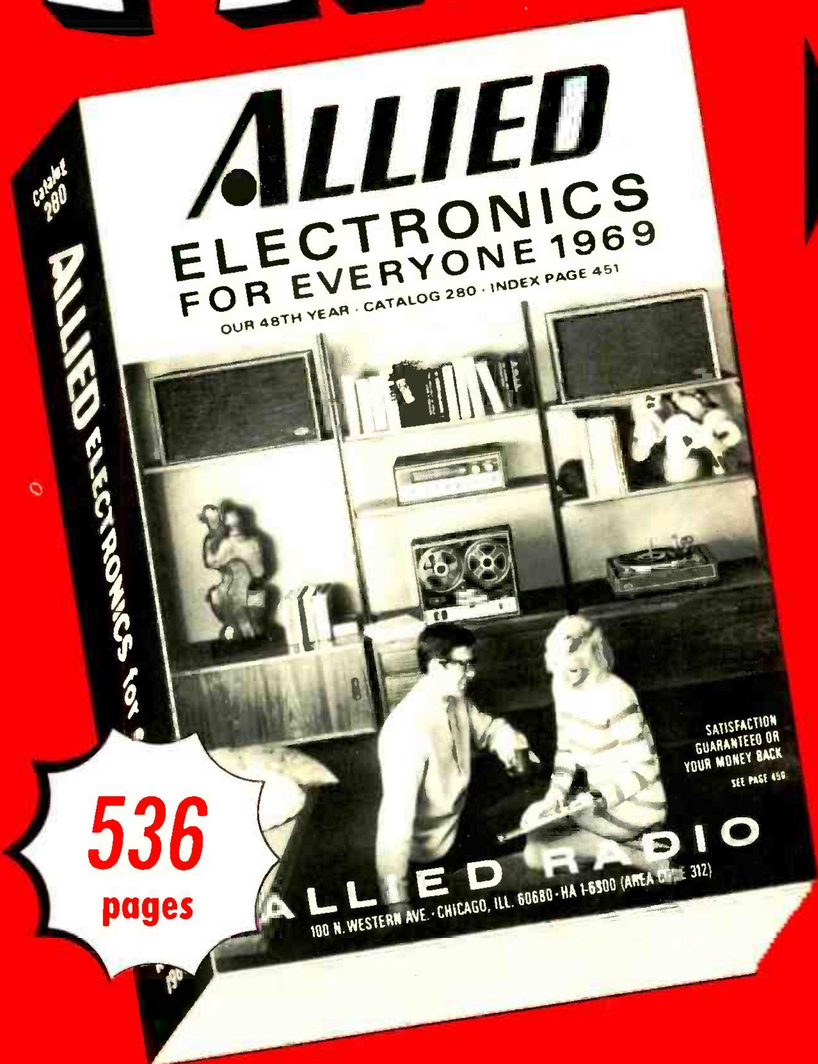

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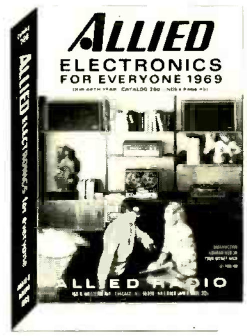

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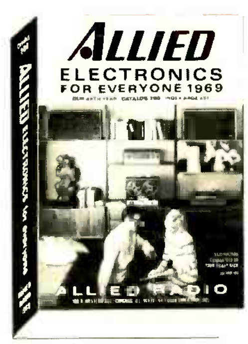

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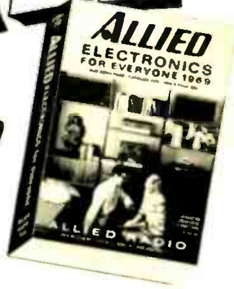

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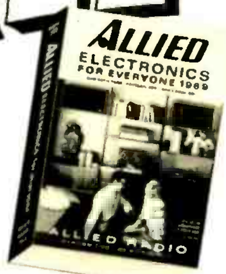

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CP. An asynchronous $n=7$ divider can be constructed and requires one less gate than the synchronous divider.

An asynchronous $n=8$ divider is most easily assembled by cascading three $n=2$ dividers. A synchronous divider is shown in Fig. 8. Regardless of the method used, $n=2$ and $n=4$ outputs will also be available and there are no unused states.

Fig. 9 is a synchronous $n=9$ divider. It has seven unused states and will recover from each. Cascading two $n=3$ dividers will provide an asynchronous $n=9$ output and a synchronous $n=3$ output.

Dividing by Ten

Many $n=10$ dividers have been devised due to their popularity in dividing and counting applications. An asynchronous $n=10$ divider could be built from an $n=2$ divider and an $n=5$ divider. A synchronous $n=2$ or $n=5$ output (depending on which divider is connected to the incoming CP) would also be available.

The synchronous $n=10$ divider in Fig. 10 operates in the so-called "shift mode." Although this divider requires one additional FF and provides only $n=10$ outputs, it is particularly useful in counting applications as we shall see later. The divider has 22 unused states—an ideal opportunity to utilize the Preset function.

Practical Systems

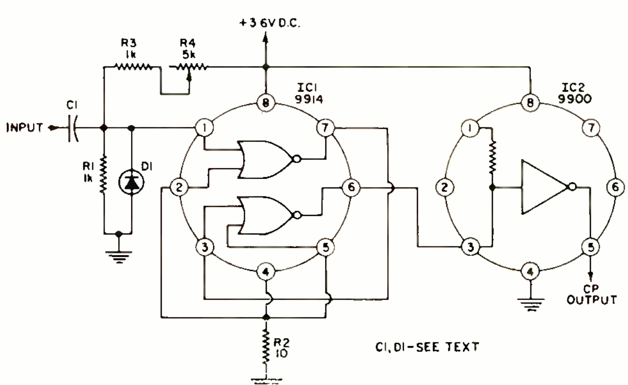
Typical frequency-divider systems consist of one or more divider stages cascaded to provide the desired division ratios and outputs. A common application is that of cascading several $n=10$ dividers to divide a 1-MHz or 100-kHz signal down to 10 kHz, 1 kHz, etc. Buffers are used between divider stages when an increase in drive level is required. They should also be provided on the output lines if external circuit loading is appreciable.

Whatever the ultimate application, the first problem encountered is usually that of converting the input waveform to a fast-fall-time pulse to act as a clock pulse for the dividers. The circuit of Fig. 11 will accept any input waveform and has been used by the author to drive some of the dividers in this article at frequencies in excess of 10 MHz.

The circuit functions like a low-hysteresis Schmitt trigger that switches at a threshold voltage of about 0.9 V d.c. *D1* may be any signal diode—its only function is to protect *IC1* from negative-going inputs. Naturally, the voltage at pin 1 of *IC1* should not exceed 3.6 volts in the positive direction. The choice of *C1* is based on the input signal amplitude and frequency. For inputs of 100 kHz and over, a 0.1-μF capacitor is adequate. If *R4* is set midway between the two trigger levels, the circuit will operate reliably on a.c. inputs well under 100 mV peak-to-peak. If *R3* and *R4* are omitted, then the minimum a.c. input must be on the order of 2 volts peak-to-peak.

The power supply requires no particular attention other than assuring that its output voltage is low in ripple and transient-free. A full-wave rectifier followed by a filter capacitance of 25,000 μF or more will be adequate on both counts. An allowance of about 25 mA d.c. per IC will suffice for estimating total d.c. current requirements.

Fig. 11. Circuit for generating clock pulses from any input. Output can drive the equivalent of 16 flip-flop "T" inputs.



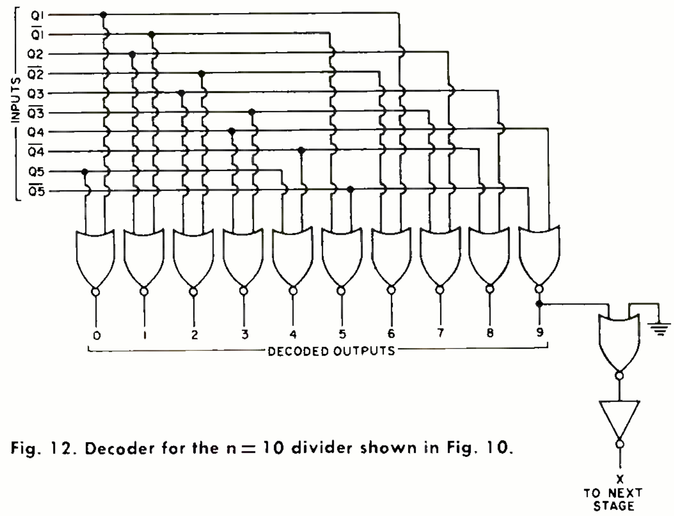


Fig. 12. Decoder for the n = 10 divider shown in Fig. 10.

Frequency Counters

Although the term "frequency divider" has been used throughout this article, the frequency dividers are actually repetitive counters. When the input CP's to the counter are regular and periodic, frequency division is obtained as a by-product of the repetitive counting operation. In *frequency-dividing* applications, one is interested in the time-varying waveforms present at the FF outputs during the counting operation; in *counting* applications, one is interested in the states of the individual FF's at a particular instant of time.

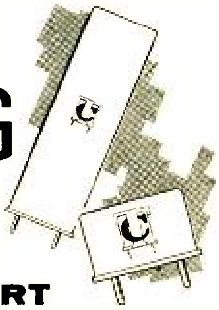
In order for the counter to be of any real value, information on the FF states must be presented in some usable form. Typically a lamp-driver/lamp circuit is used. The lamp driver is designed so that the lamp illuminates when the lamp driver input is at the 1 level and extinguishes when it is at the 0 level.

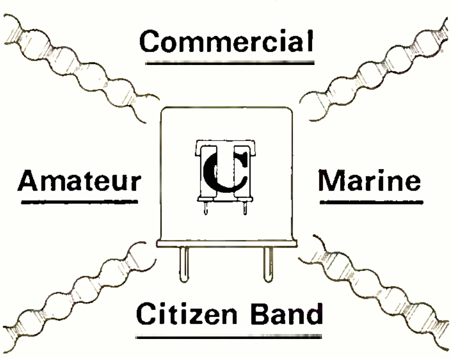
Decade Counters

The decade counter is designed to display the number of clock pulses counted in numbers from 0 to 9. On the 10th CP the counter resets to 0 and delivers an output pulse. If this pulse is connected to the input of a second decade counter, the display of the second counter advances one count for every ten counts of the first decade counter. Connected in this manner, one decade counter counts from 0 to 9 clock pulses, two decade counters count from 0 to 99 clock pulses, three decade counters can count up to 999 clock pulses, etc.

A decade counter is designed around an $n=10$ divider. Since the divider state is different for each successive CP, the lamp responses can be related to the divider states through appropriate decoding techniques. Any $n=10$ divider can be decoded, but the divider of Fig. 10 is ideally suited since it can be completely decoded using only ten two-input gates.

A decoder for the Fig. 10 divider is shown in Fig. 12. The inputs Q1 through Q5 are connected to the corresponding FF outputs of Fig 10. When the divider/counter is Preset (all FF outputs at the 0 level) only the "0" decoded output is at the 1 level. After the first CP only the "1" decoded output is at the 1 level. After the second CP only the "2" decoded output is at the 1 level. After the ninth CP only the "9" decoded output and output X are at the 1 level. Coincident with the tenth CP output X switches to the 0 level providing a CP to drive a second decade counter. ▲





Unique CD Ignition System

(*Continued from page* 48)

tion based on tests with this system, is to keep components adjusted to factory specifications. We did run several tests, but without specific instruments it would be hard to make any valid claims as to improved performance. In many cases performance was actually derated. The most significant test made was where spark-plug gaps were opened to as much as 0.150 inch and still fired properly. This would indicate that plugs could have many thousands of miles on them before they would need to be regapped or replaced. By tuning the engine with good ignition testing equipment, some adjustments may prove beneficial with some cars.

Finally, as with any high-voltage equipment, be careful when testing or adjusting the CD unit. If possible, insulate all exposed high-voltage leads and terminals. Remember that 400-500 volts can be across the ignition coil terminals when the CD system is operating. Since the spark-plug voltage now reaches considerably higher values, the plug wiring and distributor cap and rotor should be in top shape. Otherwise losses can occur through shorts and leakage. If necessary, plastic tubing can be slipped over plug wires. Another point to check is arcing between the ignition-coil positive terminal and high-voltage output terminal. Should this occur, you might try some sort of plastic baffle between these terminals or spray the coil with anti-corona solution. A dark night is a good time to look for shorts or high-voltage corona. Some light corona discharges may always be present but should cause no concern.

Bench Testing

Should you have the equipment and interest, we thought it worthwhile to include some of the test notes and results obtained during the design and construction of this unit.

The photographs of scope traces in Fig. 4 show circuit performance under medium-speed (2500 r/min) operation. A variable speed motor was coupled to an old distributor to represent an "on-the-bench engine." Note, in particular, the inverter oscillator waveforms and the fast rise-time obtained to charge C1. Also of interest is the "clean" triggering signal being applied to the gate of SCR1. For comparison with actual signals coming from conventionally operated distributor points, connect a scope across the points and observe the erratic and high current and voltage spikes that occur. This is what causes point burning and pitting which shortens point life. Finally, the distributor was run fast enough to represent engine speeds of 6000 r/min, where C1 would have to be charged at least every 2.5 ms to deliver maximum energy. In this case the criteria not only have been met, they have been exceeded. The high-voltage load, incidentally, was an actual spark plug being fired in air.

Conclusions

As mentioned before, the most significant improvements obtained with these units were increased engine performance and longer component life. Plug and point adjustments can vary quite a bit before performance suffers, and plug fouling or misfiring has not been observed. No trouble has been encountered during hot and cold driving conditions. The only failures that occurred were due to radiator hoses coming loose and throwing water into the CD unit. When dried, the unit again performed as before.

Four of these units were constructed and placed into several types of vehicles. One unit was placed in a 1960 *Ford* V-8 which had about 90,000 miles on it and several bad valves. The CD unit made a marked difference in the *Ford*, and even more so after a valve job. Over 10,000 more miles have been added since. Another CD unit was placed in a 1955 *Buick* and run about six months. The driver again reported better performance. A third unit was placed in a 1964 *International* pickup used frequently with a camper. The pickup has 5000-10,000 miles with marked improvements. The most dramatic installations were made on modified racing engines. One of these was a *Chevy* 427 used for eight races with engine speeds of 6000-8000 r/min. The other was a *Shelby* GT 500 Cobra used for six months; this showed the best over-all performance. Although the average driver doesn't use high-speed engines, this test does show reliability and indicates that more than adequate performance can be expected with normal driving.

When the initial investment is made to construct one of the units, the savings in tune-up bills alone pay dividends. If tune-up bills are reduced by even one-half, the CD unit will eventually pay for itself. This is especially true when you consider that the unit can be easily transferred to a new car when trade-in times comes. Then the economy begins all over again. ▲

(Editor's Note: The unique capacitor-discharge ignition system described here has been designed by the authors and has been constructed from the schematic diagram shown. The unit is not a commercial product nor is there a kit of components available for constructing the circuit described here.

Also, we are sorry that we do not have any information on modification of the circuit for positive-ground use or for autos with 6-volt electrical systems.)

JOHN FRYE

Some customers, by their attitudes, almost seem to ask the service technician for overcharging and poor service.

HOW TO BE A GOOD SERVICE CUSTOMER

"MAC," Barney said to his employer, "do you know the name of the joker who first said, 'The customer is always right'?"

"Can't say as I do, right offhand," the service shop owner replied, "but you sound as though you don't agree."

"I most certainly don't," the redheaded Irish youth said emphatically, "and I'll bet that glib-tongued guy would choke on his words if he had to deal with some of the chiseling characters who come in here."

"I get it! You've just had another run-in with Catalog-Carrying Charlie!" Mac guessed, grinning broadly.

"You're so right. He left just before you came back from lunch. He was in here brandishing that dog-eared wholesale electronic parts catalog of his under my nose and demanding to know why we charged him $1.40 for a radio tube he could have ordered from the catalog for only 83¢."

"I hope you told him."

"And how I told him! I said *if* he had known which tube he needed, and *if* he could have been sure that was all that was wrong with his radio, and *if* he had been willing to pay postage on the order for the tube plus the charge for his check or money order, and *if* he had been willing to wait a week on the tube, and *if* he had been willing to accept the fact that if the new tube were bad he'd have to pay postage to return it, he probably could have ordered the new tube for only slightly more than we charged him."

"What did he say to that?"

"He spluttered a lot, but I didn't let him off the hook that easily. I went on to explain the difference between the wholesale and the list price of the tube was to pay us for giving time and place utility to the electronic parts we stock. We're being paid for having those parts right here waiting on him when he needs them. What's more, we made sure that (a) his radio really needed that particular tube, and (b) that was all it needed. If his new tube becomes defective within the warranty period, we replace it immediately at no charge. Since we must pay rent, lights, heat, water, telephone, insurance, and several other bills if we are to keep this place open, ready for his convenience when he has trouble with his electronic equipment, we can't sell parts for what they cost us any more than can any other store."

"I'll bet that sent him off talking to himself."

"It surely did. But Charlie isn't the only pain-in-the-neck customer we have. The Electronic Hypochondriac is just as bad. You know the type I mean. He's the sort who is constantly looking for trouble with his electronic gear. He calls us to see if we don't think maybe the bass response of his hi-fi isn't a bit too boomy, or if the linearity of his TV set isn't a bit imperfect, or if perhaps the sensitivity of his radio may not be off a trifle. Then he becomes indignant if we charge him for telling him there's nothing wrong with his equipment but his imagination."

"My pet peeve is the Stop-the-Presses Guy," Mac said. "He's the bird who comes dashing in all in a lather and gives us a terrific song and dance to the effect he has to have his radio or TV set repaired immediately. It reportedly belongs to a poor old aunt who is a shut-in and lives only for her programs. Every hour she is without her radio or television set causes her acute mental anguish and may even shorten her life. We drop everything and get the set out *muy pronto*. Then what happens? It sits here for two or three weeks before the guy drops in very casually to pick it up, lingering only long enough to gripe a little about our 'hounding' him to get the set!"

"The Belittler rubs me the wrong way just about as much," Barney went on. "He's the one who tries to beat down the service charge in advance by 'belittling' the difficulty in the set. He assures you there can't be much wrong. 'Probably just a weak tube or a loose wire,' he tells you. He reasons there can't be much wrong 'because it was playing perfectly just before it quit.' I like to remind him that sounds very much like what they say about a fellow who drops dead of a heart attack."

"You've got a real mean streak in you," Mac said with a grin. "But how about the Man with a Relative in the Racket? Said relative is usually a nephew who 'is taking up radio' in the army or maybe a cousin who wires houses and consequently 'knows a lot about electricity and radio and stuff like that.' At any rate, this relative looked at the defective set and instantly knew what was wrong with it—which is a pretty neat trick that I wish I could emulate. He would have fixed it himself if he only had his equipment with him, but he assured our customer that 'any serviceman worth his salt could fix the set in ten minutes and should not charge more than a buck or so.' That leaves us with the ticklish and thankless job of proving the genius relative guessed wrong—which he does, of course, in the great majority of cases."

"Suspicious Sam is probably the hardest to stomach of the whole lot," Barney offered. "He has read every article ever published on the general subject of 'The TV Serviceman Will Gyp You' and quotes freely from them at every opportunity. He makes it plain he is on to all our little crooked ways and schemes and that *he* is not going to be gypped without a struggle. He wants all work—even major realignment—done right in his house, and he breathes on the back of your neck every moment you're working on his set. He demands actual proof that every component you remove is bad, and he threatens you with the Better Business Bureau if a replacement part is not an identical twin of the one you removed. His whole attitude is a constant reminder he fully expects you to try to cheat him; and, quite candidly, were I going to cheat anyone, he would be the one I'd do it to—just to prove how foolish it is to try to check up on a technician working at something you know nothing about."

"That brings up a subject about which I've been thinking for some time," Mac remarked. "Perhaps we've had too many articles on how to be a suspicious customer and not enough on how to be a good service customer. After all, the brutal fact is that it is no longer a customer's market; it is a repairman's market today. There are simply not enough available service technicians to take care of all the radios, TV sets, automobiles, washing machines, and other household appliances that break down by the thousands every hour. A good service technician can have all the business he wants and more; so a customer is not doing him a tremendous favor by dumping an ailing piece of equipment on his bench.

"But if he is a *good* technician, he still takes pride and satisfaction in doing a good repair job, expecially for a customer he likes and respects. On the other hand, he is not at all inclined to try to hold a whining, complaining, chiseling customer; and he certainly will not make a special effort to do a first-class job for one of these. The sooner such a customer takes his business elsewhere, the happier the service technician will be. Maybe that's not the way it should be, but that's the way it is; and the service customer must face up to it if he hopes to get good service."

"Hear, hear!" Barney applauded. "And since service technicians are also service customers, I've got an idea. Let's see if we can't cook up a sort of Ten Commandments for our service customers that will also apply when we have to have our automobiles or washing machines or lawn mowers repaired."

"Not a half-bad idea," Mac agreed. "Let me start with the first commandment: *Make sure you really need a service technician before you call one.* Make sure the device is properly plugged in. Are all switches and knobs in the proper position? Are the antenna leads in place? Is the station on the air, or are you sure the TV cable system is functioning? If you haven't used the equipment for a spell, get out the instructions and study them. You know, for example, how many radios we get that have nothing wrong except the radio-phono switch is in the phono position, a bandchange switch is set to a dead short-wave band or the FM position. By sheer coincidence, of course, such things are especially prone to happen after a visit from grandchildren."

"I think Commandment Two should read: *Pick a service technician you think you can trust.* Rely more on the recommendation of friends and neighbors than you do on advertising claims. If you know one good technician—be it a garage mechanic, appliance repairman, or what have you—ask him. One technician is usually a good judge of another, even in a different line of work."

"Number Three: *Be Ready for the technician when he calls.* His time is valuable, and you're paying for it. Have all pertinent symptoms written down. List any long-standing little annoyances, such as loose knobs, you want repaired while the technician is working on the set. And have everything cleared off the top of the TV set before he arrives."

"Number Four: *Don't hesitate to ask for an estimate before okaying the repair, and find out the estimate charge*

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when you call the shop," Barney advised. "A reputable technician will respect you for doing so."

"Number Five," Mac chimed in, "might go: *Don't expect a technician to display much enthusiasm for working on foreign-made electronic equipment.* It may have been low in cost and work well, but when it fails it's tough to service because of a lack of adequate service information and the difficulty of securing replacement parts."

"Here's Number Six," Barney offered: "*Don't try to tell the technician what to do.* If you do, he will carry out your suggestions first and then find what is *really* wrong with the set and fix it. You'll be paying for things you didn't need."

"Along that same line, I can suggest three other commandments," Mac said. "Number Seven: *Don't try to rush the technician.* Give him time to do a good job.

"Number Eight: *Don't insist on watching the technician work or try to help him.* Good troubleshooting requires intense concentration and the application of all the senses. Talking to the technician or allowing children to annoy him is bound to cost you money."

"Yeah, that reminds me of a sign I saw in a service shop. It read: 'We charge five dollars an hour; or seven dollars if you watch; or ten dollars if you help.'"

"There's more truth than poetry there," Mac chuckled. "Anyway, here's Number Nine: *Let the technician know you respect both his ability and his honesty.* People—even technicians—have a funny habit of giving what is expected of them."

"Let me suggest the last one," Barney said. "Number Ten: *If you are pleased with the repair job, call the shop and say so.* This will doubtless astonish them no end, but it may very well react in your favor the next time you have to call them."

"Amen," Mac concluded; "and let's be sure that you and I remember all these when we are asking for service instead of dishing it out." ▲

"Your picture tube is okay. Somebody painted the glass black!"

MOTOROLA'S NON-MECHANICAL REMOTE CONTROL

PROBABLY the most unusual single feature introduced with the 1969 models is a thoroughly electronic remote-control system—the TRR-7, built by Motorola for use with the all-transistor Quasar color chassis. The only mechanical devices are a tuner motor and relay, and an "on-off" relay. Without noisy motor-driven potentiometer controls, this unique seven-function remote-control system lets the viewer turn the set on and off, turn volume up or down, set color-picture hue, adjust color intensity (chroma), and change channels—all with a hand-held ultrasonic transistor oscillator transmitter.

The heart of the system is an insulated-gate field-effect transistor (IGFET), encapsulated with a neon switching tube and a high-quality capacitor, into a tiny device called a "memory module." The module can store, for many hundreds of hours, any particular level of voltage charge. It is that level of charge which controls the various functions.

As an example, consider how the memory module controls volume. The audio from the color receiver is fed through a special two-transistor amplifier in the remote-control chassis. The arrangement is diagrammed in block form in Fig. 1. The incoming control signal is amplified, as in any other remote arrangement. The signals detected by the audio-control discriminator circuit in the remote chassis are 38.5 kHz for volume up and 44.5 kHz for volume down. The volume-up signal produces a positive output voltage; and the volume-down signal, a negative output voltage.

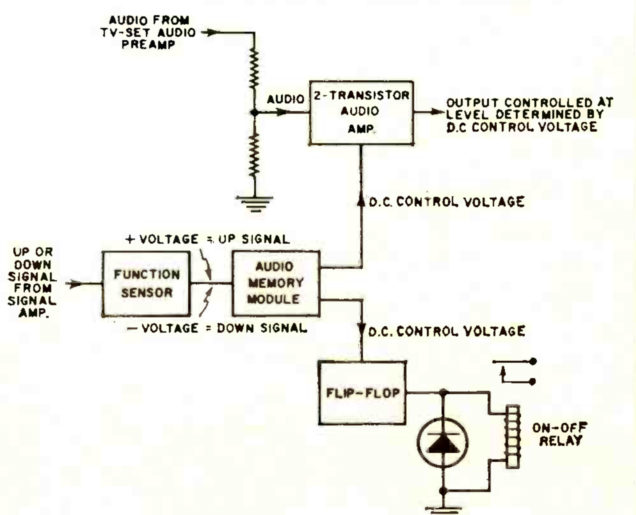
The signal being sent from the remote transmitter is detected and applied to the memory module. The neon bulb lets the capacitor charge. The polarity and amount of that charge, with the amount determined mainly by how long the volume-up (or down) signal is received, sets conduction of the IGFET. That's what determines the d.c. control voltage that is applied to the special two-transistor audio amplifier. Essentially, the amplifier functions as a volume control. The control voltage sets the output level and effectively controls volume fed to the TV-set output amplifiers.

The "on-off" function for the set is handled by the same signals, and is also shown in Fig. 1. When the volume-up button of the transmitter is pushed, the positive d.c. voltage that raises volume in the two-stage amp is also applied to a one-shot multivibrator (flip-flop). The flip-flop fires, and its output pulls in a relay whose contacts turn on the receiver. Pushing the transmitter's volume-down button not only turns the volume down by reversing the voltage from the memory module, it also unlatches the relay-control circuit; turning the set off.

Other memory-module functions operate similarly. A two-stage hue amplifier simulates the up-and-down resistance variation of turning a hue potentiometer. Only one transistor stage is needed to handle the color-intensity function, with its variable emitter-collector resistance simulating the effect of a variable control.

Channels are changed by the seventh button on the remote transmitter—it generates a 43-kHz signal. No memory module is involved. In fact, this system is very similar to other remote channel-changing arrangements. ▲

Fig. 1. Signal from remote transmitter is detected by discriminator (Function Sensor) and sent to appropriate memory module. In the audio module in this diagram, a voltage is developed that can turn the set on or off and also can control output volume by its effect on the gain of 2-transistor amplifier.



Color-Organ Design

(*Continued from page* 39)

Color Organ" in the January, 1964 issue of this magazine). The innovation presented here is the use of an active filter as a means of tone differentiation. The active filter is a single-transistor amplifier (*Q*1 in Fig. 1) with frequency-sensitive positive feedback. One frequency band will be amplified much more than others, that frequency being determined by the *RC* values in the feedback circuit. By varying the capacitor values, the different operating frequencies can be established to activate the four display colors.

The degree of amplification at the resonant frequency over other frequencies depends upon the amount of positive feedback. The feedback for each channel is controlled by a 2000-ohm trimmer, *R*9. As the potentiometer is advanced to increase the feedback, the filter selectivity increases until a point is reached where the circuit breaks into oscillation. Below this point the filter has maximum selectivity.

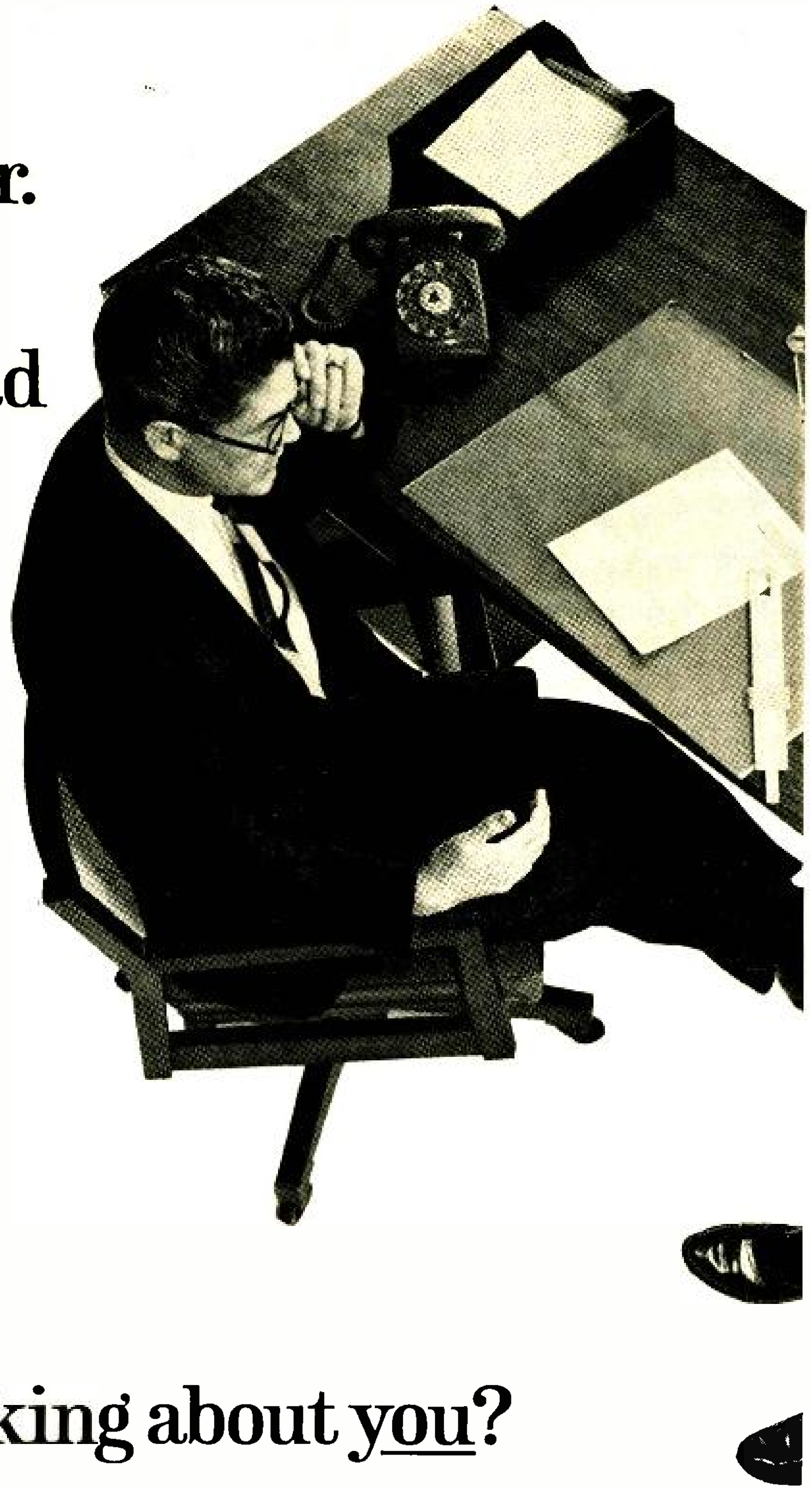
The magnitude of the feedback is adjusted by advancing *R*9 until the corresponding lamp for each channel lights with no audio input. Each potentiometer is then turned back until the corresponding lamp just goes out. This adjustment procedure produces the sharpest display.

Even with widely separated response frequencies, the average musical recording has more than enough spectral content to keep the display "alive." However, a softer display may be achieved by advancing color control, *R*3. This effectively widens the filter bandwidth to produce a color blending. This is the only color adjustment used during operation once the feedback has been set for each channel. The output of the active filter is fed to an emitter-follower amplifier (*Q*2) which triggers the SCR.

Circuit layout is not critical, so the components may be positioned as desired. Heat-generating components (SCR's, *R*1, and diodes, *D*1, *D*2, *D*3, *D*4) should be mounted where air can circulate around them. If the system is operated at power levels over 70 watts per channel, the SCR's and bridge diodes (*D*1, *D*2, *D*3, *D*4) should be mounted on finned aluminum heatsinks. Heavy wire, #14 or #16, should be used for all bridges, lamp, and SCR connections.

The color organ may be attached to any music system by connecting the input terminals to the speaker. The input transformer, *T*1, works well with 4-, 8-, or 16-ohm speakers and provides isolation between the music system and the a.c. line power used in the color organ. ▲

"He's a good worker. I'd promote him right now if he had more education in electronics."



Could they be talking about you?

You'll miss a lot of opportunities if you try to get along in the electronics industry without an advanced education. Many doors will be closed to you, and no amount of hard work will open them.

But you can build a rewarding career if you supplement your experience with specialized knowledge of one of the key areas of electronics. As a specialist, you will enjoy security, excellent pay, and the kind of future you want for yourself and your family.

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(*Continued from page* 30)

were discovered coming from a few malfunctioning color receivers, they were *soft* x-rays that have not been proven harmful to man nor animal. However, it was enough to touch off considerable investigation, and the culprit was pinned down: some faulty shunt regulator tubes in the high-voltage section. Sets with defective regulator tubes were hunted down and fixed. A few other sets were found to be radiating slightly more than was considered healthy, and those were cured by slight adjustments.

Nevertheless, the spotlight on shunt regulators had a distinct affect on 1969 models; almost half of the new chassis use some other means of regulating high voltage.

By far the most popular is the pulse-sampling type. Basically, this regulator takes advantage of the fact that high voltage in modern TV sets is developed from high-energy flyback pulses generated by the deflection yoke. The horizontal-output (flyback) transformer has a large winding that builds up this pulse energy to many thousands of volts. The resulting high-voltage pulses are then rectified to make high-voltage d.c., which is applied to the color CRT. Anything that affects efficiency of the flyback transformer also affects the high voltage developed.

So, a sample of the flyback pulse is fed to a diode (Fig. 10) from which a stabilizing voltage is developed and applied to the grid of the horizontal-output tube. Suppose the high voltage decreases for some reason. There is a corresponding reduction in amplitude of the sampling pulse, which in turn produces less bias for the output tube. The tube amplifies more, building high voltage back up to normal.

If the high voltage gets too high, the pulse is larger than normal. So is the bias voltage at the grid of the horizontal output tube, and tube output is lowered to reduce the high voltage to normal.

A resistive adjustment in the pulse-sampling and voltage-feedback network allows for high-voltage adjustment. It is set, with a meter measuring actual high voltage at the CRT, for whatever value the manufacturer recommends for that particular picture tube. This ranges from 21.5 kV in certain sets with small 14-inch screens to as high as 26.5 kV in one *Olympic* model. For the usual 23-inch set (picture tubes beginning with the number 25), the value is 25 kV.

To avoid the possibility of even slight radiation from the high-voltage rectifier or from the picture-tube face, *keep the high voltage within the manufacturer's specified limits.* If you make any adjustments at all, use a dependable high-voltage meter to make sure the high-voltage level is kept where it belongs.

There are several versions of pulse regulators. Many use a varistor instead of sampling diode. Functionally, these versions work the same, controlling the horizontal-output stage. This, in turn, regulates high voltage developed by the flyback transformer.

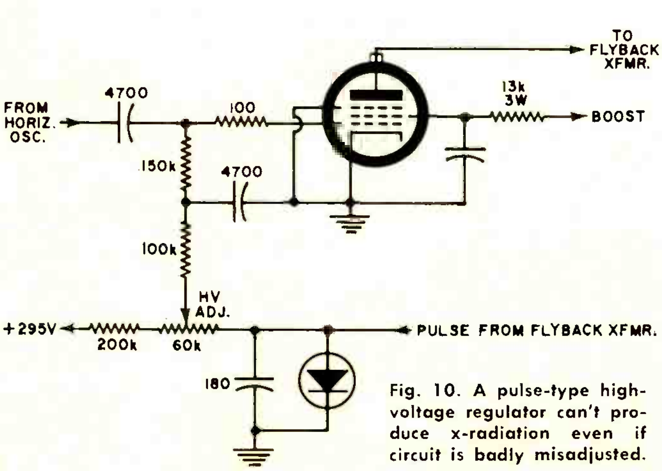


Fig. 10. A pulse-type high-voltage regulator can't produce x-radiation even if circuit is badly misadjusted.

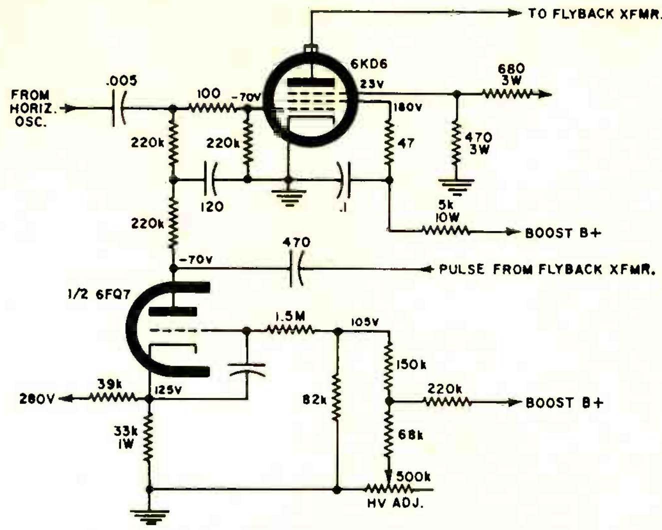


Fig. 11. Olympic pulse h.v. regulator, using keyed tube.

One *Zenith* model and some *RCA*'s use a tube-controlled regulator circuit that doesn't feed its output back to the output tube. Instead, the tube acts like a reactance connected across the flyback transformer windings. If high voltage gets too high, the tube senses it by changes in boost voltage. The tube's impedance lowers and loads down the flyback winding it is connected across. If high voltage gets too low, tube impedance rises; it becomes less of a load, and allows more high voltage to develop. As with simple pulse regulators, there is a potentiometer adjustment for setting the nominal operation point; it is adjusted while a high-voltage meter is connected to the CRT second-anode button to indicated exact high voltage.

In the *Olympic* CTC-31 chassis there is a gated pulse regulator using a triode tube—a 6FQ7—to set the bias level on the grid of the horizontal output tube. The circuit is shown in Fig. 11. A keying pulse from the flyback transformer is applied to the plate. The tube, with its operating point determined by bias from an adjustable voltage-divider network, acts like a rectifier of sorts. It produces a negative d.c. voltage with a level that is the combined result of the amplitude of the keying pulse and the bias setting. If high voltage rises, so does the pulse amplitude, and so does the negative output voltage. The output d.c. is then applied as bias to the horizontal output tube grid. If high voltage goes down, the pulse is lower; regulator-tube output is reduced, and therefore so is the bias. The action is much like that of keyed a.g.c.

What To Look For Next

A lot of last year's predictions for 1969 sets have come to pass. You see plenty of transistors working their way into top models; there are more integrated circuits scattered around; and another all-transistor color receiver, an *RCA*, has made its debut. What are some things you can expect to hear about toward the end of 1969, when the 1970 color receivers start coming out? Set manufacturers are naturally reticent. Yet, a few things can be figured out from what we already know and from the answers to a few carefully placed questions.

Watch, for example, for something exceptionally different in tuners. Of course, more tuners will be all-transistor for all channels. But something much more noticeable is in the offing. And it will make tuning a color set even more simple.

You can expect at least three more all-transistor models, probably from three different manufacturers. One will be an import.

Expect more small-screen portables, and at lower prices.

The second-set market will be as important to tinycolor as the new-set market. A few low-to-middle-income families will buy tinycolor as their first set, but most sales will be in the middle-income bracket. Top-of-the-line models will go to middle- and upper-income families, much as they do now.

More innovations are forthcoming to make color sets easy to service. *Sylvania's* idea of putting transistors into sockets is one step; *Motorola's* modular concept is another. You'll see another, quite different, before the end of 1969.

No manufacturer has found a cure for the "green-face syndrome" that still plagues color viewing. *(This is the greenish cast that sometimes comes over the faces of TV performers when color cameras are switched.-Editor)* Receiver designers have toyed with a number of ideas, but none has been practical or economical; set-makers collectively contend that the trouble is one the telecasters should overcome. Yet, don't be surprised if at least one receiver manufacturer takes positive action on a circuit. One 1970 model will have a truly automatic hue control, if present lab sketches work out.

All-channel tuning—v.h.f. and u.h.f.—is still a perplexing matter for manufacturers. Yet, a means of putting them both on one indicator dial and in a simplified control bank is possible. This, too, may get into production in time for 1970 models.

These are few of the developments you can look forward to in future sets. You may hear rumors of other innovations. If so, they are probably true. ▲

TRANSISTOR TRENDS in COLOR-TV

A funny thing happened on the way to the all-transistor color-TV. What happened was the hybrid—a part-tube, part-transistor mixture that first appeared some years back. It looked for a time as if the meaning of the word transistorization might be taken literally—that tubes would be replaced by transistors only slowly, one by one.

And then, in mid-1967, it happened. Suddenly, there was an all-transistor color-TV set. The first skeptical cry was that it was probably a promotion gimmick. But it wasn't; it was a full-fledged, all solid-state instrument, already rolling off Motorola's production line. The only vacuum tube in the whole receiver was the high-voltage rectifier (and, of course, the picture tube). No matter what anyone said about its practicality, solid-state color had arrived!

Time has proven it is here to stay, too. It has even been improved. The 1969 version eliminated that last tube, replacing it with the industry's first solid-state high-voltage rectifier for color-TV (Fig. 1).

In the new Quasar series, there's nothing left to go solid-state but the color CRT. Coupled with an unusual solid-state remote control system (see page 60), Motorola's 1969 transistor color chassis was just about the last word in transistor color-TV.

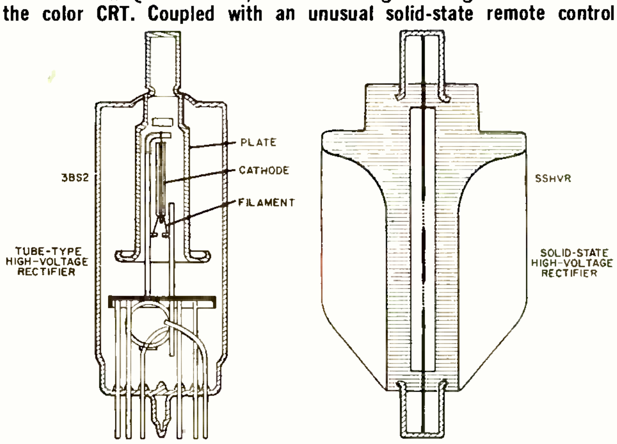


Fig. 1. Tube and solid-state high-voltage rectifiers.

Enter the Second One . . .

But not for long. Now RCA has one, too. Its CTC 40 chassis has unique features all its own.

For example, take the horizontal-deflection circuit—long the chief holdback for any kind of transistor TV. It was only recently that anyone made a transistor that could handle both the fast switching and high power demanded by this section of a TV chassis. The RCA CTC 40 got around that nicely. Instead of using a special transistor, or even a bank of them, silicon controlled rectifiers are used for horizontal deflection. The SCR's act as high-current switches that are gated by pulses from a transistor blocking oscillator. The high energy developed by suddenly switching such high currents through the deflection yoke is turned to another useful purpose: generating picture-tube high voltage. (The high-voltage rectifier is the only vacuum tube in the CTC 40.)

An integrated circuit is used in the sound section, as in RCA tube sets, but it's a new IC that includes an extra audio amplifier. The tuner is something special; it's not only solid-state but is the first TV tuner we know of to use a MOSFET r.f. amplifier for v.h.f.

And The Almost . . .

A few chassis came so close this year to being all-transistor that they can hardly be overlooked in any discussion of solid-state color sets. The record for most transistors in a hybrid design seems to be held by Packard-Bell; its CR-424 chassis has 33 transistors versus 11 tubes. Highest ratios of transistors to tubes are in Admiral's K10-2A and Setchell-Carlson's U809. Here are some highlights of the color sets we surveyed that are more than half transistor.

Admiral—new K10-2A chassis, with 7 tubes and 25 transistors. Screen size is 14-inch. Horizontal sweep and high-voltage section uses tubes. Has diode-type pulse-sampling high-voltage regulator. Video and color output amps are tubes. Something unique is special use of a junction field-effect transistor (JFET) as reactance control for the 3.58-MHz oscillator in the chroma section. (Only other FET we know of in color-TV is in tuner of RCA's all-transistor model.) Diagram of Admiral JFET reactance circuit is shown in Fig. 2.

Delmonico—Another small-screen portable, 14-inch. Chassis 7208, imported. Uses 9 tubes versus 26 transistors. Tubes used in vertical and horizontal sweep circuits, video output, color-difference amps, and v.h.f. tuner. Diode-type pulse h.v. regulator.

Packard-Bell—Chassis CR-424, uses 14-inch picture tube, imported. Has 11 tubes, used in both sweep chains, in color-difference amplifiers, video output, pincushioning. Also has 6BK4 shunt regulator. Uses 33 transistors, three of them in v.h.f. tuner.

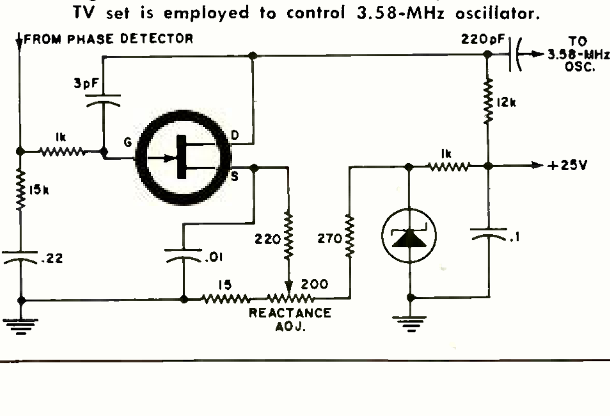
Panasonic—Two chassis, both imported. CT-21 has 12-inch screen. Uses 10 tubes, in same tube functions listed for other chassis plus audio amplifier and output. High voltage is regulated by a varistor in a pulse-sampling circuit. Transistors in this chassis number 25, including those in the v.h.f. tuner. Second chassis, the CT-63, has a 15-inch screen. Uses 10 tubes, in same functions as in CT-21 chassis. Has more transistors, 29 to be exact, owing to color-indicating circuit, extra color-killer amplifier. Both of these chassis have fine-tuning light.

Setchell-Carlson—Chassis U809, portable, 14-inch. Uses printed-circuit boards, new to Setchell-Carlson who formerly hand-wired everything. Uses 7 tubes, 25 transistors. Five of the transistors are in the u.h.f./v.h.f. tuner. Damper is solid-state instead of tube, and so is high-voltage regulator.

Sylvania—Chassis D12, only hybrid that drives a 23-inch picture tube. Has 12 tubes and 23 transistors. Tubes used for sweep chains, high voltage and regulation, 3.58-MHz oscillator and control, color-difference amplifiers, video output, tuner. Also has an integrated circuit to amplify sound i.f. and detect sound. One version, chassis D13, is used in Sylvania's Color Slide Theater—a unit with tri-color flying-spot scanner that shows 35-mm photographic color slides on TV screen.

You probably noticed that all the hybrid color-TV receivers except Sylvania's are small-screen. We keep hearing of other hybrids and transistor color chassis about to be introduced, but can get no further information at press time. A very-small-screen unit is promised by Sony, using a special picture tube called a Trinitron. It may be brought into this country in quantity sometime early in 1969, after this story goes to press. We have no details except that it will be mostly (or all) solid-state. ▲

Fig. 2. Junction FET used in Admiral hybrid color-TV set is employed to control 3.58-MHz oscillator.



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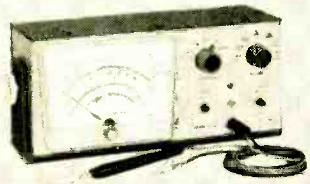

kit IM-28
$36.50
wired IMW-28
$56.95

kit IM-38
$39.50
wired IMW-38
$54.95

kit IP-18
$19.95

kit IT-18
$24.95

kit IM-17
$21.95

kit IG-57
$135.00
wired IGW-57
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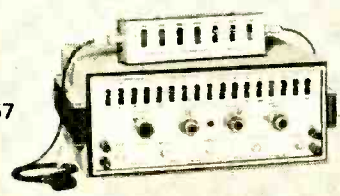
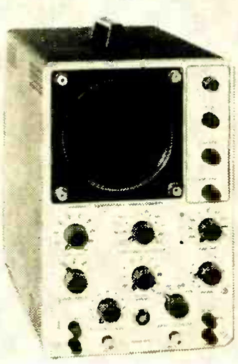




kit IO-18
$84.95
wired IOW-18
$139.95

HEATHKIT IG-18 Solid-State Sine-Square Wave Generator

A precision source of sine or square waves at a low kit price . . . that's the new solid-state IG-18 from Heath. Delivers 5% accuracy thru the wide range of 1 Hz to 100 kHz. The sine wave section features less than 0.1% distortion thru the audio range, 8 output voltage ranges from 0.003 to 10V, switch-selected internal 600 ohm load or external load and metered output of both voltage & dB. The square wave section has a 50 nS rise time and three output voltage ranges from 0.1 to 10 V P-P. Both sine & square waves are available simultaneously and the frequency is switch-selected for constant repeatability and fast operation. Circuit board construction makes the new IG-18 easy to build . . . new Heathkit styling and engineering excellence make it easy to use. Put the new IG-18 on your bench now. 10 lbs.

HEATHKIT IM-18 VTVM

The new Heathkit IM-18 continues the features that made the IM-11 famous . . . 7 AC and 7 DC voltage ranges that measure from 0-1500 volts full scale . . . 7 ohms ranges for measurements from 0.1 ohm to 1000 megohms . . . the convenience of a single probe . . . 11 megohm input impedance . . . ± 1 dB 25 Hz to 1 MHz response . . . precision 1% resistors . . . DC polarity reversing position on the function switch . . . RMS & P-P AC voltage and dB measurement capability . . . precision 4½", 200 uA meter for extra sensitivity. In addition, the new IM-18 has 120 V. or 240 V. AC wiring options, new Heathkit styling and a 3-wire line cord for safety. 5 lbs.

HEATHKIT IM-28 "Service Bench" VTVM

The new Heathkit IM-28 has the same performance specifications as the new IM-18 above, but it also has other features that put it in a class by itself, like a large, easy-to-read 6" meter . . . extra 1.5 & 5 volt AC ranges for additional accuracy . . . convenient gimbal mounting . . . "Set and Forget" calibration — all controls are adjustable from the front panel with a screwdriver . . . smooth ten-turn vernier control of Zero and Ohms Adjust for greater accuracy and easier setting . . . 120/240 VAC wiring options . . . safe 3-wire line cord. The new look of Heath instrumentation styling is evident too —handsome brown & beige color scheme, and new knobs that are easy to grip and fast to read. 7 lbs.

HEATHKIT IM-38 Laboratory AC VTVM

For all around general service work, audio design or laboratory analysis, there isn't a better value than the new Heathkit IM-38 AC VTVM. Here's why — 10 voltage ranges measure from 0.01 to 300 volts RMS full scale . . . extended frequency response of 10 Hz to 500 kHz at ± 1 dB . . . 10 megohm input on all ranges for higher accuracy . . . . wide —52 to +52 dB range . . . VU-type ballistic meter damping . . . very low AC noise . . . 120 or 240 VAC wiring options and new Heathkit styling in sharp beige & brown with an easy-to-grasp, easy-to-read knob. 5 lbs.

HEATHKIT IP-18 1-15 VDC Power Supply

If you work with transistors, this is the power supply for you. All solid-state circuitry provides 1-15 VDC at up to 500 mA continuous. Features adjustable current limiting, voltage regulation, floating output for either + or — ground, AC or DC programming, circuit board construction, and small, compact size. 110 or 220 VAC. 5 lbs.

HEATHKIT IT-18 In-Circuit Transistor Tester

In-Circuit transistor testers don't have to be expensive, and the IT-18 is proof of that . . . . tests DC Beta 2-1000, in or out-of-circuit . . . leakage Icbo and Iceo current 0-5000 uA out-of-circuit . . . identifies NPN or PNP devices . . . tests diodes in or out-of-circuit for opens & shorts . . . identifies unknown diode leads . . . matches PNP & NPN transistors. The IT-18 is completely portable — runs on just one "D" cell. Easy to use too . . . rugged polypropylene case, attached 3' test leads, big 4½" 200 uA meter, all front panel controls, 10-turn calibrate control. 4 lbs.

HEATHKIT IM-17 Solid-State Volt-Ohm Meter

Another very popular volt-ohmmeter from Heathkit engineering and it's easy to see why — all solid-state circuitry . . . high impedance FET input, 11 megohms on DC, 1 megohm on AC . . . 4 AC voltage ranges . . . 4 DC voltage ranges . . . 4 ohm ranges . . . 4½" 200 uA meter . . . 3 built-in test leads . . . DC polarity reversing switch . . . zero-adjust & ohms-adjust controls . . . continuous 12-position function switch. And that's not all — the IM -17 is battery powered for complete portability and comes in a rugged polypropylene case with built-in handle. Simple circuit board assembly. 4 lbs.

HEATHKIT IG-57 Solid-State Post Marker/Sweep Generator

The new IG-57 plus a 'scope is all you need . . . no external sweep generator required. Switch selection of any of 15 crystal-controlled marker frequencies (you can view up to six different frequencies on one 'scope trace). Select the sweep range and you are ready to instantly see the results of any changes you make. Four markers for setting color bandpass, one for TV sound, eight at IF frequencies between 39.75 & 47.25 MHz plus picture and sound carrier markers for channels 4 & 10. Three sweep oscillators produce the 5 most-used ranges . . . color bandpass, FM IF, color & B&W IF and VHF channels 4 & 10. Save hundreds of dollars and put full alignment facilities in your shop too — order your IG-57 now. 14 lbs. Kit IG-14, same as IG-57 w/o the sweep, 11 lbs. **$99.95.**

HEATHKIT IO-18 Wide-Band 5" 'Scope

The New Heathkit IO-18 is destined to be the world's most popular 'scope, just as its predecessor, the IO-12 was. Features 5 MHz bandwidth, the famous Heath patented sweep circuit — 10 Hz to 500 kHz in 5 ranges, two extra sweep positions which can be preset to often-used rates, frequency compensated vertical attenuation, built-in P-P calibration reference, Z-axis input, retrace blanking, wiring options for 120 or 240 VAC operation and new Heathkit styling in beige and brown. 24 lbs.

Home . . . From The Leader

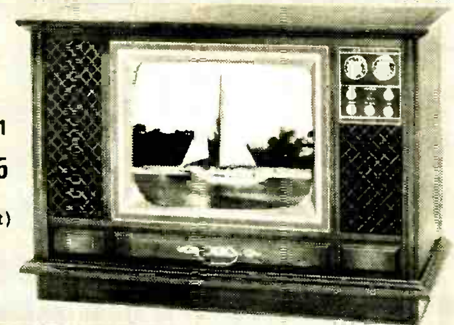
HEATHKIT

Now There are 4 Heathkit Color TV's . . . All With 2-Year Picture Tube Warranty

NEW Deluxe "681" Color TV With Automatic Fine Tuning

The new Heathkit GR-681 is the most advanced color TV on the market. A strong claim, but easy to prove. Compare the "681" against every other TV — there isn't one available for any price that has all these features. Automatic Fine Tuning on all 83 channels . . . just push a button and the factory assembled solid-state circuit takes over to automatically tune the best color picture in the industry. Push another front-panel button and the VHF channel selector rotates until you reach the desired station, automatically. Built-in cable-type remote control that allows you to turn the "681" on and off and change VHF channels without moving from your chair. Or add the optional GRA-681-6 Wireless Remote Control described below. A bridge-type low voltage power supply for superior regulation; high & low AC taps are provided to insure that the picture transmitted exactly fits the "681" screen. Automatic degaussing, 2-speed transistor UHF tuner, hi-fi sound output, two VHF antenna inputs . . . plus the built-in self-servicing aids that are standard on all Heathkit color TV's but can't be bought on any other set for any price . . . plus all the features of the famous "295" below. Compare the "681" against the others . . . and be convinced.

GRA-295-4, Mediterranean cabinet shown **$119.50**
Other cabinets from $62.95



kit GR-681
$499.95
(less cabinet)

Deluxe "295" Color TV . . . Model GR-295

Big, Bold, Beautiful . . . and packed with features. Top quality American brand color tube with 295 sq. in. viewing area . . . new improved phosphors and low voltage supply with boosted B + for brighter, livelier color . . . automatic degaussing . . . exclusive Heath Magna-Shield . . . Automatic Color Control & Automatic Gain Control for color purity, and flutter-free pictures under all conditions . . . preassembled IF strip with 3 stages instead of the usual two . . . deluxe VHF tuner with "memory" fine tuning . . . three-way installation — wall, custom or any of the beautiful Heath factory assembled cabinets. Add to that the unique Heathkit self-servicing features like the built-in dot generator and full color photos in the comprehensive manual that let you set-up, converge and maintain the best color picture at all times, and can save you up to $200 over the life of your set in service calls. For the best color picture around, order your "295" now.

GRA-295-1, Walnut cabinet shown **$62.95**
Other cabinets from $99.95

kit GR-295
now only
$449.95
(less cabinet)

Deluxe "227" Color TV . . . Model GR-227

Has same high performance features and built-in servicing facilities as the GR-295, except for 227 sq. inch viewing area. The vertical swing-out chassis makes for fast, easy servicing and installation. The dynamic convergence control board can be placed so that it is easily accessible anytime you wish to "touch-up" the picture.

GRA-227-1, Walnut cabinet shown **$59.95**
Mediterranean style also available at $99.50

kit GR-227
now only
$399.95
(less cabinet)

Deluxe "180" Color TV . . . Model GR-180

Same high performance features and exclusive self-servicing facilities as the GR-295 except for 180 sq. inch viewing area. Feature for feature the Heathkit "180" is your best buy in deluxe color TV viewing . . . tubes alone list for over $245. For extra savings, extra beauty and convenience, add the table model cabinet and mobile cart.

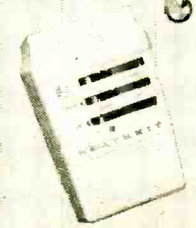
GRS-180-5, table model cabinet and cart **$39.95**
Other cabinets from $24.95

kit GR-180
now only
$349.95
(less cabinet)

Now, Wireless Remote Control For Heathkit Color TV's

Control your Heathkit Color TV from your easy chair, turn it on and off, change VHF channels, volume, color and tint, all by sonic remote control. No cables cluttering the room . . . the handheld transmitter is all electronic, powered by a small 9 v. battery, housed in a small, smartly styled beige plastic case. The receiver contains an integrated circuit and a meter for adjustment ease. Installation is easy even in older Heathkit color TV's thanks to circuit board wiring harness construction. For greater TV enjoyment, order yours now.

kit GRA-681-6, 7 lbs., for Heathkit GR-681 Color TV's **$59.95**
kit GRA-295-6, 9 lbs., for Heathkit GR-295 & GR-25 TV's **$69.95**
kit GRA-227-6, 9 lbs., for Heathkit GR-227 & GR-180 TV's **$69.95**



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For GR-295, GR-227 & GR-180
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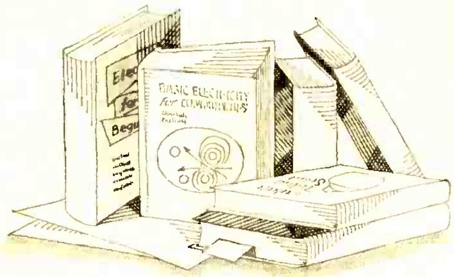


"ELECTRONIC DIGITAL COMPONENTS AND CIRCUITS" by R.K. Richards. Published by *D. Van Nostrand Company, Inc.* Princeton, N.J. 520 pages. Price $15.00.

This volume has been written for practicing engineers and students at the senior or graduate level in engineering courses. Although digital technology is only about twenty years old, its impact has been so great that virtually any engineers will, sooner or later, require a working knowledge of the field.

The book is divided into eleven chapters covering the history of digital circuits, diode switching and gating circuits, transistor switching circuits, magnetic core storage, magnetic surface storage, magnetic core switching circuits, superconductive components and circuits, tunnel diode switching and storage circuits, components and circuits for decimal counting, miscellaneous digital components and circuits, and analog-digital conversion.

The text includes 192 diagrams and an extensive bibliography listing almost 1000 references.

* * *

"VHF-FM MARINE RADIO" by Leo G. Sands & G. Geoffrey Tellet. Published by *Chilton Book Company,* Philadelphia. 325 pages. Price $6.50. Soft cover.

This book is addressed to users of marine radio equipment as well as to those who service it. The authors outline various types of equipment available and discuss what equipment is suitable for what type of vessel.

The ten chapters discuss the VHF marine band, marine radiotelephones, transmitters, receivers, power supplies and sources, antenna systems, walkie-talkies, boat installation and maintenance, coast stations, and operations. The balance of the book is given over to appendices which reprint all sorts of material pertinent to licensing and operating of marine radio, world-wide coast stations, FCC field offices, etc. The text material includes photographs, partial schematics, and line drawings to amplify the subject matter.

* * *

"TRANSISTOR CIRCUIT MEASUREMENTS" by Donald P. Leach. Published by *McGraw-Hill Book Company,* New York. 269 pages. Price $5.50. Soft cover.

This is a workbook designed to be used in conjunction with any good semiconductor or electronics textbook to give the student practical experience in working with semiconductor circuits. Most of the projects are at a fairly basic level although some of the experiments toward the end of the volume involve the independent design of circuits.

There are 31 experiments in this workbook, most of them requiring a minimum amount of parts and equipment. Each experiment includes work sheets for the student to fill out and turn in to the instructor for grading or correction.

Three appendices carry references, parts and equipment listings, and data sheets for various commercially available semiconductor devices.

* * *

"PULSE AND LOGIC CIRCUITS" by Angelo C. Gillie. Published by *McGraw-Hill Book Company,* New York. 395 pages. Price $9.95.

This volume is well suited to individual self-improvement programs as well as more formal classroom instruction at the technical institute and community college level.

The twenty chapters cover an analysis of basic waveforms, network analysis techniques and theorems, series *RC* high-pass: square-wave pulse input, the effect of shunt capacitance, series *RC* high-pass with other input waveforms, series *RC* low-pass circuits; series *RL* and *RLC* ringing circuits, fundamentals of delay lines, basic transistor switching characteristics, nonlinear waveshaping and diode gating, transistor gate and logic circuits, fundamentals of multivibrators, multivibrator trigger circuits, some logic circuit generators, basic sweep generators, transistor bootstrap circuits, diode matrix circuits, basic counting circuits, and other counters and register circuits. Five appendices and the answers to odd-numbered problems complete the book.

* * *

"EDUCATIONAL ELECTRONICS EQUIPMENT" edited by G.W.A. Dummer & J. Mackenzie Robertson. Published by *Pergamon Press Inc.*, 44-01 21st Street, Long Island City, N.Y. 11101. 1129 pages. Price $38.00.

This data book provides information on a wide range of electronic and electronic-based equipment designed specifically for educational and instructional use. In addition to listing aids for general education, the book covers equipment for instruction and training in physics, electronics, industrial techniques, and computer operation as well as ETV systems.

Specifications on the various products, manufacturers, typical applications, accessories available, etc. are provided in large, clear, easy-to-read format. The copy is lavishly amplified by photographs, cut-away views, typical application photos, adjustment and service notes, hook-up diagrams.

School administrators and teachers of audio/visual courses will find this invaluable in making their choices of equipment to meet their specific needs.

* * *

"PORTABLE FM RADIOTELEPHONES" by Fred M. Link. Published by *Chilton Book Company,* Philadelphia. 155 pages. Price $4.50. Soft cover.

This is a handbook for those who use, service, and manufacture two-way FM portable radiotelephones. It is intended to supplement information available in user's manuals, service notes, and sales brochures.

The chapter on applications outlines typical uses, frequency allocations, and permissible uses for the service. Transmitters and receivers are covered in the next two chapters while typical portable units are discussed in the fourth chapter. Power sources, accessories, maintenance, and licensing and operating procedures each command a chapter.

Various units are illustrated and discussed and there are charts comparing specs on different available models. The section on maintenance includes a rundown on test equipment needed to handle such servicing work.

* * *

"VOLTAGE AND POWER AMPLIFIERS" by Robert E. Sentz. Published by *Holt, Rinehart and Winston, Inc.,* New York. 277 pages. Price $3.95. Soft cover.

Designed as a textbook for classes at the technical institute or junior college level, persons with the requisite background could also use this as a home-study volume for upgrading their occupational skills.

After an introductory chapter dealing with the various classes of amplifiers, the text goes on to cover the interstage coupling effects on gain and bandwidth; input impedance of an amplifier; effect on frequency response of incomplete bypassing of emitter, cathode, or screen; gain-bandwidth product, pulse response of wide-band amplifiers; frequency compensation techniques; cathode and emitter followers; special forms of amplifiers; phase inverters; direct-coupled amplifiers; class-A single-ended power amplifiers; push-pull power amplifiers; and class-B and C tuned power amplifiers. Questions, problems, and references are appended to each chapter with answers to the odd-numbered problems included in the text. ▲

Adding Speakers to Hi-Fi System

(*Continued from page* 33)

the simplest arrangement. If the load presented by all the speakers in parallel is too low, individual resistors should be used in series with all the speakers. If the main speaker impedance is appreciably greater than the recommended minimum, it need not have a series resistor. Circuits to switch these resistors in and out as needed would be excessively complicated.

When two speakers are operated in series, the switch can be connected most simply to short out the unwanted speaker (Fig. 4C).

Operating Levels and Controls

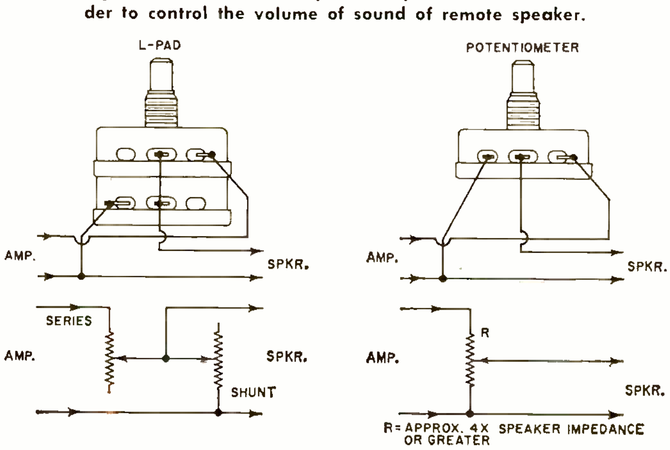
Since modern amplifiers are essentially constant-voltage devices, the same voltage is applied to all speakers operated in parallel. The power fed to a given speaker is inversely proportional to its impedance, while its output is directly proportional to its efficiency. For example, if an 8-ohm and a 16-ohm speaker of equal efficiency are paralleled, the 8-ohm speaker receives twice as much power as the 16-ohm speaker. When series resistors are incorporated into the amplifier, the effect is to reduce the discrepancy. In the circuit previously described for monophonic operation of remote speakers (Fig. 5B), there is a loss of about 9 dB for a 4-ohm speaker, 6 dB for an 8-ohm speaker, and 2 dB for a 16-ohm speaker. The 6-dB loss, incidentally, is desirable when the additional speaker is operated as a center-channel speaker for stereo.

Fig. 7 illustrates two methods of individual volume control for remote speakers. The L-pad is the more elaborate and expensive of the two, but it offers the advantages of little or no loss of power when set to maximum, proper impedance load seen by the amplifier, and preservation of a high damping factor. The potentiometer uses up some of the available power even when set to a maximum (about 1/5) and reduces the damping factor to a value of 1 at 50% of full rotation. A really elegant but expensive method is to use a small (0.5-ampere) variable transformer as a level control. Individual controls for all speakers provide means for balancing each stereo pair.

When using local controls, care should be exercised to avoid operating them at an unnecessarily low setting, with the amplifier volume control turned up high. This wastes power and increases distortion.

Power ratings on controls need not be as high as one might think. Heating in the controls is determined by the relatively long-term power dissipated. The average power, even of highly compressed program material, is well below 10% of the amplifier rating. Consequently, a control rating of 10% of the power fed to the speaker is satisfactory. This means 2-5 watts in most applications. ▲

Fig. 7. Connections of L-pad and potentiometer in order to control the volume of sound of remote speaker.



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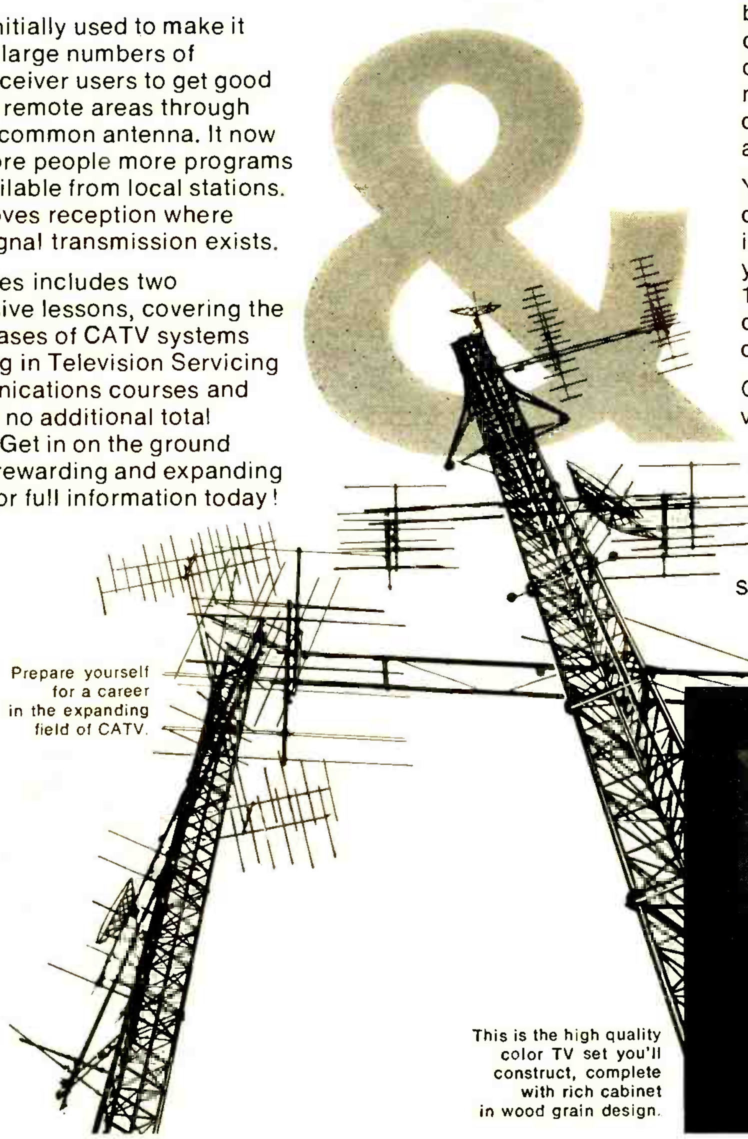

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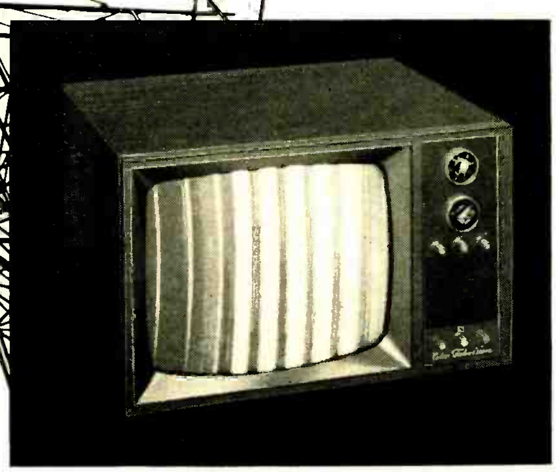

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TEST EQUIPMENT
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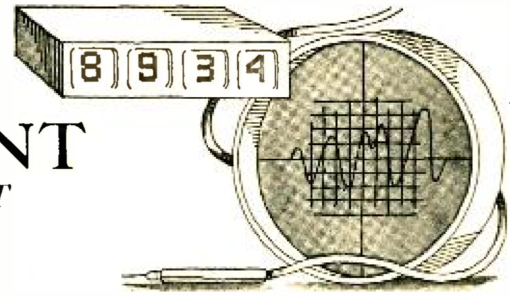
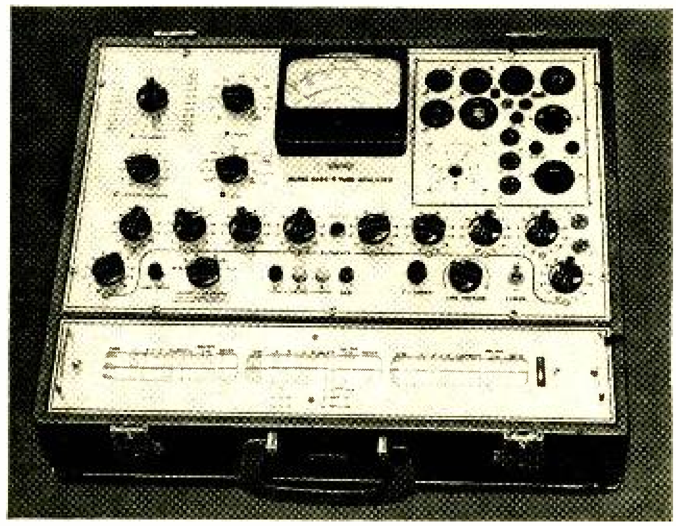


Triplett Model 3444-A Tube Analyzer

For copy of manufacturer's brochure, circle No. 3 on Reader Service Card.



THERE are plenty of vacuum tubes still in use in home-entertainment and industrial equipment. For example, although transistors are coming to our TV sets, most such receivers use vacuum tubes and these sets will have to be serviced for years to come. In addition, various industrial equipment using tubes will be with us for some time. Therefore, there is still a need for tube testers or their somewhat more sophisticated counterpart, the tube analyzer.

The new *Triplett* Model 3444-A is a mutual-conductance tube analyzer that has been designed for use in industrial engineering laboratories, for production-line testing, and in service test centers. It can also be used for precisely plotting curves of the characteristics of industrial tubes.

The analyzer has 16 built-in sockets of which two are multiple, giving the operator the equivalent of 19 sockets. It will accept all vacuum tubes presently used in electronic equipment.

In making the G_m test, a calibrated known a.c. signal voltage is applied to the tube being checked. The plate current is monitored with a sensitive voltmeter across a small (33-ohm) plate resistor. Readings are calibrated directly in terms of G_m up to a value of 60,000 micromhos. A 5-kHz test signal is used with a high-pass filter in the meter circuit input to eliminate any errors that could possibly be introduced due to hum pickup.

The tester can also check: plate-current cut-off, tube gas, rectifiers under load, thyratron firing voltage and grid current, dual-section tubes with only one lever movement, cut-off measurements on voltage amplifiers, and shorts and leakage between electrodes.

The updating of the roll chart is simplified by putting the chart in a separate compartment (at the bottom of the instrument) that can be snapped out of the tester's carrying case. The arrangement sort of reminds us of the plug-in coils used in the *National* HRO receivers we operated many years ago.

The gray, leatherette-covered wooden case measures about 15¼" x 18¾" x 7¾" and it has a hinged, removable lid. Price of the analyzer is $470.00. ▲

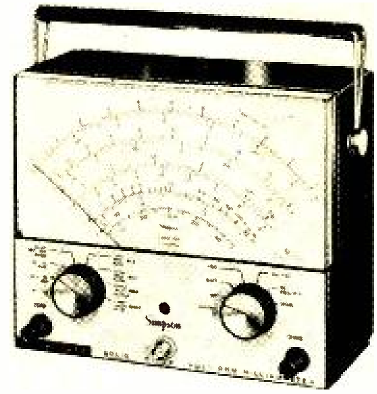
Simpson Model 313 Solid-State V.O.M.

For copy of manufacturer's brochure, circle No. 4 on Reader Service Card.

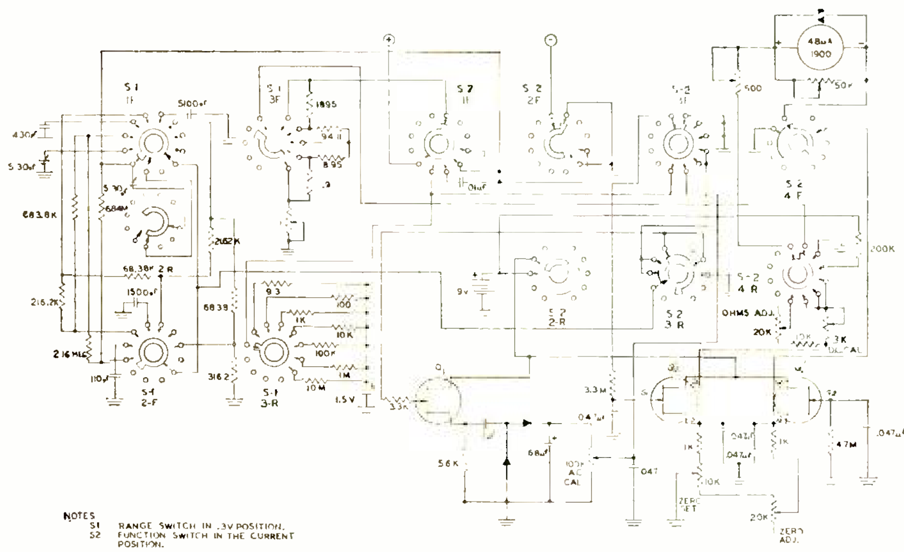
MORE and more test-equipment makers are getting into the act with their own transistorized v.o.m.'s using FET's. The latest one to come to our attention is the new *Simpson* Model 313. As we have said several times in this column, transistors are a natural to replace the tubes in the usual v.t.v.m.

or to upgrade the ordinary v.o.m. By using transistors, which can be battery-operated, and especially by incorporating a field-effect transistor input stage, we have the portability of the v.o.m. and the high impedance of the v.t.v.m.

The Model 313 has the 11-megohm input impedance of its vacuum-tube counterpart but it is completely portable and independent of the a.c. power line. The single 9-volt battery which powers the meter can keep it operating for over 300 hours. The meter itself is used to check the condition of the battery. When battery replacement is required, the round transistor-radio type is readily available. A 1½-V flashlight cell is used for the ohmmeter section.



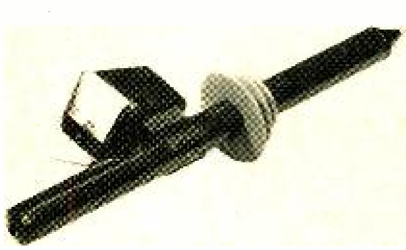
The meter movement has a 7-in scale and features a taut-band suspension. A back-to-back connected varistor across the movement (see diagram) protects it from overloads as great as 2000 times the normal full-scale values. Frequency and temperature compensation keep the readings accurate and stable. There are eight full-scale voltage ranges from 0.3 to 1000 volts on both a.c. and d.c.; seven resistance ranges, and five d.c. current ranges from 100 μA to 1A. Frequency response on a.c. is from 20 Hz to 100 kHz on the three lower ranges and from 20 Hz to 20 kHz on the remaining ranges. Accuracy for both a.c. and d.c. measuremens is 3± percent of full scale. Price of the Model 313 is $100.00. ▲



B&K Model HV-30 High-Voltage Tester

For copy of manufacturer's brochure, circle No. 5 on Reader Service Card.

ONE of the most important adjustments made by the TV service technician on a color receiver is the setting of the high voltage. In order to do this properly, we need an accurate high-voltage meter that will read between the 20 to 25 kV used in most sets. Of course, it is possible to use a high-voltage probe with a conventional v.o.m., but it's a lot more convenient to simply attach a 50-μA meter movement to the probe. That's just what was done in the new *B&K* Model HV-30 tester. Unlike another such tester that we covered some time ago in this column, the meter case is simply clipped onto the body of the probe so that it can be readily detached and put down on its own adjustable stand while the technician handles the probe separately.



The meter has an accuracy of ±2 percent at 25 kV, and ±3 percent of full-scale (30 kV) over-all. Each meter is calibrated for best accuracy at the most commonly used voltage of 25 kV.

Measuring 14½-in long, the tester with all leads and insulated connectors attached is supplied in a soft-lined protective carrying case. Price of the tester is $24.95. ▲

EW Lab Tested

(*Continued from page 22*)

standingly uniform over-all power output from the new radiators.

The low-frequency harmonic distortion was very low indeed. We usually measure distortion at a 1-watt level, but knowing the capabilities of the speaker, we used 10 watts in this test. Even at this house-shaking power, the woofer distortion hit a maximum of only 9% all the way down to 20 Hz. Above 50 Hz, distortion in the bass area averaged a low 2%. The tone-burst response was also excellent, as might be inferred from the exceptionally smooth frequency response.

In our listening tests we compared the AR-3a with an AR-3 side by side. Depending on the choice of program material and the settings of the mid-range- and tweeter-level controls on the speakers, we could make either speaker sound marginally better than the other. The differences were all at the higher frequencies; lower down the two were identical. With the level adjustments set identically, there was an advantage to the AR-3a, but it could not be detected without an A-B comparison.

The improved dispersion of the new upper-range drivers was more easily verified. With FM-tuner interstation hiss fed to the speakers, changes of the listener's head position relative to the AR-3 revealed a slight "beaming" of the highs. The AR-3a, on the other hand, had virtually perfect dispersion at all frequencies—perhaps the most non-directional forward-facing speaker we have tested.

The slightly higher price of the AR-3a is principally due to the changes in the crossover-network capacitors (it uses a total of 206 μF of paper-dielectric capacitors, as compared to 30 μF in the AR-3). We believe that the added cost is justified on an initial purchase. However, the conversion of an AR-3 to an AR-3a, while possible, must be done at the factory at a cost of $90, which in our (and *AR's*) view is hardly warranted. The AR-3 continues to be available at its original price of $225. The AR-3a sells for $250 in most finishes and for $225 in unfinished pine. While the differences between the AR-3 and the AR-3a are not earth-shaking, the AR-3a is unquestionably an improved design which can be considered very, very good by any loudspeaker standard. ▲

Viking 433 Tape Deck/Preamp

For copy of manufacturer's brochure, circle No. 2 on Reader Service Card.

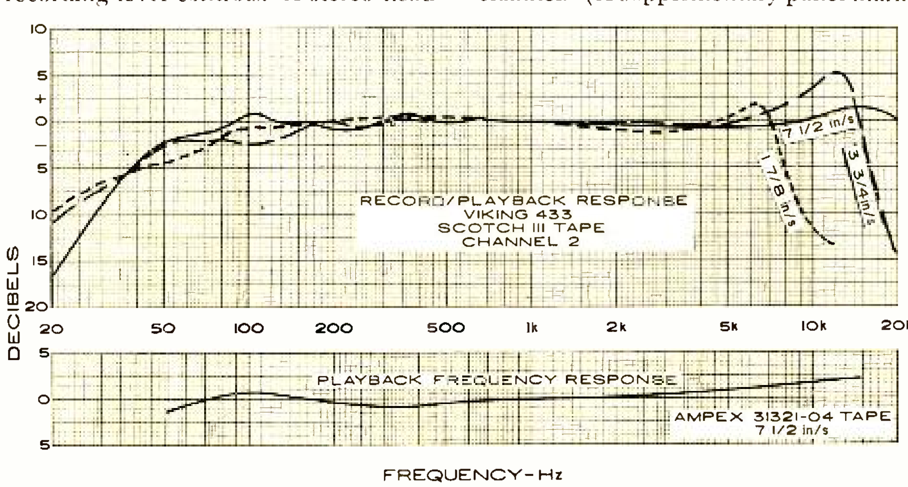
THE *Viking* 433 tape deck/preamp uses four tracks, three heads, and has three speeds. This unusually flexible solid-state deck provides a wide variety of operating modes. Output of the unit is about 1 volt, making it suitable for use with any stereo power amplifier.

The function switch can be set for normal stereo play or to play either the left or right channel through both outputs. It can be set to record in stereo, or on either channel alone. Finally, there are two positions that permit playing either channel and simultaneously recording it on the other, together with any added external program material.

Each channel has a high-level Aux input and two Mic inputs with separate recording-level controls. A stereo headphone jack will drive phones of 4-ohm or higher impedance. A pair of highly legible, illuminated meters indicate the signal levels of the program source or the tape-playback preamplifiers, depending on the setting of a front-panel rocker switch. The meters have a fast response time and good damping, and we would guess that they come closer to being real vu meters than most such level-indicating devices.

Since it is a three-head machine, the *Viking* 433 has separate record and playback preamplifiers and provides instant off-the-tape monitoring.

The Function knob setting is indicated by four colored lights which show the recording or playback status of each channel. (A supplementary panel mark-



ing would be helpful since the user has no indication of which way to turn the knob to reach a given setting.) There is also a Normal/Echo rocker switch. When it is in the Echo position, a portion of the playback preamplifier output is fed into the recording preamplifiers, delayed by the interval between the record and playback heads. This does indeed produce a sort of echo for those who may want this kind of effect.

The tape transport has three control levers. One sets the tape speed, together with the necessary equalization. The basic transport operating lever has Off-Standby-Play positions. Above it is a red Record button which must be pressed simultaneously with moving the lever to Play in order to make a recording. As a further safeguard, the function selector must be set to one of its Record positions before any recording can actually take place. A Pause button stops and starts the tape instantly when pressed and released, and it can be locked in place by a slight twist.

For wind or rewind, the control must be in Standby and the third lever must be moved from its Stop position to either Reverse or Forward. When it is returned to Stop, the tape must be allowed to come to a full stop before returning to the Play mode. Failure to observe this precaution, in our sample of the machine, broke a tape. Completing the deck controls and indicators are a four-digit push-button-reset index counter and a red light that indicates when the machine is ready to record.

The *Viking* 433 proved to be a very good performer. The over-all record-playback frequency response at 7½ in/s was ±1.5 dB from 70 to 20,000 Hz and down 4 dB at 40 Hz. The playback response with the *Ampex* 31321-04 test tape was +2, −1 dB from 50 to 15,000 Hz. At 3¾ in/s, the record-playback response was better than many recorders operating at twice that speed. It was ±5 dB from 40 to 16,000 Hz, with the major departure from flatness being a 5-dB peak at 12,500 Hz.

The 1⅞-in/s speed, which on most tape recorders can barely reproduce intelligible speech, has real musical value on this machine. The record-playback frequency response was ±2 dB from 70 to 7500 Hz. Although some brilliance was lost from music recorded at this speed, it was always pleasant, listenable, and far superior to the customary "AM-radio" quality.

The wow and flutter were extremely low at 7½ in/s, measuring 0.03% and 0.06%, respectively. At 3¾ in/s, they increased slightly to a still insignificant 0.07% and 0.10%. The signal-to-noise ratio was 45 dB at 7½ in/s, 44 dB at 3¾ in/s, and 43.5 dB at 1⅞ in/s. The "noise" was all hiss, no hum being audible or measurable. The tape speeds were slightly slow, with a timing error of about 45 seconds in 30 minutes of playing. The wind and rewind speeds were truly fast, less than 60 seconds being needed to pass 1200 feet of tape in either direction.

After a brief familiarization period, we found the unit to be a very easy-to-use recorder. Its sound was above reproach. At 7½ in/s, the only audible difference between input and output signals was a very faint hiss. At 3¾ in/s, the chief difference was a slight added brilliance. And, as we mentioned earlier, it sounded fine even at 1⅞ in/s. The sound-on-sound mode worked perfectly, and after copying one channel onto the other about ten times, there was remarkably little degradation of quality. One could hardly ask for more.

The *Viking* 433, in a handsome walnut base, sells for $389.95. For custom installation, less base, it sells for $369.95. A plug-in remote-control pause accessory is available for $25.00. ▲

MORE SENSITIVITY FROM YOUR TRANSISTOR RADIO

By JOHN E. CAMPBELL

HAVE you ever wished that you could squeeze just a little bit more sensitivity from your transistorized AM broadcast receiver, especially on a single station? If so, a gentle wave of a magic wand may make your wish come true.

All you will need is a permanent magnet and your receiver. If the magnet has a fairly strong field you won't even need to open the case of your set. Just tune in the station you wish to "perk up" and make a slow pass with the magnet down the length of the built-in ferrite antenna rod. If you detect a rather sharp increase in volume anywhere along the line, slow down and find the peak. That's all there is to it. You can now either balance the magnet where it is, tape it in place, or obtain some small ceramic magnets and tie or glue them in position directly on the ferrite rod.

Suitable magnets are available from Radio Shack, Edmund Scientific Co., and many others. A more universal supplier may be your local hardware dealer who handles magnetic cabinet latches. Just about any magnet will do as long as the field is strong enough to saturate a small portion of the ferrite rod. ▲

Now, what's the best way to play your records for under $80?

For years the AR turntable, at $78,* has been the only truly fine record playing mechanism you could buy for under $80.

A well informed audiophile, who wanted to save some money on his complete stereo system, bought the AR turntable. Period.

But now, if you're out to make an informed choice of a low cost turntable, you'll have to take one other product into consideration.

The new automatic Dual 1212. At $74.50.**

Just like the AR, the Dual 1212 exceeds every NAB standard for broadcast turntables in rumble, wow, flutter and speed accuracy.

But only the Dual lets you vary any of its speeds by 6%. That'll come in handy if you're pitch-sensitive.

The Dual has three speeds (including 78). The AR has two.

Just like the AR, the Dual will accept any currently available cartridge, and track it at its optimum stylus force.

But so that your cartridge will ride in the center of a stereo groove at low tracking forces, the Dual has built-in anti-skating compensation. (The AR has no equivalent device.)

And to protect your cartridge, the Dual has a cueing control that gently lowers the arm anywhere on your record. It also lets you conveniently interrupt play for a time, and then continue in the same place. (Again, no AR equivalent.)

The Dual is automatic. It can start or stop automatically. With one record or a stack of six. (The tracking force of the Dual arm won't vary from first record to last.) And even when you place its arm on a record by hand, the Dual will start turning automatically.

The AR is a manual turntable with no automatic features.

Your records will probably sound exactly the same played on whichever of the two turntables you choose.

So go to your dealer and see them both. And then decide which way you want to play records.

With a host of Dual convenience features, for $74.50.

Or without them, for $78.

United Audio Products, Inc., 535 Madison Avenue, New York, N.Y.10022.) Dual

*Including base and dust cover. **Base and dust cover are extra.

SPLIT PROBE MEASURES CURRENT

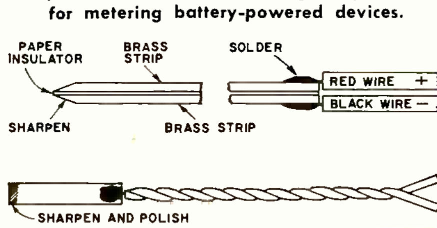
By ROBERT E. BROCK
Ampex Corp.

WHENEVER it's necessary to measure load current or battery voltage without removing batteries or disconnecting the battery holder, the split probe is a useful device. The split probe (Fig. 1) is a sandwich of two ¼" x 1¼" strips of brass shim stock separated by a strip of thin paper. While the sandwich should be as thin as possible, it must be stiff enough to permit its insertion between the battery terminals and the contact strips of the battery holder.

When 0.006-inch brass shim stock and 0.002-inch paper are used, the 0.014-inch sandwich will be stiff enough to push between the cell's positive terminal and its contact strip in the battery holder. (Before cementing the layers together, solder a short length of red insulated wire to one end of one of the brass strips; and a black insulated wire to the other. Later, these two leads will be used for metering purposes.) Care should be taken to assure the leakage resistance from shim to shim is higher than 1 megohm to avoid measurement errors in sensitive circuits. In addition, twist the black and red leads from the probe assembly together to minimize noise pickup. Additionally, alligator clips may be soldered to the wires to facilitate meter connections.

Although the split probe falls in the general category of a "home brew" device, its many applications will benefit service and laboratory technicians alike. For example, the load current of many types of portable electronic entertainment equipment exceeds the battery capacity. Some small transistor radios have load current ranges of 6 to 10 mA. The electronics in transistorized tape recorders draws about the same current—but when the motor is operating, the load is increased 50 to 200 mA. ▲

Fig. 1. Brass shim stock with fish paper in between makes a good probe for metering battery-powered devices.



CERTIFICATION FOR ENGINEERING TECHNICIANS

By LOUIS E. FRENZEL, Jr.

NO one can deny that technicians are extremely important members of our country's technological manpower team. Business, industry, and the government use technicians to perform many professional and semi-professional services. These include: maintenance, repair, and installation of equipment; research and development projects; component design; and support functions such as drafting, technical writing, and sales.

Despite their contributions, technicians have not received nearly as much recognition as they deserve. It has only been within the past few years that their status has improved and their contributions been more fully recognized.

There are two organizations which have helped technicians obtain this recognition. First, there is the Institute for the Certification of Engineering Technicians (ICET). Sponsored by the National Society for Professional Engineers, this organization was established in 1961 to examine and determine the competency of technicians who voluntarily applied for certification. Competency is determined by investigating the applicant's education, work experience, background, and character. References and endorsements are also solicited from employers and others familiar with the applicant's abilities. Upon verification of his competency, the technician is awarded a certificate in one of three grades: junior engineering technician, engineering technician, and senior engineering technician. The junior grade (JET) is for those just entering the field either upon graduation from an accredited technical school or upon completion of two or more years of basic training. After five years of experience beyond the junior level requirements, the technician qualifies for the engineering technician (ET) grade. Ten additional years of experience later qualifies the technician for the senior level (SET). Applicants must be 25 years of age for the ET grade and 35 for the SET grade.

At present there are well over 10,000 certified technicians in the United States in all fields. Most have found their certification an asset in seeking a new job or a promotion within their companies. In addition, many employers recognize certification as a valuable means of establishing the competency of their technician employers and recommend it highly. In fact, some companies require certification for some key technical positions.

Another organization that furthers the technician's cause is known as ASCET, the American Society of Certified Engineering Technicians.

Certified technicians soon discovered that they would be more readily accepted as professionals if there were an organization devoted to promoting their interests. As an examining body, the ICET could not do this. Thus, in 1964, a group of certified technicians founded ASCET. The purpose of this independent organization is to foster recognition of the contributions of engineering technicians; cooperate with other engineering societies; improve utilization of technicians; and to assist in his social, educational, economic, and ethical development. This program is implemented by local chapter meetings in major cities, an annual national meeting, and through various publications. Membership is open to any certified technician.

If you are a career technician seeking a way to improve yourself, consider certification. It is well worth the time and effort involved. It may help you get a salary increase or a better, more responsible position.

Complete information on either of these two programs can be obtained from the ICET at 2029 K Street, N. W., Washington, D. C. 20006, or ASCET Box 1627, Topeka, Kansas 66601. ▲

BART: Electronics Aids Transit

(Continued from page 38)

The ATC will insure that all trains moving over a given section of track will operate at the same speed. The scheduling of trains will remain extremely flexible, since the computer continually updates schedule conditions.

Train-control information is encoded by frequency-shift keying of a carrier frequency in the audio range (below 10 kHz). By means of trackside and car-mounted loops, this information is transmitted to the on-train electronics. Each passenger station has associated with it a transmitter to encode additional information used in stopping and starting trains. The train electronics systems make extensive use of integrated circuits for reliability and the other well-known advantages of IC's.

A coding system in the ATC reduces the possibility that outside interference will cause spurious responses. Six bits must be transmitted in proper time sequence over a particular time interval if the system electronics is to interpret the code as a command signal.

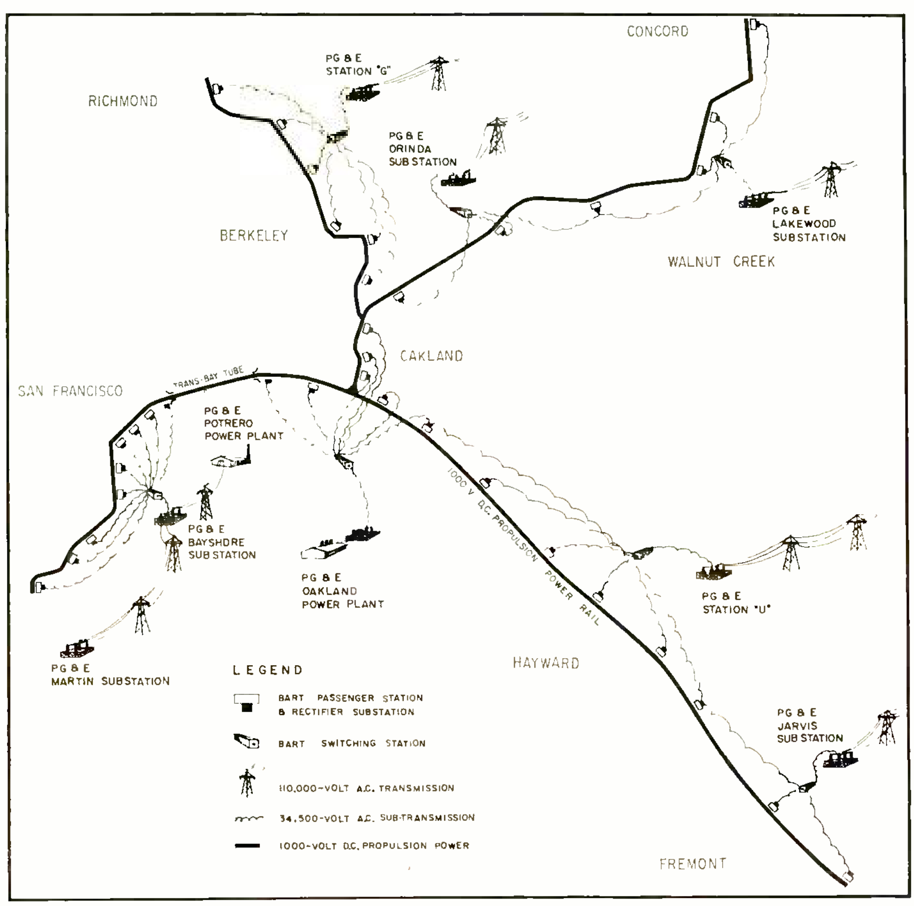
Security and Communications

In addition to the radio communications link between the train attendant and wayside stations and central control, each train will have an intercom system for announcements and passenger communications with the train attendant. The use of closed-circuit television is planned as a means of insuring safety and security for passenger stations. The CCTV system would permit a single station attendant to monitor remote train platforms, as well as permit passengers to seek any assistance they may require.

As a goal, BART expects a basic fare structure of approximately 5 cents per mile for distances up to 10 miles, the rate thereafter decreasing to about 2 cents a mile. Thus the 30-mile trip from Concord to downtown San Francisco would cost about a dollar and the trip will take less than 40 minutes. At rush hour, the same trip by car would require about one hour and cost 25 cents in bridge toll, $1 to $2 in parking fees, and about $3 in operating costs.

One cannot easily evaluate, in monetary terms, the safety and relaxed atmosphere of the train as compared to the trip by car. The inherent advantage of BART is clear. If our cities are to survive strangulation by traffic, and if our citizens are to avoid the insidious poisoning of the air they breathe, mass transit must take over. BART is a first step in the right direction. And, as so often is the case with technological problems, electronics holds the key to a practical solution. ▲

Fig. 3. System power supply and distribution to be used for BART.



A.C. LINE VOLTAGE MONITOR

By CHARLES D. GEILKER
Research Associate
Warner & Swasey Observatory

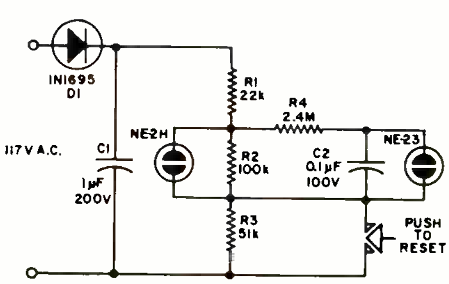
In situations where electronic equipment must be left operating unattended for long periods of time, it is often desirable to have some check on whether low supply voltage, or even outright power failure has occurred in the interval since the equipment was last serviced.

In the voltage monitor circuit shown in Fig. 1, the NE-2H lamp has a higher d.c. striking voltage than the NE-23 although they maintain the same voltage level once the lamps have fired. In the circuit, *D1* and *C1* form a simple half-wave rectifier which places 150 volts across the resistance divider string, *R1*, *R2*, and *R3*. When the line voltage is turned on, the voltage drop across *R2* is insufficient to fire the NE-2H; however, it does exceed the 65-volt firing level of the NE-23, and the NE-23 blinks since a relaxation oscillator is formed by *R4* and *C2*.

Momentarily depressing the reset switch shorts out *R3* and fires the NE-2H. Now the maintaining voltage of the NE-23 drops and the blinking stops. Should a power failure occur, or the line voltage drop below 100 volts, the NE-2H goes out and the NE-23 will signal the fact by blinking until it is reset again.

R1 sets the "blink threshold" for low line voltage. Thus, increasing the value of *R1* from 22,000 ohms to 26,000 ohms raises the threshold from 100 to 105 volts. In addition, some NE-2H's are polarity sensitive and may require that the leads be transposed for proper operation. Ordinary 5% resistors work satisfactorily throughout the circuit. ▲

Fig. 1. Blinking NE-23 signals power failure.



NEW PRODUCTS & LITERATURE

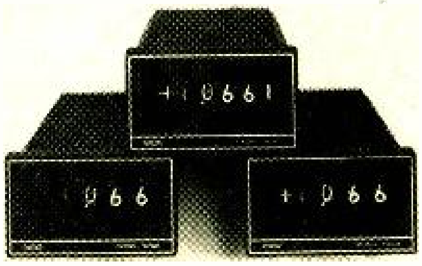
Additional information on the items covered in this section is available from the manufacturers. Each item is identified by a code number. To obtain further details, fill in coupon on the Reader Service Card.

COMPONENTS • TOOLS • TEST EQUIPMENT • HI-FI • AUDIO • CB • HAM • COMMUNICATIONS

DIGITAL PANEL METERS

A new instrument line consisting of three digital panel meters and two panel-mounting remote readout units has been announced.

The line is designed for a wide range of applications by system and OEM manufacturers.



The meters are all housed in the same compact aluminum casting, measuring $3\frac{1}{4}$" x $5\frac{1}{4}$" w. x 9" d. Weight of the meters is less than 5 pounds.

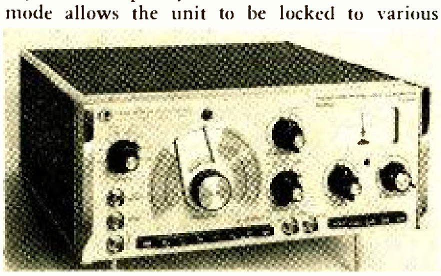
The Model 7020 is a three-digit unit, single range, single polarity, reading at a speed of three readings per second. It is available in five input ranges from 150 mV full-scale to 1000 V full-scale. The Models 7030 and 7040 both provide overrange, dual polarity with automatic indication, and reading speed of six readings per second. The 7030 is a three-digit meter and the 7040 has four digits. Both will operate remote readout units. The 7030 is available in five full-scale input ranges from 199.9 mV to 1000 V; the 7040 is offered in four input ranges from 1.2 V to 1000 V. Fairchild Instrumentation

Circle No. 156 on Reader Service Card

WAVEFORM GENERATOR

The Model F240A phase-lock waveform generator, when locked to an external frequency standard, will generate sine, square, triangle, and ramp outputs with the frequency, accuracy, and stability of the standard. A front-panel mounted phase-angle meter indicates the phase angle relationship of the output signal to the external standard. This phase angle may be adjusted from 0° to 180°, lead or lag without loss of phase lock.

Selection of either "wide" or "narrow" capture ranges is provided. In the "wide" mode, the unit will automatically lock to an external frequency within a given range without having to adjust the frequency control dial. The "narrow" mode allows the unit to be locked to various



harmonics of the reference signal. Fast and slow tracking modes are also provided. Data Royal

Circle No. 126 on Reader Service Card

SOLAR-ACTUATED CONTROL

A solar-actuated, automatic outdoor lighting control which is designed to provide 14-20% longer life is now available as the Series 5241.

The "Post Lantern Control" has been tested for 6000 "on-off" operations—the equivalent of 18 years' continuous service. The unit is a photoelectric switch which incorporates a stationary heater element. The only moving parts are the bimetal and the contact, a feature which significantly extends heater life. The new unit has a shatter-proof polycarbonate window and all exposed parts are corrosion-resistant. Sigma Instruments

Circle No. 127 on Reader Service Card

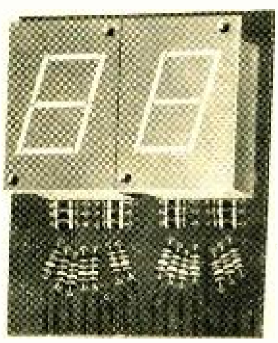
CLEANER FOR TV TUNERS

A new aerosol product which cleans all types of TV tuners has been put on the market under the tradename "Tun-o-Wash". According to the company, the cleaner will completely remove deposits of grease, oil, and dirt from tuners without damage or danger to the set. The spray nozzle is designed to apply the chemical with the proper propelling force to dissolve and wash away the foreign matter. Chemtronics

Circle No. 6 on Reader Service Card

NUMERIC READOUTS

The 718 series seven-segment readout display features one-inch characters mounted directly on a printed-circuit board, together with selected neon lamps and the required series and shunt resistors. Displays are available in groupings of



from 2 to 8 modules, which can include plus-minus, decimal, color, and special caption module.

Installation is achieved with the boards plugging directly into standard PC board connectors, with a terminal spacing of 0.156 inch. Displays are available for operation at 150-160 V d. c. or 110-125 V a. c.

Front portion modules for PC board mounting are also available separately for those wishing to use the readouts on PC boards of their own design. Dialight

Circle No. 128 on Reader Service Card

PC-BOARD TRIMMER

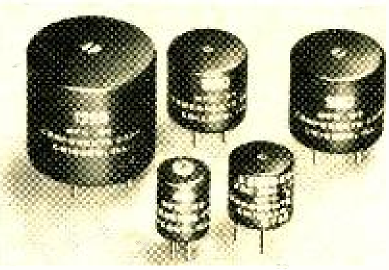
A single-turn resistance trimmer specifically designed for 0.1-inch printed-circuit grids has been introduced as the Type AFR.

Rated at $\frac{1}{4}$ watt, the new trimmers are built to withstand severe environmental conditions. Their design includes a hot-molded resistor track and low resistance collector track bridged by a single moving contact brush. Fifteen models cover the resistance range of 100 ohms to 5 megohms ±20%. Leads are designed for mounting directly on 0.1-inch matrix PC wiring boards using the trimmer's leads. Ohmite

Circle No. 129 on Reader Service Card

ADJUSTABLE INDUCTORS

A new series of miniature adjustable inductors in five sizes to cover a wide range of inductance is now available. The unique design allows for screwdriver adjustment, yet each adjustment is repeatable regardless of the number of times



coil is readjusted. Positive stop at top and bottom of the adjustment range prevents damage and lost tuning slugs. Standard units allows the nominal inductance to be varied by ±5%. The adjustment range permits use of wide tolerance tuning capacitors in narrow frequency applications, while the magnetic shielding allows the inductors to be mounted in close proximity to other components. They are designed for printed-circuit board mounting with the PC pins fastened to a phenolic base. Components Corporation

Circle No. 130 on Reader Service Card

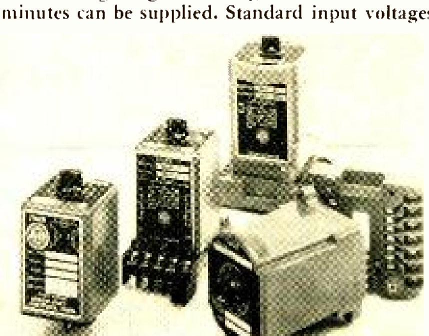
PC BUILDER'S KIT

Kit No. 500 contains printed-circuit boards and all of the chemicals and supplies needed to make professional PC's. Each kit contains two PC boards, $4\frac{3}{4}$" x $3\frac{3}{4}$", a resist ink pen, one 6-ounce bottle of resist ink solvent, and one $\frac{1}{16}$" drill bit. The kit is packed in a see-through acrylic box which serves as a developing tray. Complete step-by-step instructions are supplied with each kit. Injectorall

Circle No. 131 on Reader Service Card

TIME-DELAY RELAYS

A new line of transistorized time-delay relays is now available in more than 7000 different time delay and interval timing variations. Standard timing ranges from $\frac{1}{10}$ of a second to 15 minutes can be supplied. Standard input voltages



are from 24 to 220 volts with special variations available on order.

Complete specifications on these new relays will be supplied on request. Arrow-Hart

Circle No. 132 on Reader Service Card

FAST-FIRING SCR's

A new series of 80-A fast-firing SCR's capable of handling 800 amps per microsecond inrush current has been introduced as the 81RLB. The new series combines all the parameters necessary for service in applications demanding high power, fast turn-on, and fast turn-off, even with high reapplied dV/dt, such as high-frequency inverters for a. c. motor drive systems, according to the company.

Obtainable to 1200 V in a TO-94 package, the SCR's have lower switching losses, providing higher frequency operation at higher power levels. The combination of the epitaxial process, including contour groove and shorter emitter construction, with accelerated cathode excitation provides the fast-firing parameters for this device. International Rectifier

Circle No. 133 on Reader Service Card

LINEAR-MOTION POTS

The "Slide-Trol" linear motion potentiometer was designed specifically to meet the needs of circuit board and panel space limitations. It is available in values of 40 ohms to 15 megohms. The rectangular element permits higher wattage ratings due to uniform heat dissipation. A phenolic housing eliminates shock hazards. The movable contact is a patented design that provides nine contact points for low noise and low contact resistance.

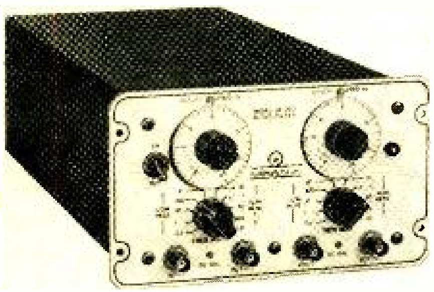
The units may be mounted horizontally, vertically, or sideways; singly or in groups and with snap-in or twist-tab mounting. Stackpole

Circle No. 134 on Reader Service Card

SOLID-STATE FILTERS

A new group of continuously adjustable solid-state active filters with a frequency range from 0.2 Hz to 20 kHz is now available.

Designated the Model AF-210 (single channel) and the Model 220 (dual channel), this new series offers high parameter stability and uniformity, according to the maker. Featuring



high-pass, low-pass, band-pass, and band-reject functions, they also provide selectable frequency response flatness (Butterworth or time domain). Attenuation is 80 dB or greater with a slope of 24 dB/octave in stop bands and 48 dB/octave when the individual channels are connected in series.

The filters use conservatively derated silicon semiconductors throughout. Multimetrics

Circle No. 135 on Reader Service Card

INVERTER/CHARGER

A new combination inverter and charger has been introduced as the Model TIC-620. As an inverter, the unit delivers 620 VA output (120 volt, 5 amp nominal) from a 12-volt battery with no-load to full-load frequency stability of ±0.5 Hz and high efficiency performance at greater current draws. Fused input and output circuits protect the inverter and battery from overload and an automatic shut-off takes effect when battery voltage decreases to a value of 10.5 volts.

With 117-V a.c. input, the charger provides 25 amps maximum at a nominal 12 V d. c. A three-position switch provides low, medium, or high charge rates. One meter on the face of the unit shows in amps, charging rates, or current draw from battery when inverting. Three pilot lights signal "charge", "invert", and low battery voltage condition. The inverter-charger unit measures 7¼" high x 14½" wide x 10" deep. Electro Products

Circle No. 7 on Reader Service Card

TRIMMERS WITH PC PINS

Various combinations of PC pins are available with the recently introduced line of half-inch-square metal glaze trimmers, Type 255.

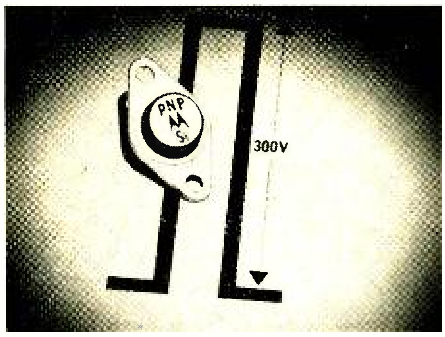
The units are available with three different printed-circuit pin configurations and provide for flat mounting or for two versions of edge mounting. Flat mounting is identified with the suffix "-10", following the series; edge mounting, with adjustment made from the side, by the suffix "-207"; and edge mounting with adjustment from the top, by "-208."

The devices are rated at ¾ watt at 70°C. They are available in resistance values from 100 ohms to 2 megohms, ±10% standard tolerance. IRC.

Circle No. 136 on Reader Service Card

FAST-SWITCHING TRANSISTOR

Two "p-n-p" high-voltage silicon transistors designed for demanding power-switching applications, have been introduced as the 2N5344 and 2N5345. The 2N5345 is a 1-ampere unit



capable of handling up to 300 V (V_{CE}) while the 2N5344 is rated at 250 V. According to the company, both transistors are excellent fast switches with a maximum total turn-on time of only 200 nanoseconds at 500 mA and 100 V.

The transistors are packaged in hermetically sealed TO-66 cases for thermal efficiency which results in the high power dissipation rating of 40 W at 25°C case temperature. Operating temperature range is −65°C to 200°C. Motorola Semiconductor

Circle No. 137 on Reader Service Card

HIGH-TEMPERATURE LIGHTS

The new "Hi-Temp Glo-Lites" are UL listed for operation in ambient temperatures up to 150°C, the maximum operating temperature for neon lamps. Built with an anodized aluminum body and faceted glass lens, a special ceramic cement is used to seal the leads and lamp within the "Glo-Lite". Stock leads are 10" and available only with #20 AWG stranded copper wire insulated with type "A" white asbestos insulation.

They are specially suited for use in heating appliances, ovens, and other industrial equipment. They can be mounted with either a plug button mount or speed nut in 5/16" to 25/64" diameter holes and on panels 1" to 5/64" thick. A choice of 125 or 250 volt units is available. Drake

Circle No. 138 on Reader Service Card

INFRARED SLIDE CHART

A new infrared wavelength/compound circular slide chart has been issued. Of special interest to spectroscopists, one slide translates wavelength to compound. When the cursor is set to any given wavelength, the chart automatically identifies most of the compounds producing absorption bands at that wavelength. The flip side presents wavelengths of the main absorption bands of 61 different classes of chemical compounds.

Additional information on the slide chart and ordering details will be supplied on request. Barnes Engineering

Circle No. 139 on Reader Service Card

MICROMINIATURE TUNERS

The MTLC line of microminiature tuners has recently been redesigned and ruggedized. This new line of LC circuits is packaged in TO-5 cans. Since the tuning element is a Modutrim variable ceramic capacitor measuring only 0.208" x 0.280" x 0.120" and all other circuit components are proportionally small, the header plays an important role in holding all elements securely in place. All components are pre-positioned on the header for perfect mechanical alignment. A new, improved potting compound is used and then the header, with components attached, is epoxied to the can.

There are ten standard MTLC units, plus a wide range of variations and special designs for application in military and aerospace equipment. JFD

Circle No. 140 on Reader Service Card

ANTI-STATIC SPRAY

A new aerosol, No. 610, has been developed to neutralize static electricity generated by friction or atmospheric conditions. Used sparingly, the product is said to give immediate relief. Regular use keeps machinery and parts in production free from troublesome static. It dries instantly and clear and can be used on anything. The aerosol can has an extension tube for hard-to-reach areas. Sprayon Products

Circle No. 8 on Reader Service Card

SOLID-STATE CHANNEL STRIPS

A complete line of 82-channel solid-state single-channel strips is now available for MATV installations. There is a model for every TV channel, 2 through 83, plus a special model covering the entire FM spectrum.

The new strips eliminate the need for converters. Encased in rugged, extruded aluminum housings, the SL-3000 strips can be rack, shelf, or panel mounted. Since each unit contains its own power supply, failure of one particular amplifier does not affect the rest of the system in any way. JFD

Circle No. 141 on Reader Service Card

A.C.-A.C. POWER CONVERTER

A solid-state, convection-cooled 400-Hz, three-phase to 50-Hz single-phase power converter with European and American convenience outlets is now available.

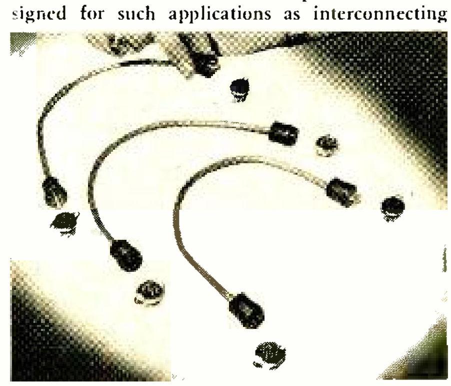
The unit features two output voltages: 115 V a. c. at 1 kVA and 200 V a. c. at 500 VA. The converter features simplified circuitry along with complete overload and short-circuit protection. Due to its 85% efficiency, the unit is contained in a standard rack-mounted chassis which measures 8¾" x 19" x 18". Power Systems

Circle No. 142 on Reader Service Card

CABLE ASSEMBLIES

A new packaged kit concept of providing electrical and electronic equipment engineers with combination connector and socket cable assemblies for use without the need for short-run assembling of components has been developed as the "Uni-Kit."

The 30 new combinations of connecting cable assemblies with connector components are designed for such applications as interconnecting



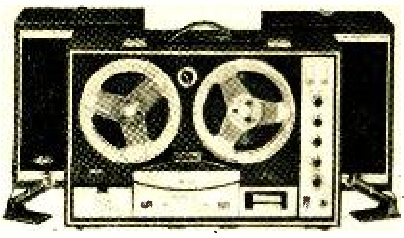
laboratory electronic instruments, test equipment, production equipment, communications gear, etc. There are three basic configurations: connector-connector with interconnecting cable and two sockets; socket-socket and two connectors; and connector-socket and one socket and connector. Five conductor cable lengths are available. Methode

Circle No. 143 on Reader Service Card

HI-FI — AUDIO PRODUCTS

STEREO RECORDER

The Model TR-1080 solid-state stereo recorder features automatic reverse which permits the unit to record and play in both directions without reel turnover. It can be set for one complete



play and shut off, continuous replay, or automatic stop at any predetermined point.

The recorder is designed to permit sound-on-sound and sound-with-sound for special effects. It is equipped with a solid-state stereo amplifier and the preamp outputs permit use of the recorder as a tape deck for playback through a stereo system.

A pause control with instant release and push-to-reset four-digit counter make it easy to edit while recording. The recorder operates at 7½, 3¾ and 1⅞ in/s. It has two mike and two auxiliary inputs. The outputs are preamp, two external speakers, front-panel stereo headphone jack. Response is 40-19,000 Hz at 7½ in/s and flutter and wow is under 0.15% at 7½ in/s. It comes with two microphones with stands, patch cords, and sensing tape. It measures 12¾" x 19⅛" x 12¼". Allied Radio

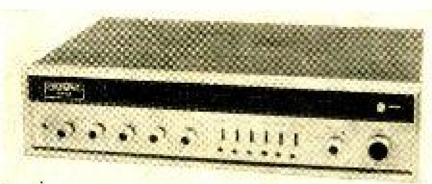
Circle No. 9 on Reader Service Card

AM-FM STEREO RECEIVER

The SA-70 is a 90-watt AM-FM stereo receiver which incorporates four IC's and three FET's. The circuit has two r.f. stages, a four-section tuning capacitor, and six tuned circuits for maximum sensitivity.

To insure reliable automatic mono/stereo switching and to prevent accidental triggering of the stereo indicator light, the SA-70 uses a multiplex circuit with seven tuned circuits and a ceramic filter. A calibrated field-strength meter facilitates pin-point tuning.

The receiver has a full complement of audio tone controls and professional lever switches. Dual bass and treble controls allow individual adjustment of each channel. High and low filter switches permit the listener to tailor the music



to his taste. Up to five speakers and various accessories can be connected to the SA-70 to form a complete home entertainment center.

The receiver is housed in a wood cabinet with a sculptured control panel finished in silver with contrasting black trim. Panasonic

Circle No. 10 on Reader Service Card

INSTRUMENT AMPLIFIER

The Model 140A amplifier is designed to be used with various types of electronic musical instruments to provide a clean 300-watt equivalent peak power rating.

It is flat up to 5000 Hz and the acoustic energy output at higher frequencies increases as the frequency approaches 20,000 Hz. Completely solid-state, the Model 140A uses two JBL 15" low and mid-range drivers and two very-high-frequency, high-efficiency drivers. Each of its two separate channels is equipped with bass, treble, presence, brightness, reverb, and volume controls. Tremolo operates on channel 2 alone.

All controls and electronics are in a separate piggy-back unit that is fastened to the top of the speaker cabinet and can be separated if desired. A ten-foot extension cable to connect the control console and speaker and foot switches for both reverb and tremolo are available as accessories. RMI

Circle No. 11 on Reader Service Card

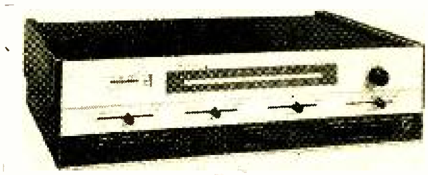
75-WATT STEREO RECEIVER

The Model DB250 AM-FM stereo receiver is rated at 75 watts (IHF) and features IC's for better limiting, improved capture ratio, lower distortion, and greater reliability, according to the manufacturer.

FM selectivity is rated at 60 dB. Solid-state, resonant ceramic filters provide over ten times greater FM selectivity than conventional filters. A mechanical filter in the AM section similarly improves selectivity and eliminates interstation heterodyning.

The receiver has functional linear attenuator slide controls for various levels and push-button control of function, speaker selection, loudness compensation, mode and power. The circuit is of modular construction.

Response of the amplifier section is broad and flat from 20 to 20,000 Hz. The receiver comes

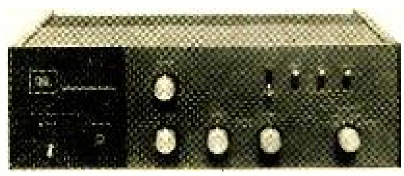


in its own enclosure with solid walnut end pieces and measures 16½" wide x 4½" high x 12½" deep. Bogen

Circle No. 12 on Reader Service Card

INTEGRATED AMPLIFIER

The SA660 integrated stereo amplifier supplies 60 watts of continuous r.m.s. power per



channel with less than 0.2% harmonic distortion at any frequency from 20 to 20,000 Hz, both channels operating, according to the company. IM distortion is less than 0.2% at 120 watts or any lower power level while noise is 85 dB below rated output from high-level inputs and 72 dB from low-level inputs.

Special features of the amplifier include concentric bass and treble controls for optimum response from both channels in any environment, a built-in aural null stereo balancing system, and an exclusive T-circuit for precise control over the associated speaker system all the way down to zero hertz. The unit measures 5 1/16" x 16 13/16" x 13¾". JBL

Circle No. 13 on Reader Service Card

PORTABLE STEREO RECORDER

Sony's new Model 770 is an a.c.-d.c. seven-inch portable stereo recorder which incorporates a number of features that make it suitable for professional recording applications.

It features the company's SNR noise-reduction system which provides noise-free playback of all recorded tapes by automatically reducing the gain of the playback amplifier during quiet passages. It reduces the noise level to almost inaudibility and doubles the dynamic range of the recorded material.

Operating at three speeds, frequency response is 20-22,000 Hz at 7½ in/s. Wow and flutter is 0.09% at 7½ in/s and S/N ratio is 58 dB with the SNR switched off and 64 dB with it switched on.

The recorder is available in two versions: the 770-2 has four heads, two-track erase, record

and playback, plus a four-track playback head. The 770-4 has four heads, four-track erase, record and playback, plus a two-track playback head. Superscope

Circle No. 14 on Reader Service Card

CONSOLE SPEAKER SYSTEM

A new console speaker system which incorporates two 12-inch woofers with plastic foam cone suspension, an 8-inch midrange with a rubber cone suspension, and an aluminum voice-coil tweeter is now on the market as the "Six-B".

The speakers are encased in a picture-frame cabinet with molding designed to blend in with furnishings of any period. A pedestal base "floats" the cabinet. A special grille cloth seems to change pattern in color and texture as the position of the viewer and of the light sources change.

Frequency response is 20-20,000 Hz and the system will handle 60 watts of program material. Impedance is 8 ohms. The enclosure measures 25" high x 29" wide x 15" deep. Electro-Voice

Circle No. 15 on Reader Service Card

DUAL-POWER RECORDER

The Model F-98 is designed for voice or music recording in business, schools, or the home. It features solid-state electronics, a high-power amplifier, and an acoustically matched speaker.

The compact portable (12" x 9" x 4½") contains a built-in dynamic remote-control microphone with a separate microphone input for conference recording. It will record or play up to 1½ hours on a single tape cassette. Record level control is selectable—automatic or manual.

Other special features include vu recording level meter, tone control, cassette ejector, digital tape counter, push-button operation, monitoring while recording, battery or a.c. operation, and servo drive motor with electronic speed control. Concord

Circle No. 16 on Reader Service Card

MARINE SOUND SYSTEM

A new marine "Sound Center" designed to provide maximum clarity and range in voice projection and sound pickup, is now available

in a single unit for various boating applications.

In addition, the unit includes a manual and automatic fog horn, an intercom facility, and a unique alarm feature which can be connected to warn of fires, bilge leaks, or break-ins. Operating on 12-volts d.c., the Sound Center has a compact 10" x 3$\frac{1}{2}$" x 5$\frac{3}{8}$" console. The housing is of vinyl-clad aluminum with an internal speaker mounted in its molded front panel. It also has a carbon microphone with a coiled cord, press-to-talk switch, and mounting clip. Simpson Electronics

Circle No. 17 on Reader Service Card

CASSETTE RECORDER/PLAYER

A new version of the Micro 12 portable cassette recorder/player, featuring a leatherette carrying case with built-in speaker, is now available as the Micro 22.

In addition to the case/speaker, the outfit includes an a.c. adapter, earphone, telephone pick-

up, and remote-control dynamic microphone. It comes with three 60-minute blank cassettes. The recorder may be played through its own speaker or through the larger speaker mounted in the bottom of the carrying case. It operates on five "C" cells or a.c. current. The entire outfit weighs approximately 5 pounds and measures 10" x 3$\frac{1}{16}$" x 12$\frac{3}{8}$". Compartments in the carrying case are used to hold accessories and cassettes. Ampex

Circle No. 18 on Reader Service Card

CB-HAM-COMMUNICATIONS

CB TRANSCEIVERS

A new line of portable CB transceivers which feature all-solid-state circuitry and new slim-design is now being marketed under the Realistic label.

The line starts with a low-cost 100-mW unit and steps up in power and price to a professional six-channel, 5-watt model.

The TRC-1B is a single-channel 100-mW unit with 7 transistors and 1 diode; the TRC-25A is a dual-channel, 9-transistor 100-mW unit with separate speaker and microphone; "Rover-1000" is a 1-watt, single-channel, 11-transistor, 2-diode, 1-thermistor model with automatic noise limiter and battery indicator; "Sportsman" has 2 watts output, a single channel, 10 silicon transistors, 3 diodes, 1 thermistor, automatic noise limiter, and battery indicator.

The top-of-the-line models are the TRC-99A with 3 channels, 13 transistors, 6 diodes, 3 thermistors, and one IC, base-loaded telescopic antenna, automatic range boost, noise limiter, battery and r.f. indicator, separate microphone and speaker, and adjustable squelch controls; the TRC-100 is a 5-watt unit with 6 channels, 14 transistors, 7 diodes, 3 thermistors, and one IC.

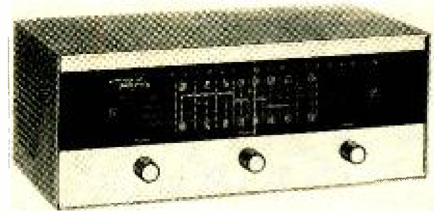
All units come equipped with batteries, telescopic antenna, and crystals for CB channel 11. All 1- to 5-watt units include a carrying case. Radio Shack

Circle No. 19 on Reader Service Card

AVIATION-BAND MONITOR

The tunable "Flight Monitoradio" Model AR-136D covers the frequency range from 108 to 136 MHz. It features a graphic dial that presents frequency assignment areas for navigation facilities, terminal air traffic control, enroute air traffic, and the emergency channel.

Three simple controls, "on/off-volume", squelch, and tuning provide for trouble-free operation from standard 117-volt a.c. lines. The



receiver contains 9 tubes and delivers 0.8-watt audio output at less than 10% distortion. A simple 24-inch wire antenna gives good reception in high signal-strength areas, according to the company.

The all-steel cabinet is vinyl-laminated in wood grain and measures 12" x 6$\frac{1}{4}$" x 6$\frac{1}{2}$". Regency

Circle No. 20 on Reader Service Card

MANUFACTURERS' LITERATURE

SEMICONDUCTOR CATALOGUE

A 28-page catalogue describing the company's line of semiconductor products is now available for distribution. Included are electrical specifications and ratings on regulators, MIL-Spec items, general-purpose diodes, rectifiers, tunnel diodes, temperature-compensated reference devices, SCR's, TD/SCR switching system, tunnel diode trigger, photovoltaic components and devices, and readouts.

Dimensional drawings are included for all case types. Centralab

Circle No. 144 on Reader Service Card

BIOMEDICAL INSTRUMENTS

A 36-page brochure describing biomedical monitoring and recording systems has been published. The two-color, fully illustrated publication describes physiological data instrumentation for clinical and research applications, operating rooms and intensive care units—from the basic transducers and signal conditioners to the final data readout and recording devices. Honeywell Test Instruments

Circle No. 145 on Reader Service Card

INSTRUMENTS CATALOGUE

A new 20-page catalogue covering the firm's entire line of digital instruments is now available for distribution.

The publication gives complete technical details on a line of digital volt- and multimeters, panel-mounting meters, electronic time and frequency measurement instruments, and curve tracers. The booklet also includes pricing information as well as optional capabilities, plug-ins, and available accessories. Fairchild Instrumentation

Circle No. 146 on Reader Service Card

RELAY DATA

A 20-page distributor stock catalogue that provides technical and buying data on more than 50 electromechanical relays and optoelectronic components is available.

Three new products lines are included in the catalogue for the first time. All products are illustrated and dimensioned, and descriptive copy and tabular data provides basic specifications, ordering information, and prices.

The catalogue also includes a relay selection guide which is cross-referenced for desired performance features to specific general-purpose, sensitive, power, and high-performance relays, and a section on engineering considerations in relay selections. Sigma

Circle No. 147 on Reader Service Card

ALL-PURPOSE POWER SUPPLIES

Catalogue #154 is a 40-page publication which describes a complete line of power supplies and related devices. It is designed to provide simplified access to specific models which meet most power-supply requirements.

Included in the catalogue are MIL-Spec d.c. power modules, wide-range d.c. power modules, slot-voltage modules, d.c.-to-a.c. inverters, a.c.-to-a.c. frequency changers, solid-state a.c. regulators, dual-tracking modules, and a variety of laboratory power supplies intended for bench or experimental use. ERA

Circle No. 148 on Reader Service Card

TAUT-BAND PANEL METERS

Catalogue No. 868 describes three new lines of taut-band panel meters. The meters are high-precision, permanent-magnet/moving-coil units offered in a wide range of sizes and types.

Complete specifications and prices are included, together with full information on options, modifications, and specials. Modutec

Circle No. 149 on Reader Service Card

PHOTOCONDUCTIVE CELLS

A new line of photoconductive cells which offers narrow resistance tolerance in an off-the-shelf product, is described in a one-page data sheet.

Resistance tolerance of the "T" series of photocells is guaranteed to be within ±15% of stated values from 1 to 100 footcandles. The data sheet includes dimensions, a table of specifications, and a curve of resistance vs illumination level. Clairex

Circle No. 150 on Reader Service Card

SOLID TANTALUM CAPACITORS

Specifications GR500 and GR500/J covering Kemet Style KG graded high-reliability solid tantalum capacitors are now available.

Specification GR500 is general-product specification covering Kemet's requirements for high reliability, solid-electrolyte, hermetically sealed solid tantalum capacitors with predetermined failure rates. Capacitors covered by this specification are intended for use where failure rate, shelf life, stability, leakage current, and maximum resistance to environmental factors are of major importance.

Specification GR500/J is a complete section providing applications information and data for "KGJ", which are available to 0.0001% per thousand hours failure rate level. Union Carbide

Circle No. 151 on Reader Service Card

INSTRUMENT CATALOGUE

A new line of precision industrial instruments is illustrated and described in a new 12-page catalogue, Bulletin 368A.

The catalogue has prices and specifications on solid-state digital equipment including a v.o.m., a new electronic counter, and a digital system featuring plug-in modules for voltage, current, and resistance measurements as well as automatic ranging.

Also included are strip-chart recorders, a multi-range milliohmmeter, and multicorders. Simpson Electric

Circle No. 152 on Reader Service Card

RESISTOR CATALOGUE

A revised edition of Catalogue A covering standard wirewound and film resistors has been issued in a 56-page format.

Included for the first time in the expanded product lines shown in the catalogue are established-reliability film resistors and bobbin resistors, miniature epoxy molded bobbin resistors, housed film resistors for through-chassis mounting, and a complete line of wirewound, film, and Cermet packaged networks.

The company's standard lines of precision and commercial wirewound resistors are also covered. Dale

Circle No. 153 on Reader Service Card

SOLID-STATE RELAY

Catalogue 750 describes unique features of the SSA line of solid-state relays, such as inherent contact isolation and universal operating voltage range.

Also included in the publication are electrical and mechanical specifications; contact forms, ratings, resistance on closed or open contacts, isolation characteristics, and timing. Mechanical specs include mounting and terminal information plus data on conformance to environmental conditions. Ohmite

Circle No. 154 on Reader Service Card

POWER-LINE FILTERS

Various custom-designed power-line filters, ranging from single-circuit to eight-circuit filter paks and designed for use in airborne, satellite, and commercial applications are covered in a new 8-page brochure just issued.

Attenuation curves, dimensional diagrams, and basic schematics are outlined for 13 filter pak models including all-purpose filter paks for input power lines in console systems, high-attenuation models (greater than 100 dB) from 14 kHz to 1 GHz either a.c. or d.c., special designs for multi-voltage power supplies, and the Model EMI-F0013 featuring six 10-amp filters in a pak less than four cubic inches. Sanders Associates

Circle No. 155 on Reader Service Card

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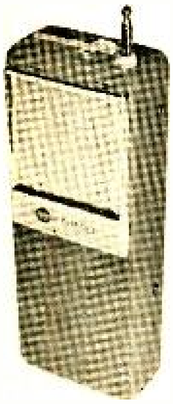

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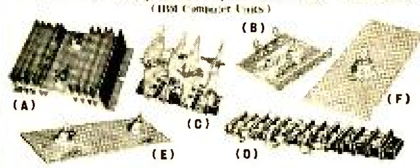

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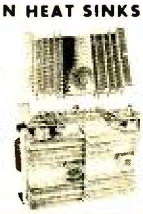

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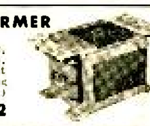

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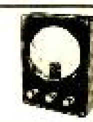

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F. Office use. left-over. unaccounted. spoiled after printing	55.472	57.108
G. Total (Sum of E & F—should equal net press run shown in A)	228,118	226.299

I certify that the statements made by me above are correct and complete.

PHILIP SINE, Treasurer

ELECTRONICS WORLD JANUARY 1969
ADVERTISERS INDEX

Printed in U.S.A.

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