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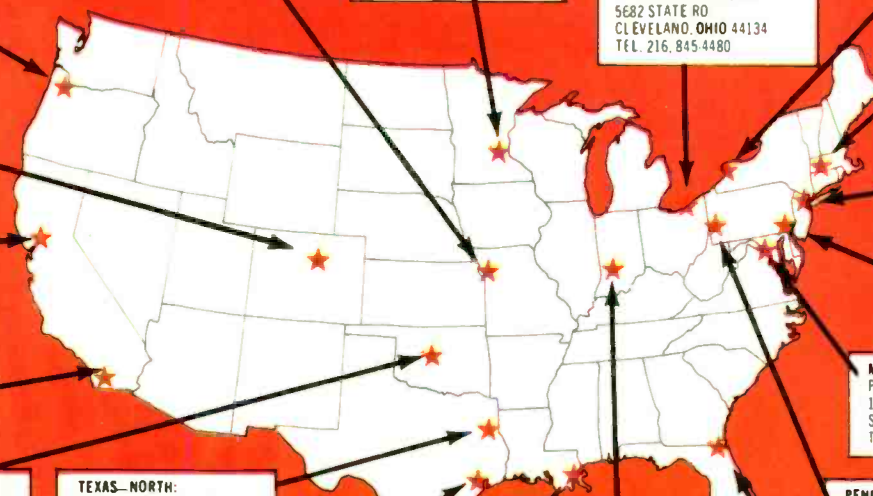

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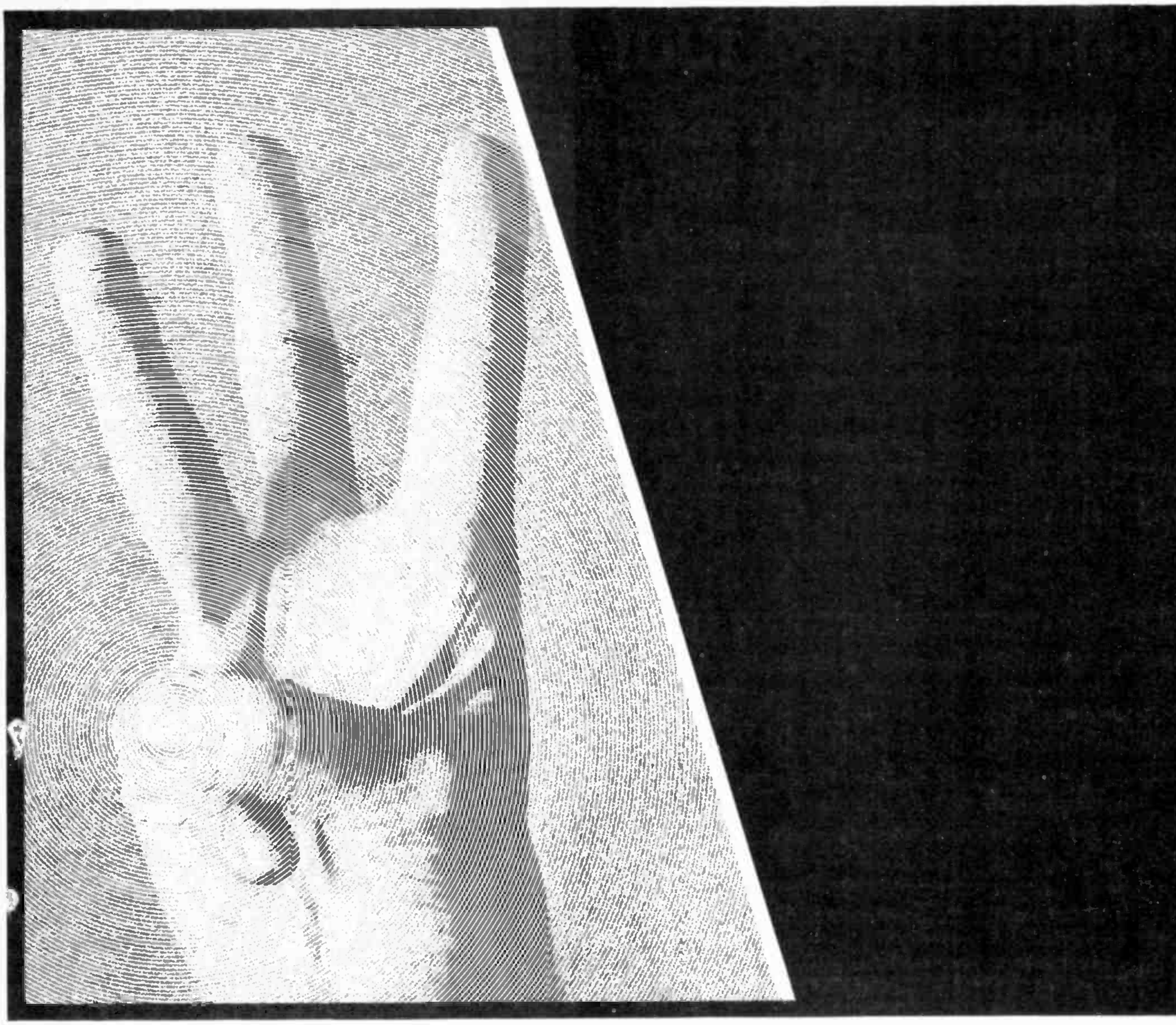

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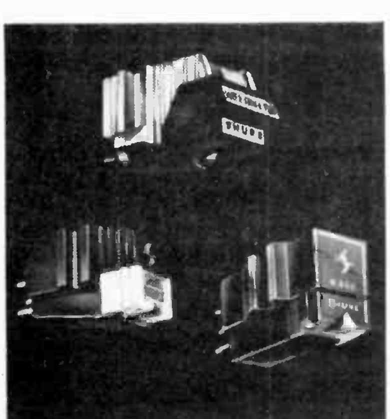

Permit us this momentary bit of self-indulgence, because our intentions are pure: to assist you in choosing the best phono cartridge for your hi-fi system, within the practical limitations of your audio budget. To begin, if you feel uncomfortable with anything less than state-of-the-art playback perfection, we heartily recommend the Shure V-15 Type III, a cartridge of such flawless performance it is the perfect companion to the finest turntables and tone arms available today — and those coming tomorrow. At a more moderate level of performance and price, we suggest the Shure M91ED, a superb performer second in trackability only to the Type III. Finally, for optimum performance under a budget austerity program, the yeoman Shure M44E is for you. All in all, these are three great ways to enjoy music with the kind of system you have decided is best for you.

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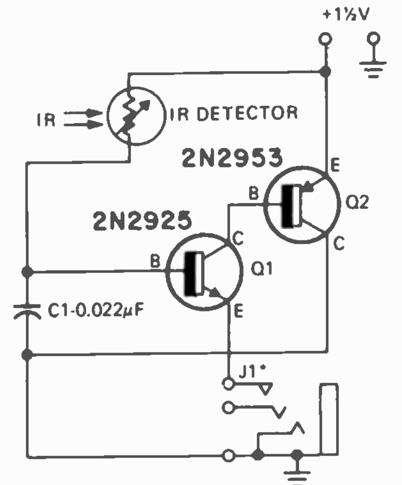
APRIL 1974



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. . . see page 56

Cover photograph by Walter Herstatt
Cover design by Louis E Rubsamen

Radio-Electronics is indexed in *Applied Science & Technology Index and Readers Guide to Periodical Literature.*

Radio-Electronics, April 1974. Vol 45. No 4 Published monthly by Gernsback Publications, Inc 200 Park Avenue South, New York City 10003 Second-class postage paid at New York N Y and additional mailing office One-year subscription rate U S A , U S. possessions and Canada $7 Pan-American countries $8 Other countries, $8 50 Single copies 60c

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looking ahead

Domestic satellite

The United States' first "domestic satellite" communications system is now in operation — but the satellite itself is Canadian. RCA has inaugurated the "Satcom" system, linking the East and West Coasts and Alaska. For its initial phase, RCA has leased two rf channels on Canada's Anik-2 domestic satellite, sending and receiving via its own earth stations in New York, San Francisco, Juneau and Anchorage. Although some network television programs have already been relayed to Alaska via the satellite, it's expected that the initial service will be primarily devoted to public telephone communications, data links and private-line telephone. Some time in 1976, the Satcom system is scheduled to have three of its own satellites and additional earth stations near Atlanta, Chicago, Dallas, Denver, Los Angeles, Seattle and Washington, as well as Valdez, Prudhoe Bay, Nome and Bethel, Alaska.

By leasing channels from Canada's satellite, RCA got the jump on Western Union, which plans to inaugurate domestic service using its own satellites this summer. Both systems, as well as others planned for the future, will offer all types of electronic communications services, including network television relay, as an alternative to current land-line links.

Video outlook dim

That gee-whiz product of the future, the low-cost home videoplayer, now seems likely to remain a product of the future at least through the end of this year, despite numerous false starts in the last few years. The energy crisis, parts and materials shortages, unexpected technical bugs and marketing timidity appear to have pushed the mass-market videoplayer into next year at least. This wonder product has been "imminent" for at least the last five years, and, except for its appeal to those consumers well heeled enough to pay $1,500 or $2,000, the video recorder and player will probably continue to be a commercial-industrial-education market item into 1975.

The only 1972–1973 venture into the consumer market, Cartridge Television Inc.'s home videotape system, bit the dust last year in a bankruptcy proceeding. RCA's MagTape SelectaVision home VTR deck, originally scheduled for introduction in late 1973, has undergone a long series of delays as a result of supply problems, design modifications and other vexations, and is now tentatively scheduled for "test marketing" next December, with no firm decision as to whether it actually will be offered to the mass consumer market at all.

The videoplayer which seemed most likely to succeed in 1974 — the TeD videodisc system developed by Germany's Telefunken and Britain's Decca — now is also back on the drawing board. Although mass marketing in Germany had been announced last fall and deliveries to consumers had been scheduled to start at the first of this year, Telefunken was forced to stop production after mechanical problems were discovered. Telefunken is still talking about getting its system on the market around midyear, but there is strong evidence that it may decide to hold off for the rest of the year until a strong library of prerecorded videodiscs can be built up.

Japan, which usually is in the forefront of consumer electronics developments, has been playing the "home video revolution" real cool. Sanyo Corporation, the TeD hardware licensee for Japan, still maintains its marketing target is "late 1974" — but concedes that slippage (or a complete review of the whole situation) is possible. Other Japanese manufacturers — Japan Victor, Sony, Panasonic — are already offering "home color VTR's" through department stores in their home market. These, however, are actually standard closed-circuit videocassette machines in consumer dress, and they're priced at around $1,400 for a deck attachment, or $2,200 to $2,500 for a console version including a color set — far above any mass-market price. And these recorders can't be expected to come down in price in their present form.

Materials and power shortages have sharply reduced the incentive for manufacturers to offer innovative products on the consumer market. "Look at it this way," said one manufacturer. "We know there's a market for color TV sets and stereo. A home videodisc or videotape system is an unknown quantity. OK, so we've a limited quantity of plastic or semiconductors or something else that could be used in either product. We're going to play it safe and put it in the product we know we can sell."

TV set safety

How safe are television receivers? The question is under investigation again — this time by the government's new Consumer Product Safety Commission. A preliminary report from the Commission's field offices, involving 42 counties, unearthed 916 fires in the 12 months ended Aug. 31, 1973 which appear to have been caused by TV sets. Another report by the Commission, based on consumer complaints, hospital records and newspaper clippings, analyzes accidents involving 51 TV sets, almost all of them color, in which it is stated that 23 people were killed and 51 injured. Most of the incidents were the result of fires, but five involved electric shocks, one an "explosion."

In other data released by CPSC, the National Electronic Injury Surveillance System is quoted as listing 857 injuries related to television in the year ended last August 31. Of these, six involved burns, five electric shocks; the remainder seemed to be the result of falling TV sets, injuries received by consumers trying to lift heavy sets, and so forth.

Philco name sold

One of the oldest brand names in consumer electronics — Philco — is being sold for the second time. Founded in 1892 as a producer of batteries, Philco made its first radio in 1928 and was sold to Ford Motor Co. in 1961. At press time, Ford had agreed to sell U.S. rights to the Philco name, as well as its American sales organization, to White Consolidated Industries of Cleveland. The current Philco-Ford organization plans to continue domestic manufacture and sale of car radios and other automotive products, and will sell color TV sets to White, which will market them. White is scheduled to take over the Philco-Ford plants in Taiwan (Formosa) and in Watsontown, Pa. White manufactures machine tools as well as Kelvinator, Gibson and Hamilton home appliances. Philco's Latin American subsidiaries will continue to be owned and operated by Ford, as will its aerospace and communications operations.

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

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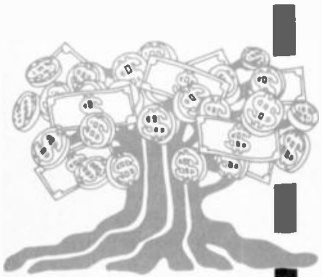

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Recording cuts coming

A threatening shortage in the production of vinyl, the petroleum-based raw material for modern records, is causing postponements and uncertainty in the recording industry. "Nobody says, 'We don't have any vinyl' but some pressers have gone to two or three days production a week" reports the head of one company that depends on outside pressers for its records.

Some reporters are hoping that the threatened shortage may increase the talent/vinyl ratio in records, as companies eliminate marginal recordings in favor of the better artists. However, the situation may well make it hard for the new performer—talented or otherwise —as record companies concentrate on pressings of name artists that are sure of a good market.

Oddly, a major cause of the tight situation—other than international politics—is said to be an exploding demand for plastic plumbing pipe, which —like phono records—is made of polyvinyl chloride. ●

First domestic satellite system launched over U.S. and Alaska

The nation's first domestic satellite communications system was inaugurated January 8, in ceremonies attended by the Governor of Alaska, the Lieutenant Governor of California, the Chairman of the FCC, Senator Jacob Javits of New York, and other public figures from Alaska and elsewhere.

In the first phase of the joint operation by RCA Global Communications and RCA Alaska Communications, channels are being leased on Canada's Anik II satellite, which is in stationary orbit over the Equator at 109° west longitude, and "sees" the whole Western Hemisphere. Later, RCA satellites, the first of which is expected to go into operation in late 1975, will take over.

The present earth stations are near New York City, San Francisco, Anchorage and Juneau. Other stations are planned, especially in Alaska.

The Satcom system is now using the 5925-6245-MHz (5.925 and 6.245 GHz) band for transmission from earth stations to satellite, and the 3700-4200-MHz band from satellite to earth.

THE 1976 satellite and launcher, exhibited in model form by Howard. R. Hawkins, Executive Vice president of RCA. The three satellites will carry 24 transponders each and will be lifted into space by Thor/Delta rockets.

A combination of frequency division multiplexing-frequency modulation (FDM/FM) and FM single-channel-per-carrier techniques are used, with a capability of up to 1000 one-way FDM/FM voice channels and 600 one-way voice channels with the single-channel per-carrier technique.

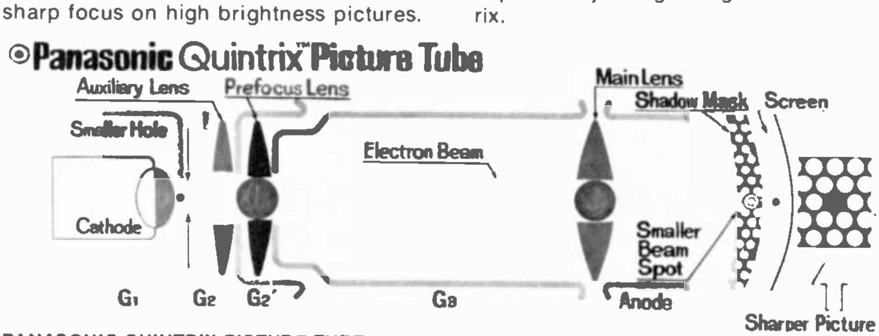
A second phase, is expected to go into operation in 1976. It will use three satellites, each with 24 transponders;each capable of handling 1000 FDM/FM and 600 single voice channels, as well as a television channel and a high-speed data stream. The number of ground stations will also be augmented.

The new system will reduce costs of communications across the United States, as well as between the 48 states and Alaska, and makes live television more practical economically for Alaska. It will also permit upgrading telephone facilities in that state, and will facilitate introducing specialized services, such as transmitting programs for CATV operators. ●

Multi-grid television tube improves picture brightness

The Quintrix picture tube was unveiled by Panasonic in its first 19-inch Quatrecolor television receiver at the recent Chicago Consumer Electronics Show.

The new tube is stated to maintain sharp focus on high brightness pictures. This is due to an additional focusing grid that minimizes blooming. A high-voltage chassis and high electron current increase the brightness. Picture contrast is improved by a negative guard-band matrix.



PANASONIC QUINTRIX PICTURE TUBE uses an additional grid to produce effects.

Mrs. David Sarnoff

Lizette Sarnoff, widow of David Sarnoff, died January 8 in New York City, after a brief illness. She was the wife of David Sarnoff from July 4, 1917, until his death in December 1971. Speaking only French when she met the young David, she is credited with teaching him just enough French to propose.

Mrs. Sarnoff, an accomplished amateur sculptress, was a trustee of the Sculpture Center of New York City, a member of the Women's Executive Committee of the United Hospital Fund, a member of the Manhattan chapter of the Board of the National Women's Committee of Brandeis University, a member of the Executive Committee and honorary national chairman of the Women's Division, Albert Einstein College of Medicine, and honorary vice president of its New York chapter.

Mrs. Sarnoff is survived by her three sons: Robert W. Sarnoff, New York, Chairman and Chief Executive Officer of RCA; Edward Sarnoff, New York, Chairman of the Board, Fleet Services Inc., and Thomas W. Sarnoff, Beverly Hills, California, Staff Executive Vice President, West Coast, the National Broadcasting Company. Also surviving are nine grandchildren. ●

Fourth Annual Hugo Gernsback Scholarship Awards

Radio-Electronics announces the fourth Annual Hugo Gernsback Scholarship Awards for 1974. The program consists of a $125 grant to the most deserving student at each of eight technical home-study schools serving the electronics field.

Eight second awards to the second most deserving student at each of these homestudy schools, have been provided by RCA Electronic Components, Harrison

(continued on page 12)

Essential Electronic Servicing Help from Sams

Here are seven extremely helpful books that can make a serviceman's work much easier. Five of them are just off the press, one is a new second edition, and one came out in '73. It'll pay you to check them out.

VIDEO TAPE RECORDERS
By Harry Kybett
This basic text on the fast-growing field of helical vtr's contains information seldom found in service manuals, which only cover specific models. It explains the fundamentals of video tape recording; describes electronic circuits and mechanical systems in currently available machines; lists basic problems encountered and their solutions; and presents recent developments in the field. 352 pages, softbound.
No. 21024 $8.95

ELECTRONIC FLASH EQUIPMENT
By Verl Mott
A fully informative book on the use of flash/strobe equipment, the problems sometimes encountered, and the service information needed to overcome those problems. Its information on the basic flash unit, flash tubes, triggering circuits, power sources, storage, and service can save you time and frustration. 112 pages, softbound.
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1-2-3-4 SERVICING HI-FI TURNTABLES
By Forest H. Belt
Greatly simplifies understanding of the mechanisms in terms of four divisions: record changers by sections, assemblies within sections, breakdown of assemblies, and mechanical parts. The following chapters cover specifics for each type of drive system, tone arm and turntable. In addition, problem diagnosis—locating, isolating, and pinpointing faults is explained so that servicing can be accomplished quickly and easily. 192 pages, softbound.
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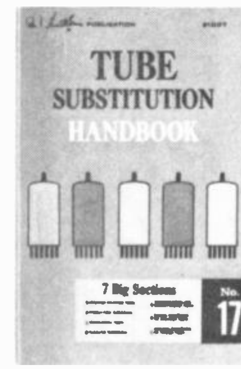

TUBE SUBSTITUTION HANDBOOK, 17th Edition
By the Howard W. Sams Engineering Staff
Quick and accurate information for making suitable substitutions when exact replacements are not available. Lists over 18,000 replacements in seven sections: American receiving and picture tubes, industrial tubes, cross-reference of subminiature tubes, communications and special tubes, cross-reference between American and foreign tubes. 96 pages, softbound.
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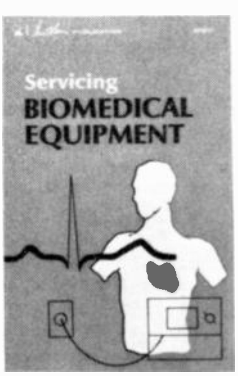

SERVICING BIOMEDICAL EQUIPMENT
By Elliott S. Kanter
Introduces the biomedical technician to the specialized types of electronic and electromechanical devices used in present-day hospitals. Describes test procedures, service and maintenance techniques, and safety factors of centrifuges, electrocardiographs, defibrillators, monitoring devices, oxygen and vacuum devices. 160 pages, softbound.
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COLOR-TV SERVICING GUIDE 2nd Edition
By Robert G. Middleton
This guide uses color photos of symptoms of circuit defects as they appear on the picture-tube screen. If the serviceman follows these picture clues and uses proper troubleshooting methods, he can service sets correctly and in less time. Covers both tube and solid-state circuits. 112 pages, softbound.
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ELECTRONIC SECURITY SYSTEMS
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The principle and operation of the various electronic devices used for industrial and home security systems are covered in detail. Chapters on: scope and application, switches and relays, sensors and encoders, indicators and alarms, electrical and electronic control and alarm circuits, security communication and systems installation, closed-circuit tv, transmission media. 416 pages, hardbound.
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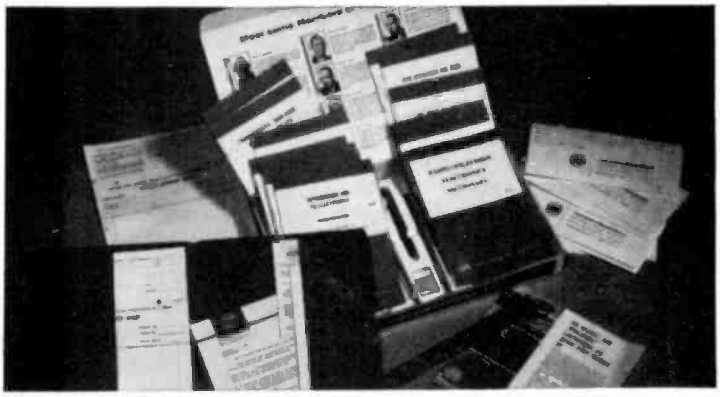

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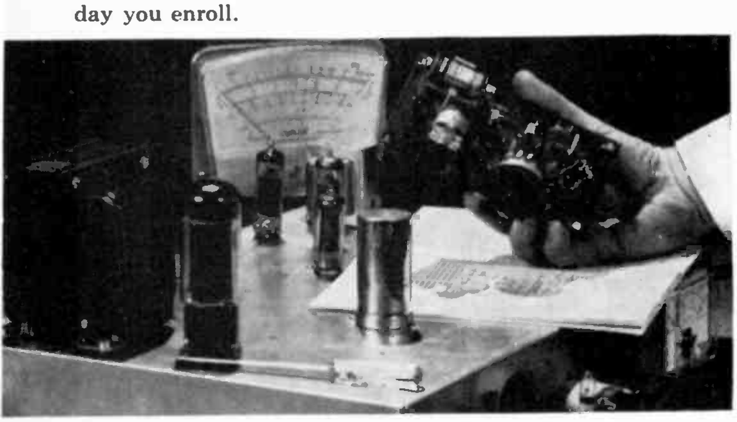

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(Continued from page 6)

N. J. This award consists of an RCA WV-529A Service Special VOM, user price $53.50 each.

The scholarships were established by **Radio-Electronics,** in memory of the late Hugo Gernsback, electronic pioneer, inventor and publisher to perpetuate Mr. Gernsback's interest in developing the technological skills of young people.

Hugo Gernsback founded **Radio-Electronics** magazine in 1929 for electronics service technicians, engineers, and advanced hobbyists. The 1974 scholarship award winners will be announced in the magazine during the course of the year.

The eight schools participating in the program are: Bell & Howell Schools, Cleveland Institute of Electronics, CREI Capitol Radio Engineering Institute, Grantham School of Engineering, International Correspondence Schools, NRI Training, National Technical Schools and Sylvania Technical School. •

GEORG NEUMANN OF MICROPHONE FAME receives the Maker of the Microphone Award for 1973. The award, given each year by Deutsche Grammophon for an outstanding contribution to the world of sound, is presented by Peter Burkowitz (left), engineering director of the firm, in memory of Emile Berliner, inventor of the microphone and disc record, and founder of the company. Neumann is discussing the award with his managing director, G. Luetzkendorf (right). •

CET's now number more than 7K

The International Society of Certified Electronics Technicians (ISCET) reports that over 7,000 certified technicians are now registered. According to Ron Crow, executive director of the program, there are CET's in all 50 States, in Canada and Mexico, and in 15 other countries.

Certified Electronic Technicians are persons with a total of four years experience or schooling in electronics technology and who have passed the written examination administered by ISCET (a subsidiary of NESDA, the National Electronic Service Dealers Association).

The examination consists of a basic section, which all examinees must take, plus several options: Consumer Electronics, Audio-Hi Fi, Communications, Industrial and MATV reception.

The program is already making itself felt, and according to Dick Glass, CET, executive vice president of NESDA, some employers are beginning to pay a higher hourly rate to CET's than to non-certified employees.

CET exams are given quarterly, on June 15, Sept. 15, Dec. 15 and March 15. Most test locations are in public or commercial educational institutions. (Tests in the New York City area may be taken at RADIO-ELECTRONICS.) The exam fee is $10. For further details, or to reserve a seat at the next test session, technicians are invited to write to ISCET, 1715 Expo Lane, Indianapolis, IN 46224. •

MEETING OF CETA AT POUGHKEEPSIEhears Radio-Electronics' Editor Larry Steckler discuss warranties. CETA (Consumer Electronics Technicians Association) has been active in the Poughkeepsie—Kingston area of New York, and had already brought up the matter of warranty abuse in a Newsletter last Fall. Left to right in the photo are Mrs. Ken Parese, CET; Ken Parese, CET, treasurer of CETA; Larry Steckler, CET, at podium; Ron Palluth, CET, president of CETA; Mrs. Palluth, and Dick Jones, vice president of CETA.

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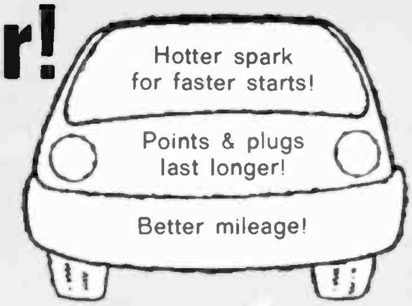

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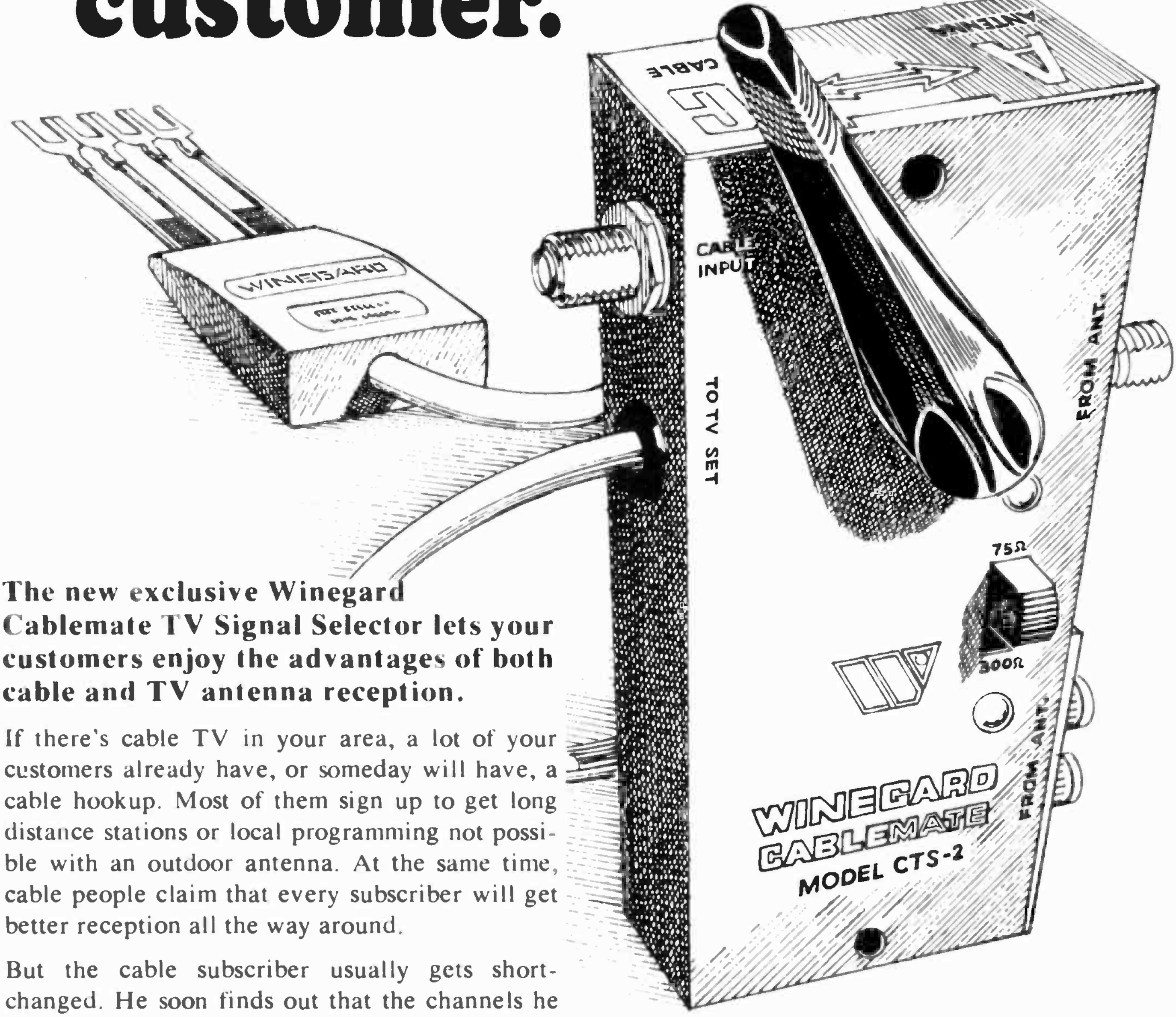

The new exclusive Winegard Cablemate TV Signal Selector lets your customers enjoy the advantages of both cable and TV antenna reception.

If there's cable TV in your area, a lot of your customers already have, or someday will have, a cable hookup. Most of them sign up to get long distance stations or local programming not possible with an outdoor antenna. At the same time, cable people claim that every subscriber will get better reception all the way around.

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Technicians Frequently Get Blame

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Cable outages, too, are a frequent customer complaint.

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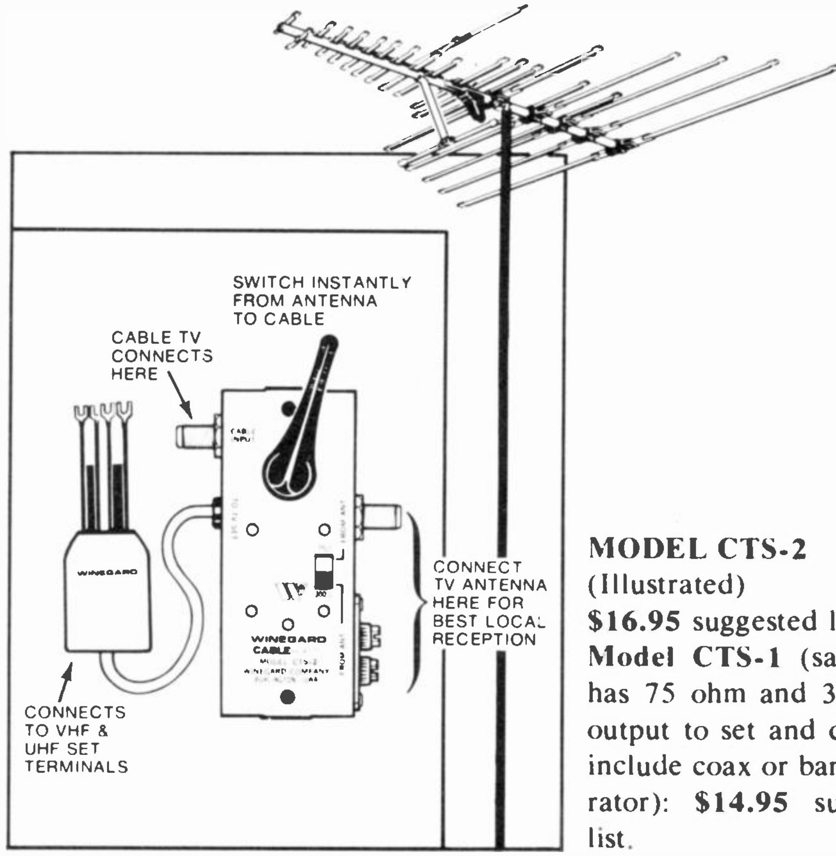
Cablemate lets you connect cable signal **and** the antenna signal to the TV receiver. The viewer simply flips a switch to select antenna or cable.

can turn a new TV antenna



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Cablemate, of course, is not an ordinary switch. It has specially designed circuitry with 58db isolation to prevent interference between cable and antenna signals. And it gives you a choice of coax or twinlead antenna input.

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As you can tell, you stand to gain a lot from one switch! But then remember it comes from Winegard, the folks who consistently originate new and better products for the TV service industry.

For more information, circle the reader's service card or write to: Winegard Company, 3000 Kirkwood Street, Burlington, Iowa 52601

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Circle 77 on reader service card

equipment report

TELEMATIC KC-270 "CRYS-MATE"

Circle 76 on reader service card

A SOURCE OF ACCURATE RF SIGNALS is a very very handy thing indeed to have around an electronics shop. Of course, a quartz crystal is considered as a standard. On many occasions we need a quick and easy source of signals, or, we need to *check* a crystal. The TeleMatic Co. has brought out another of the little handy-dandy test instruments that will do all of these things. This is the model KC-270 Crys-Mate Crystal checker and frequency standard.

It's about the size of a pack of Super-King cigarettes and not nearly as hazardous to your health (according to the label). It's a self-contained transistor oscillator circuit, very likely a Pierce. It will oscillate with any stock crystal. Just plug the crystal in and away you go. It even has a tiny pilot light on the panel; if the crystal is oscillating, this glows quite brightly. No oscillation, no glow, and no go!

The applications for such a unit would fill a book, of course. One very handy test would be for activity of a 3.58-MHz crystal from a color TV set. Just take it out of the circuit, and plug it in. If the INDICATOR light glows brightly, this crystal is able to oscillate. If it isn't oscillating in the circuit, something else is wrong. With another 3.58-MHz crystal, you might use the Crys-Mate as a substitute color-oscillator, to clear up doubts about operation of a given circuit. A pin-jack on the panel provides rf output. You can plug a short piece of wire in here to radiate signals into any circuit. Or: plug a test-lead in here, and feed the signal through a small capacitor into any circuit.

If you run into a need for an odd-ball marker frequency when doing sweep alignment work, plug a crystal on that frequency into the Crys-Mate and couple its output into the sweep generator's EXT MARKER input.

Use a 4.5-MHz crystal, and align TV sound i.f. stages and sound detectors precisely. The crystal will give you a very accurate source of rf for "zero-ing" the detector output. Use a 10.7-MHz crystal, and check i.f. alignment of any FM receiver. The FM detector can be precisely set on zero, and the shape of the S-curve checked; this can be done without a scope if you must. For the best FM stereo reception, the detector must be right on the nose.

The oscillator circuit is powered by one 9-volt battery. Without a crystal plugged in, it draws only 4 Ma. With a crystal, about 50 mA. So, the battery life should be good. An on-off switch is provided to save battery life.

A good crystal gives a surprisingly bright glow of the INDICATOR light. This can be used as an indication of crystal activity, as well as for the rare but possible intermittent crystal. Some of these will operate, but are hard to start. This tester will catch these, as well as cracked crystals, which may oscillate, but will be away off frequency.

For checking frequency of unknown crystals, or known crystals for that matter, feed the rf signal from the Crys-Mate's rf output into the antenna of a communications type radio receiver that will cover the frequency band needed. Now, feed in the rf output of an rf signal generator. Tune the radio dial until you hear the "thump" of the Crys-Mate's unmodulated output. (If you want to hear it more easily, turn on the bfo). Now, tune the rf signal generator until you hear a zero-beat. The signal generator is now on the crystal frequency. If the receiver dial is very well calibrated, it can be used to find the frequency. Either one can be used to check the other.

You will usually be able to pick up a great many harmonics of the crystal's fundamental frequency, as you go higher in frequency on the dial. The lowest frequency signal, at the greatest amplitude, will be the fundamental. I have heard signals as high as the twentieth harmonic, on a sensitive vhf communications receiver.

The crystal socket used will fit the small type crystal cases, like those used on the 3.58-MHz color crystals. If you have one with a different case, just stick a couple of pieces of solid wire in the socket, and bend them until you can make each one touch one pin of the crystal being tested. That's all you need; if it's good, the light will tell you.

The Crys-Mate isn't an expensive instrument, but it can certainly be a very useful one. You'll find lots of things to do with this piece of test gear. **R-E**

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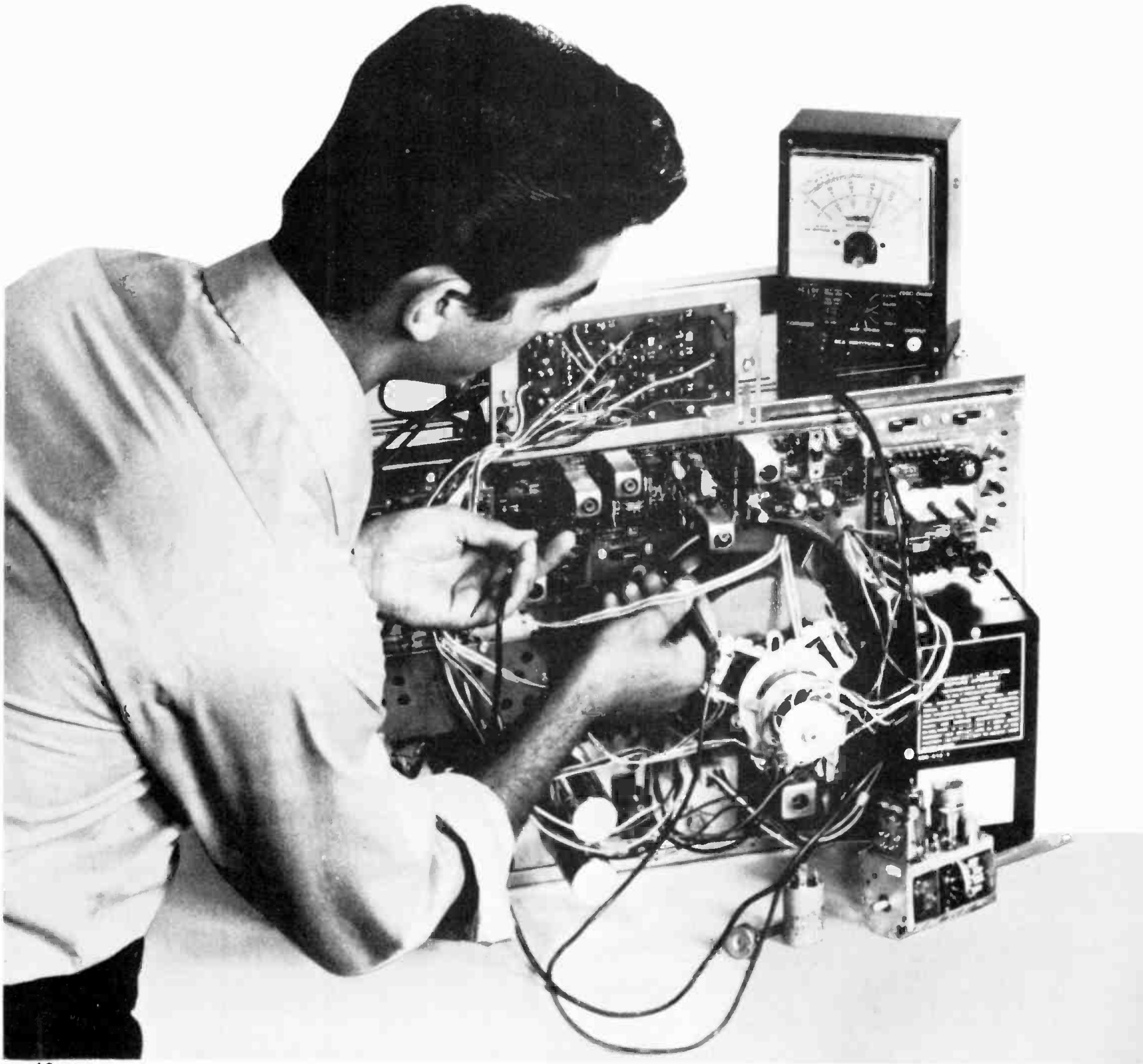

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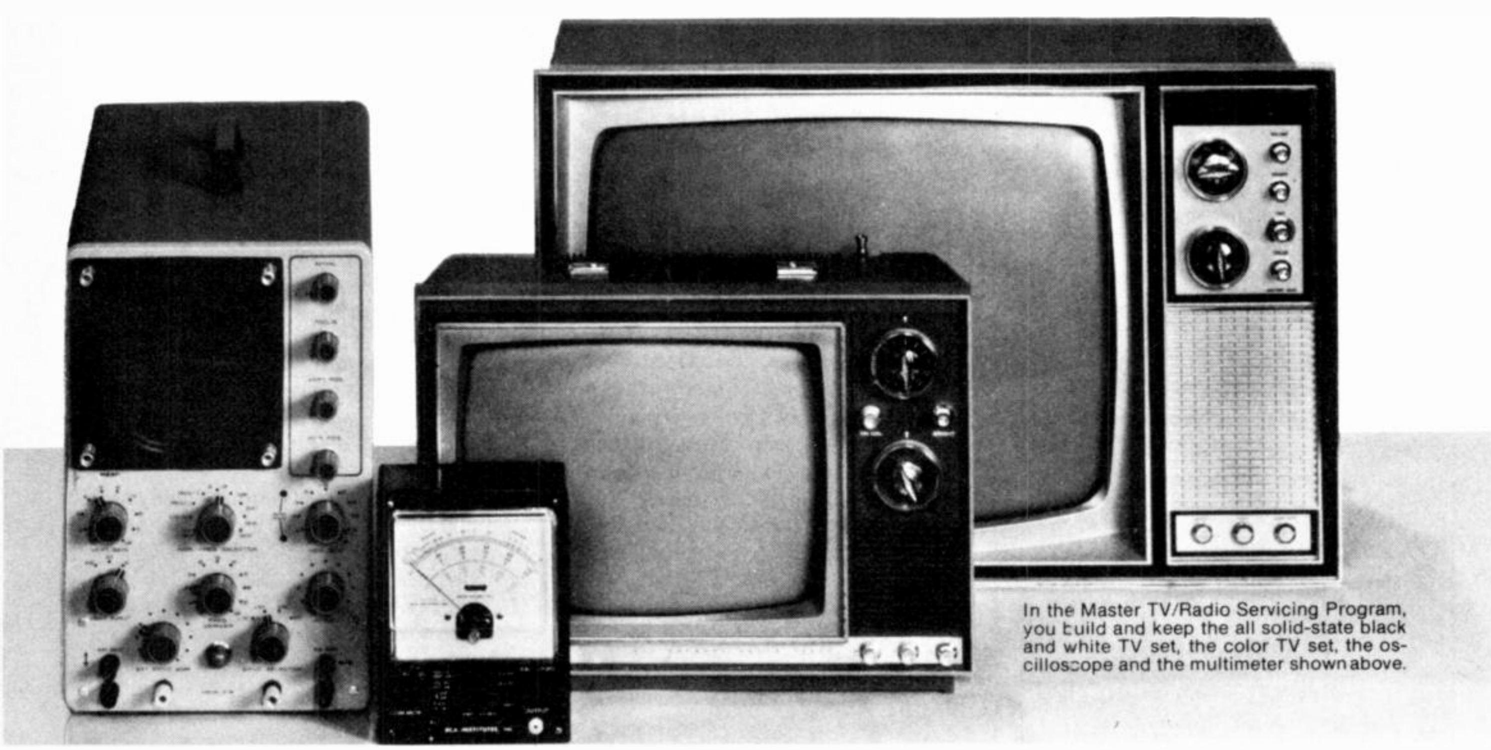

In the Master TV/Radio Servicing Program, you build and keep the all solid-state black and white TV set, the color TV set, the oscilloscope and the multimeter shown above.

appliance clinic

NICAD CHARGING RATES?

by JACK DARR
SERVICE EDITOR

A READER WRITES, I WANT TO CHARGE NiCad batteries, in a 4-cell unit. Can I use resistors to regulate the current flow, with either a transformer operated dc power supply or a line-connected charger? Also, how about the new battery units I've been hearing about, that will charge in 3 or 4 hours. Can I adapt the regular types for this, without damage?"

Let's take this a piece at a time. Yes, you can use resistors to regulate the current flow. Charging at too high a rate can damage the cell, or even cause it to explode. For correct charging use a dc voltage just enough greater than the cell voltage to cause the charging current to flow at the given rate.

This maximum current varies with the battery *type*. There are quite a few different sizes, from the small "button" cells up to the large C and D cells: For an Eveready type B20 cell, at 1.25 volts, which must be charged at a rate not greater than 2.0 mA for 14 hours, up to the high capacity CH2.2T cell (also a 1.25-volt type, but it can be charged at a *rate of 220 mA*.)

Voltages will be given as "volts per cell" or 1.25 volts each. To get higher voltage, the cells are simply stacked in series. Although the charging voltage will vary, the charging *current* must be the same for multiple cells as for one cell, since they are in series. Charging voltage for a single cell will be 1.35 to 1.45 volts. For a 15-volt "battery" (group of cells) the charge voltage would be 16.2 to 17.4 volts, for a 50-mA rate in this one battery.

As for charging circuits, I would personally prefer a transformer-isolated dc power supply circuit, like Fig. 1. A single half-wave rectifier can be used; no filtering is needed. (I don't like line-connected circuits; they scare me.) With a dc supply like this, you could adapt it for different battery voltages by simply hooking a large bleeder resistor as a voltage divider across the dc output. By making this variable or adjustable, the charging voltage and current can be set to any needed value.

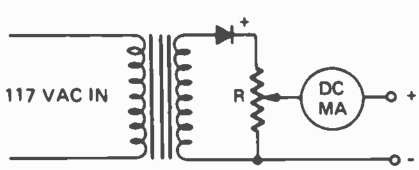

FIGURE 1

The fast-charge types

The fast-charge types are probably the Eveready units called "Fast-Charge Hustler" type cells. They can be completely recharged in about 3 to 4 hours. For uses such as cordless power tools, etc.

Before you try to recharge *ANY* NiCad cell at a high rate, be very sure tha it is one of the fast-charge types!

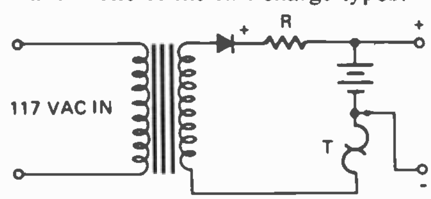

FIGURE 2

A specially designed charger should always be used with these. The Eveready Battery Handbook recommends several circuits for this; the simplest is shown in Fig. 2. Note the thermostat. When this type of cell is being recharged, the *cell-temperature* is the best indicator of reaching a full-charge condition. During recharge, the cell stays at almost a constant temperature of around 75°F. When it approaches a full-charge, the temperature rises very rapidly. When it reaches cutoff temperature, of around 112 to 120°F, it's fully charged. The thermostat opens at 110 to 120°F, and recloses from 95 to 105°F.

This action will automatically start recharging again, just as soon as the cell has cooled down far enough. So, the cell will be kept at full charge at all times, without over-charging. It'll always be ready to go at full charge.

There are several different charging circuits given; they range from the simpler one of Fig. 2 up to an electronic voltage-regulated type. In this, a small thermistor is built right into the battery. This is the temperature-sensor which controls the electronic voltage regulator.

Incidentally, the complete title of the invaluable Handbook used for the preparation of this Appliance Clinic is the "Eveready Battery Applications Engineering Data", and is published by Union Carbide Corp., Consumer Products Divison, 270 Park Ave. New York, N.Y. 10017. It is available at most radio-TV supply houses, for $6.95. R-E

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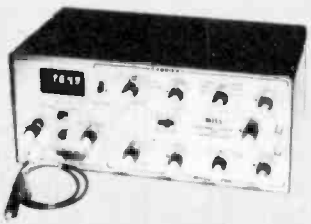
SG 1900—The Audio Sweep Generator provides the capabilities of both a fixed frequency (CW) and a sweep generator in a laboratory quality instrument. Modes include CW, linear sweep, and log sweep with a sweep time of 10 milliseconds to 100 seconds. Waveforms are sine, square, and triangle. The range is from 1 Hz to 100 KHz. The output has fixed attenuation levels of 0, 20, and 40 dB $\pm$1 dB, as well as continuously variable attenuation.

Prices: Kit . . . . $119.95 Assembled $149.95

Two



WG 1700—The Waveform Generator/Frequency Counter is well suited to a wide variety of test work. Six carrier waveforms (sine, triangle, square, ramp, sawtooth, and pulse) and three internal AM or FM modulator waveforms (sine, triangle, and square) are featured. The carrier frequency range is 1 Hz to 1.5 MHz in twelve overlapping ranges; the modulator waveform frequency range is 100 Hz to 150 KHz in six overlapping ranges. Both outputs are buffered for low output impedance. The unit also accepts external AM or FM modulating signals. The frequency counter with adjustable sensitivity measures the waveform generator output frequency and frequency of external signals from 1 Hz to over 10 MHz, with input impedance of 100K ohms.

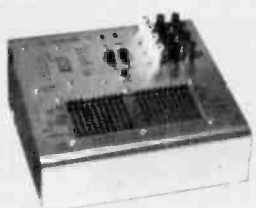
Prices: Kit . . . . $199.95 Assembled $249.95

Three

DV 1600—The 2-1/2 digit Digital Voltmeter is a perfect companion for MITS' other fine test equipment. Features include full scale measurement of alternating and direct current in five ranges from .1 ma to 1 amp, measurement of AC and DC voltage in four ranges to 1000 volts, and measurement of ohms in six ranges to 10 megohms. The resolution in low ranges for voltage is 10 mv; for current, 10μa; and for resistance, 1 ohm. The DC accuracy is $\pm$5% and the AC accuracy is $\pm$1%. Other features include autopolarity and 100% overrange capability on all ranges, which effectively doubles full-scale capability.

Prices: Kit . . . . $ 89.95 Assembled $129.95

Four



ICT 1800—The Integrated Circuit Tester is ideal for testing digital integrated circuits and for breadboarding IC's while developing circuits. The eighteen LED indicators show the status of the IC under test. The internal 5 volt 1 amp power supply, which has overtemperature and overcurrent shutdown capabilities, is also available for external use. The cross bar switch allows complete programming of the IC under test. Other features include an internal two speed clock, single step capability, and four each remote outputs and inputs.

Prices: Kit . . . . $119.95 Assembled $169.95

Plus

ICT 1810—The Operational Amplifier Tester with fast, simple GO/NO GO test capability tests operational amplifiers for gain, stability, input offset voltage, and input bias current in a dynamic operating environment. A single LED indicates IC status.

Prices: Kit . . . . $29.95 Assembled $39.95

Power Sale

PS 500—The 5 Volt Power Supply, which has overtemperature and overcurrent shutdown capability, is an ideal unit to power TTL, DTL, and other IC's. Features include load regulation at 0.6% and line regulation at 0.005%. Output voltage is 5 volts $-$.2 volt.

Prices: Kit . . . . ~~$29.95~~ $19.95 WHILE THEY LAST!

Warranty: Full two-years warranty on assembled units, ninety days on kits.
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RE-4-74

Circle 10 on reader service card

These are made of many, many selenium diodes stacked in series. They use enough of them so that the total voltage rating will be high enough to stand the applied voltage. Voltage ratings of these should be about 7500 volts max.

Tube rectifiers can get weak from old age, like any other tube. This is easy to check; just pop in a new tube. If the focus voltage comes back up, this was it. The solid-state focus rectifiers can also "grow weak." If enough of the little pills short or leak, the output voltage will drop. If they arc over internally, they'll sometimes make the case bulge or blow open in the middle.

In general, a solid-state focus rectifier can be substituted directly for any of the tube types. This is a very handy thing, especially in those irritating cases where the socket of the focus rectifier has arced over and burned up. Instead of replacing the socket, which is usually a rough job, take the plate lead loose. Mount a solid-state focus rectifier on terminal strips, to keep it from arcing to other things, and tie the plate lead to the anode (negative) end. Tie the lead from the focus control to the positive end. Be sure to clean up and tie the heater leads of the original tube, so they can't get into any trouble.

There are lots of readily available solid-state replacements; RCA SK-3066, and others. These have a voltage rating of 7500 volts, and plenty of amperage (sic; 5 mA max!)

Final hint: in a dry circuit, you would think that any series resistance would have little effect. Yet, if the focus pin or its socket contact, on the picture tube, "corrodes," this can cause a very tricky *intermittent* loss of focus! Confirmation; personal experience plus many letters in the Clinic! Clue: focus voltage, read at the focus control, source, etc. does *not* change when the raster de-focuses.

To check for this, pull the picture tube socket off, and examine the focus pin and the socket contact. This will be the one with a pin missing on each side of it. If you can see distinct traces of a light green powdery substance, look out! You may find that the socket contact has been almost eaten away. This is apparently the same as the green "corrosion" we used to see in audio transformers, etc. in old radios. Seems to be caused by the presence of air on a copper conductor carrying a positive voltage. Can't do better than that, but it's close. Some of them can be cleaned up. If it's bad enough, the socket must be replaced. **R-E**

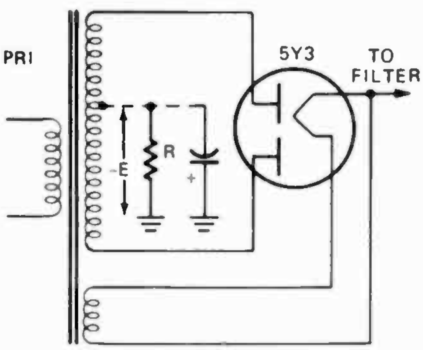
reader questions

HOW TO WASTE DC VOLTAGE

I'm restoring an old radio, a Crosley 66TC. Original power transformer was 300 volts, and I've got one with 350 volts each side of the center tap. How can I get rid of the excess dc voltage?—E.S., Laura, Ohio

"Throw it away". Open the HV

secondary center tap and add a resistor to ground. Adjust the value of this so that it develops whatever voltage drop



you want. This will subtract from the dc "B+" voltage.

This shouldn't cause any hum, but it might. If so, add a filter capacitor as shown. Don't forget to connect the + to ground. A lot of the older sets used this negative voltage for bias on power tubes, etc.

ODD COLOR PROBLEMS

The color keeps popping in and out, and acting very funny, on this GE CB21 chassis. All tubes in the color section have been replaced; no help. Where do I go from here?—H.S., Vincennes, Ind.

After all of the tests you have made (which were right!) I believe I'd go and have a look at that little neon lamp in *series* with the burst amplifier grid. This has caused some intermittent color problems in the past. Try a new one.

THE BOOST THAT DIDN'T!

This Motorola TS-579-A has the most weird group of symptoms I ever saw! Raster only half-width, high voltage low, boost low. However, the 6DQ6 cathode current is 110 Ma.; screen voltage OK, grid drive 150 volts peak to peak. Tubes good.

Suspecting the boost capacitor, I bridged it; no help. There's another one in there; bridged it. No help. Noticed that the schematic said the boost capacitor went to +135 volts. Thought this was a typo, and shunted a capacitor from boost to +270 volts. Whammo! I got the raster, boost and high-voltage back!

Later, I checked the Motorola schematic, and the boost capacitor does go to +135 volts! But, it won't work with it hooked there. What's going on?—J.G. Mena, Ark.

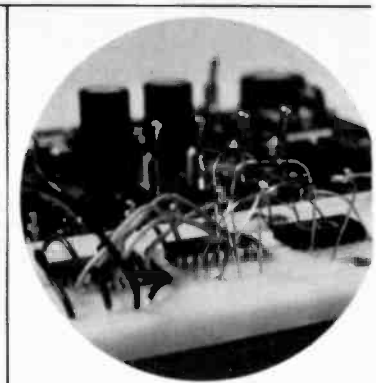
That isn't a typo. The boost capacitor does go to +135 volts on this chassis. I thought the same thing, the first time I ran into it. After some intensive head-scratching, I tried the same thing you did—shunting the boost capacitor to the +270 volts. That other 0.1-μF capacitor you see in there is the

(continued on page 69)

Communications Engineering

Aeronautical & Navigational

Television Engineering



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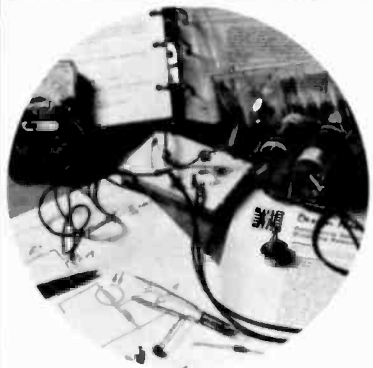

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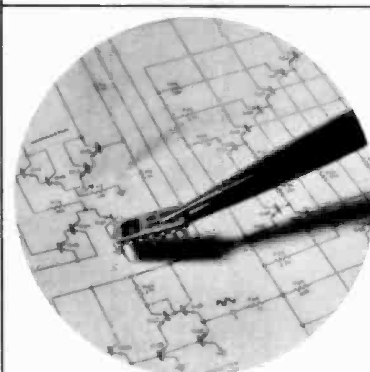
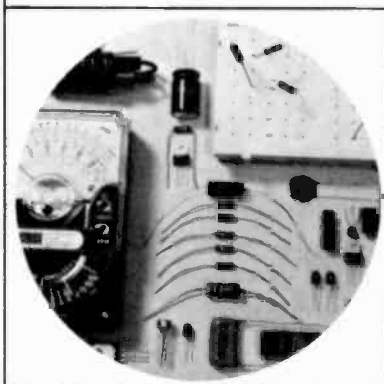
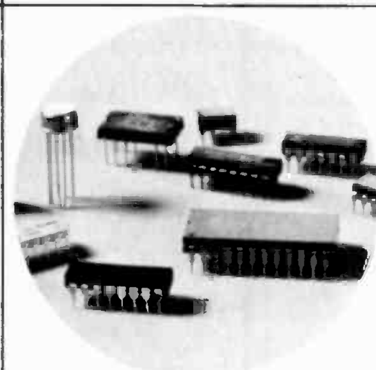


Industrial Electronics



Microwave Engineering



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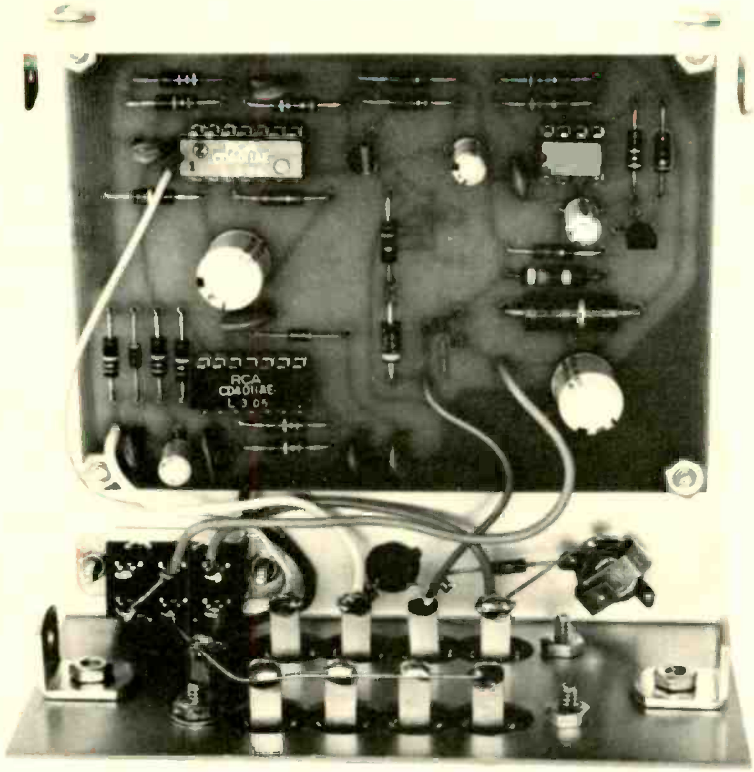


Build an Electronic Security Alarm

Your chances of stopping an intruder are only as good as your alarm system. This one uses open- and closed-circuit sensors.

By MICHAEL S. ROBBINS

DO YOU NEED A GOOD BURGLAR alarm for your home or workshop? Here's an all solid-state design with many of the features found in the best professional units.

A 15-second delay timer and logic array designed around two low-power CMOS IC's make possible some of the unique characteristics of the alarm. To set the alarm, the power is switched on, the door is opened and then closed. If the door is reopened and the alarm is not switched off within fifteen seconds, an earpiercing electronic siren is set off. A standard 12-volt lantern battery powers the alarm making it independent of the ac line. Until the siren is set off, the total current drain of the unit is only 120 µA, assuring long battery life. A small weatherproof speaker is the only other external component required.

How it works

An understanding of the NAND gates operation is helpful in understanding how the alarm works. The truth-table below shows the possible states of the NAND gate. In this application a "1" represents 12-volts while a "0" represents zero volts or ground.

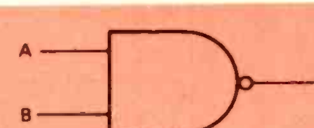


Table I

INPUT A	INPUT B	OUTPUT
0	0	1
0	1	1
1	0	1
1	1	0

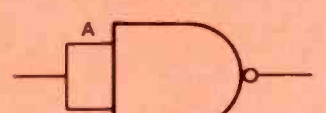
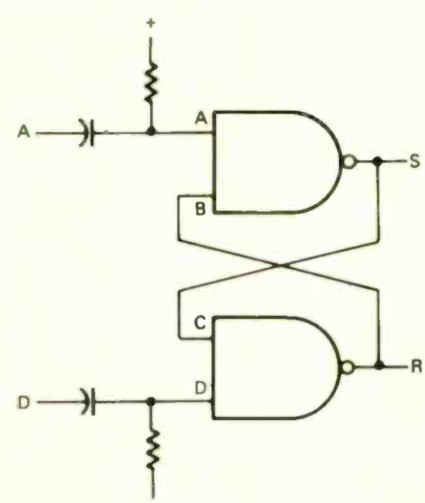


Table II

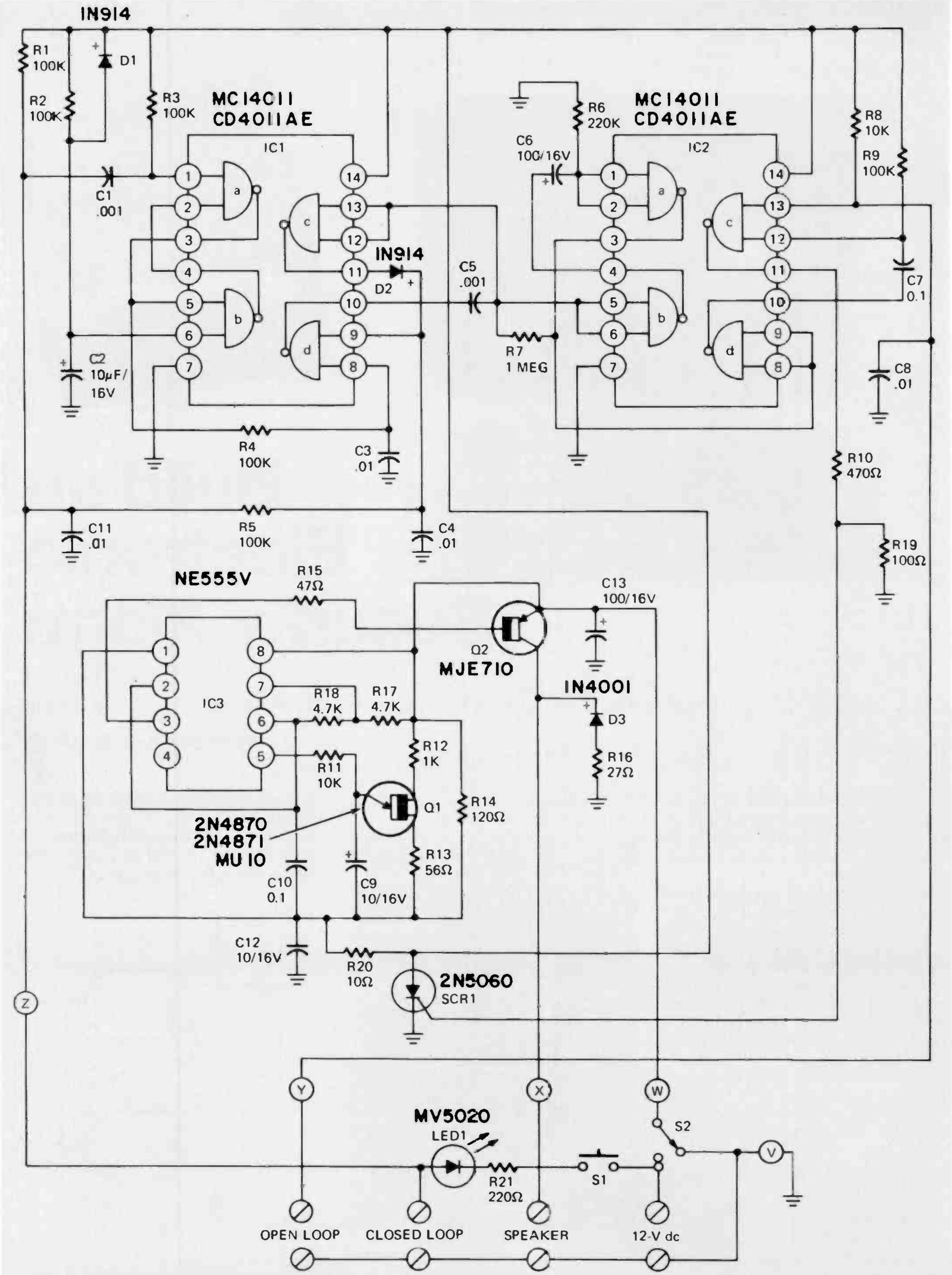
INPUTS A & B	OUTPUT
0	1
1	0

By connecting both inputs together an inverter is produced.

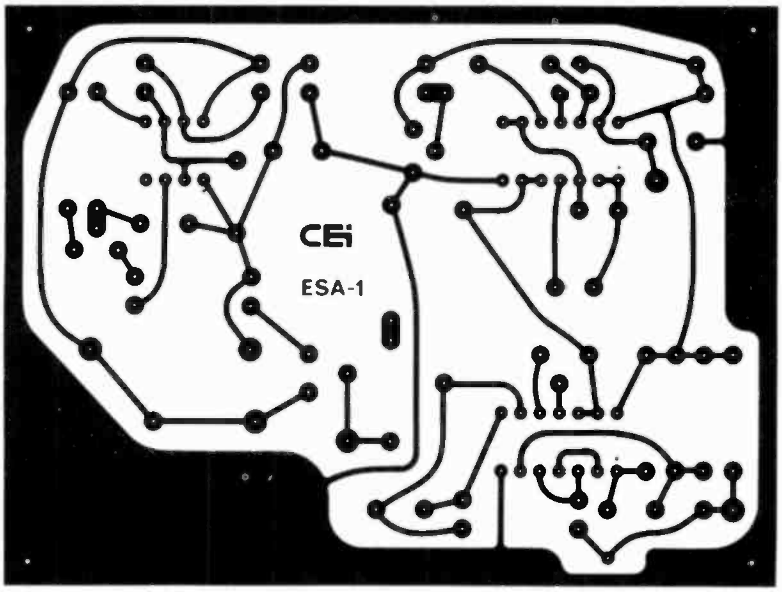
Two gates, two resistors and two capacitors can be connected together to form an ac coupled bistable latch (R-S flip-flop). If we start by assuming that output S is "1" when power is first applied then the NAND gate truth table shows that output R must be "0". If we



apply a negative pulse to input A, nothing happens, but if we apply a negative pulse to input B, output R becomes

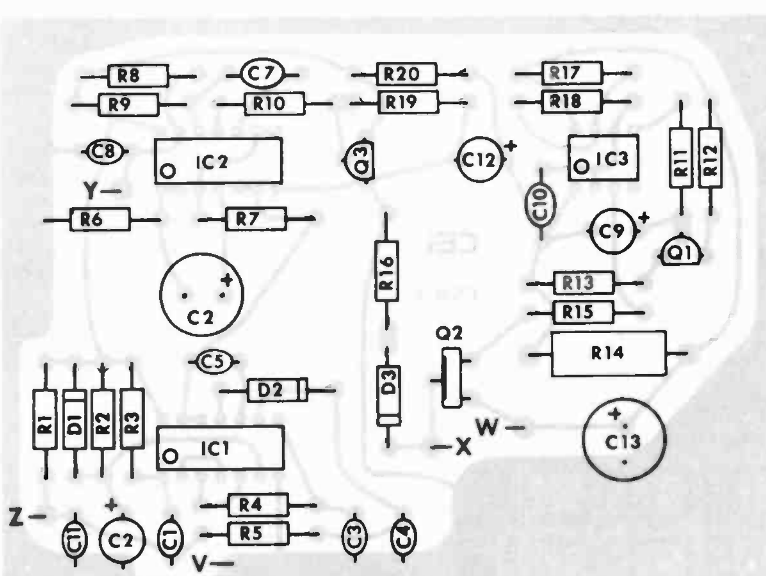


CIRCUIT OF THE SECURITY ALARM SYSTEM. Closing a door as you leave arms the device. A subsequent tripping of any of the normally open or normally closed sensors starts a timer which—after 15 seconds—turns on the multi-vibrator that produces the alarm blast.



PARTS LIST

C1, C5—0.001-pF disc ceramic capacitor
C2, C9, C12—10-µF, 16-V PC-type electrolytic capacitor
C3, C4, C8, C11—0.01-µF disc ceramic capacitor
C6, C13—100-µF, 16-V PC-type electrolytic capacitor
C7, C10—0.1-µF disc ceramic capacitor
D1, D2—1N914 silicon diode
D3—1N4001 silicon rectifier
IC1, IC2—CD4011 AE (RCA) or MC14011 (Motorola) CMOS Quad NAND gate I.C.
IC3—NE555V (Signetics) or MC1455P-1 (Motorola) timer I.C.
LED-1—MV5020 series (Monsanto or equivalent) light-emitting diode with mounting clip
Q1—2N4870, 2N4871, or MU10 (Motorola) unijunction transistor
Q2—MJE 710 pnp power transistor (Motorola)
R1, R2, R3, R4, R5, R9—100,000 ohms, 10%, ¼ or ½-watt
R6—220,000-ohm, 10%, ¼ or ½-watt resistor
R7—1-megohm, 10%, ¼ or ½-watt resistor
R8, R11—10,000-ohm, 10%, ¼ or ½-watt resistor
R10—470-ohm, 10%, ¼ or ½-watt resistor
R12—1000-ohm, 10%, ¼ or ½-watt resistor
R13—56-ohm, 10%, ¼ or ½-watt resistor
R14—120-ohm, 10%, 1-watt resistor
R15—47-ohm, 10%, ½-watt resistor
R16—27-ohm, 10%, ¼ or ½-watt resistor
R17, R18—4700-ohm, 10%, ¼ or ½-watt resistor
R19—100-ohm, 10%, ¼ or ½-watt resistor
R20—10-ohm, 10%, ¼ or ½-watt resistor
R21—220-ohm, 10%, ½-watt resistor
SCR1—2N5060 silicon controlled rectifier (Motorola)
S1—Single-pole, normally open pushbutton switch
S2—Spdt switch
Misc.—Printed circuit board, four-point terminal strips, suitable cabinet, solder wire, etc.
Note—The following are available from Caringella Electronics, Inc., P.O. Box 327, Upland, CA 91786: PC board, drilled and etched, No. ESA-1PC, at $5.95, postpaid in USA; Complete kit including cabinet, wire, etc., No. ESA-1K at $24.95 plus $1.50 handling and shipping. California residents add 6% sales tax on all items.



FULL-SIZE PATTERN OF THE PC BOARD is at the top of this page. The position of the parts on the board is illustrated above. Watch capacitor and diode polarities.

a "1" and output S becomes a zero. By suitably connecting input D we can guarantee that output R will be "1" each time the power is applied. This is the configuration of IC1-a and IC1-b in the alarm. By further modifying the circuit, the outputs can be made to change from "0" to "1" for a predetermined interval upon the application of a negative pulse to the input. This configuration, a monstable flip-flop, is used in the fifteen-second timer composed of IC2-a and IC2-b.

Circuit operation

Two external sensing circuits can be used with the unit. The closed-circuit loop is composed of series-connected, normally closed magnetic reed switches, conductive foil tape on windows, and other normally closed sensors. The first opening of any of these switches (usually the one at the front door) has no effect on the normally-reset latch (R-S flip-flop) composed of IC1-a and IC1-b. However, closing the door causes a negatively going pulse to be applied to the latch causing it to change states and to un-latch the NAND gate IC1-d. The next opening of any switch in the closed loop will cause a positive pulse to be applied to the now unlatched NAND gate. This pulse will then trigger the monostable delay which in 15 seconds generates a pulse to trigger SCR1. The inhibit circuit (IC1-c and the OR gate)prevents subsequent closing or opening of the loop from resetting the delay.

The SCR trigger pulse can also be generated by closing any switch in the open-circuit loop. This parallel connected circuit could consist of one or more panic buttons, pressure switches or photoelectric "eyes". There is no delay in the open-circuit loop.

The siren-like tone is generated by a timer IC connected as a 1,000-Hz free-running square-wave oscillator. The oscillator is frequency modulated downward by a 2-Hz unijunction transistor ramp generator.

Power transistor Q2, a pnp, operates as a switching amplifier capable of switching 1.25A into an 8-ohm speaker. This is an earpiercing square wave output of about 12 watts. Additional sound power is obtained by using resistor R16 in series with flyback diode D3 allowing inertia to carry the speaker cone beyond its rest position.

Construction suggestions

Although the alarm could be built on perforated board, the printed circuit board shown here makes for a more professional-looking, error-free construction job. Be careful when handling the CMOS IC's as they can be damaged by static electricity. Use sockets or Molex pins for the IC's. Do all soldering with a small pencil iron and a good grade of rosin-core solder. Diode, LED, and electrolytic capacitor polarity and pin markings on the transistors, IC's and the SCR must be carefully observed. The LED is mounted in the plastic clip packed with it. Two 4-point terminal strips are used for external connections. The "hot" connections are all tied to one strip while the second serves as the ground return.

(continued on page 88)

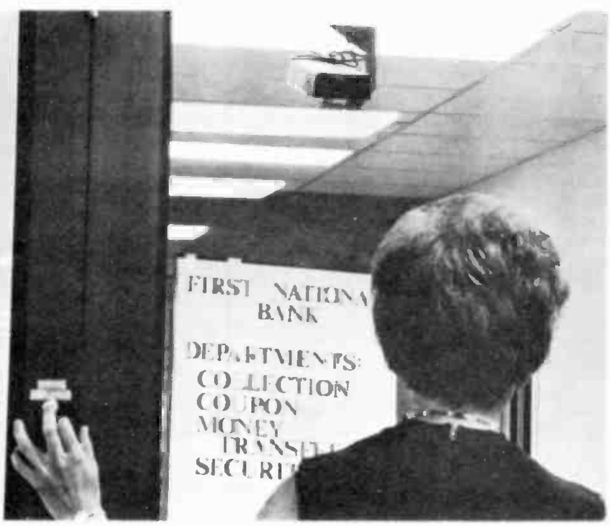
CCTV On

Internal security is one of the major
and business firms. Closed-circuit TV
with fewer personnel. This

POLICE CHIEF and dispatcher monitor one of three CCTV cameras mounted in crime-prone areas in Hoboken, N. J.

TWO OF THE LITTLE-KNOWN APPLICATIONS of CCTV (Closed-Circuit TV) today are in security surveillance and police work. You are probably not familiar with either of these uses, although you are likely to have seen CCTC cameras in department stores and highway tunnels. In this article we will look at two examples of CCTV at work.

The first is an operating security system custom tailored to fit the needs of the First National Bank of Maryland's Baltimore branch. The system, installed by the Motorola Communications Division is said to save the bank a significant amount of money over conventional security approaches.



BANK EMPLOYEE pushes button at door for admittance. CCTV camera and intercom provide visual and voice identification to guard who monitors activities in building and controls the door.

BANK'S SECURITY GUARD monitors some of the 30 CCTV cameras in First Maryland Bank building. This frees other guards for more vital roles in bank's security system.

James Barrett, security officer for the bank, explains the cost savings. "Without our new electronic surveillance system, we would need as many as ten guards per shift. With this system we find that three guards in the lower level and two in the upper levels are sufficient."

As we can readily see, that represents a saving of 50% in the work force and adds up to a considerable number of dollars—year after year.

Inside the system

The security system centers around a series of closed-circuit TV cameras located in strategic positions on various floors and focused on sensitive entrance/exit areas leading to various bank departments. The system also includes special sophisticated security alarms, an intercom system, electronic door controls and vehicle detection sensors.

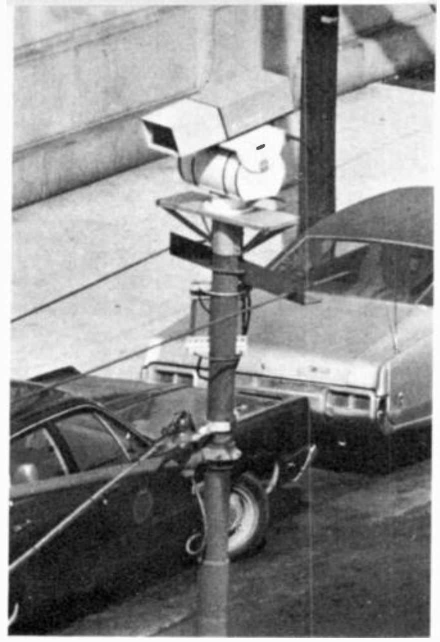
At the heart of the entire system is the master control console, located in the basement. On this console are displayed all of the building's door-lock

SECURITY OFFICER AND GUARD COMMANDER at CCTV master console. ID cards below screens are to check persons entering various bank areas.

The Job

problems faced by many banking provides efficient surveillance is the story of three installations.

by ROBERT S. HAIMES



ATOP UTILITY POLE, the CCTV camera keeps watch on street activities. Camera is monitored by police.

controls, intercoms, CCTV monitors and other related equipment. The area in which the master control console is located, is the most totally secure area in the entire building. The console itself, is misleading; for while it looks formidable, and ultra-complex, it is basically quite simple.

At his console desk, the security officer monitors the arrival of armored cars on CCTV cameras as well as persons entering any department of the bank. He views all of the many parking levels in the building, and the 10th floor restaurant—without interfering with normal procedures in the 22-story building. Each of the systems is designed to aid and assist the guards.

Let's start with the two weatherproof CCTV cameras that are mounted on the rear alley side of the building's rollaway basement door. They guarantee that only authorized vehicles such as armored cars and special bank messenger cars can enter the basement parking area. The guard at the console—at a touch—can pan, tilt, or zoom the CCTV camera so he can check not only the license of each vehicle, but the driver as well.

Once cleared for entry, the guard at the master control raises the door, and then promptly closes it as soon as the vehicle is inside. To continue control inside the basement, two more indoor cameras are positioned to monitor traffic.

Protect the computer

To safeguard the computer center at the bank, two CCTV cameras are mounted immediately inside of each access door, giving the guard at the master control console total surveillance of the area. This coverage is teamed with bullet-resistant Plexiglas doors at each of the elevator lobby areas, premise alarms (to detect forced entry) to control access and guards positioned immediately inside each elevator door lobby.

On the four floors occupied solely by bank personnel, the security system is again wrapped around CCTV cameras that are located inside each elevator lobby door and premise alarms on the glass doors at both ends of each elevator lobby. An intercom is also used for questioning by the guard in the master control room, if necessary.

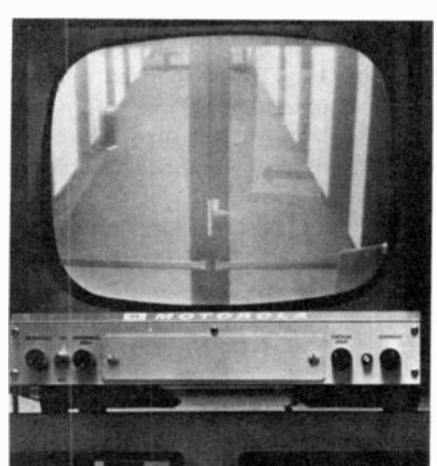
The bank's executive offices also contain a CCTV camera, a premise alarm and a secretary-receptionist with a radio-voice link to the main guard room for emergencies.

Finally, the security system also keeps a check on the upper three floors of parking, all of which are reserved for bank-owned vehicles and cars of bank employees. In addition to regular guards, the parking area is constantly monitored via CCTV camera with voice contact to the master control console. Traffic control gates prevent the general public from using the bank parking areas, and CCTV cameras ensure that the system is foolproof.

CCTV and the police

Another relatively new area for CCTV is in police work. Let's look at

SECURITY PERSONNEL at monitor watch arrival of armored truck at basement entrance of First Maryland Building. The monitor they are watching is one of nearly thirty mounted in the master control console in the bank's basement area.



THE 14-INCH MONITORS allow pictures on any of the 9-inch screens in the console to be blown-up for closer observation.

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Harry Remmert decided he needed more electronics training to get ahead. He carefully "shopped around" for the best training he could find. His detailed report on why he chose CIE and how it worked out makes a better "ad" than anything we could tell you. Here's his story, as he wrote it to us in his own words.

Harry Remmert gives his CIE Electronics course much of the credit for starting him on a rewarding career. He tells his own story on these pages.

By Harry Remmert

"AFTER SEVEN YEARS in my present position, I was made painfully aware of the fact that I had gotten just about all the on-the-job training available. When I asked my supervisor for an increase in pay, he said, "In what way are you a more valuable employee now than when you received your last raise?" Fortunately, I did receive the raise that time, but I realized that my pay was approaching the maximum for a person with my limited training.

"Education was the obvious answer, but I had enrolled in three different night school courses over the years and had not completed any of them. I'd be tired, or want to do something else on class night, and would miss so many classes that I'd fall behind, lose interest, and drop out.

The Advantages of Home Study

"Therefore, it was easy to decide that home study was the answer for someone like me, who doesn't want to be tied down. With home study there is no schedule. I am the boss and I set the pace. There is no cramming for exams because I decide when I am ready, and only then do I take the exam. I never miss a point in the lecture because it is right there in print for as many re-readings as I find neccessary. If I feel tired, stay late at work, or just feel lazy, I can skip school for a night or two and never fall behind. The total absence of all pressure helps me to learn more than I'd be able to grasp if I were just cramming it in to meet an exam deadline schedule. For me, these points give home study courses an overwhelming advantage over scheduled classroom instruction.

"Having decided on home study, why did I choose CIE? I had catalogs from six different schools offering home study courses. The CIE catalog arrived in less than one week (four days before I received any of the other catalogs). This indicated (correctly) that from CIE I could expect fast service on grades, questions, etc. I eliminated those schools which were slow in sending catalogs.

FCC License Warranty Important

"The First Class FCC Warranty* was also an attractive point. I had seen "Q" and "A" manuals for the FCC exams, and the material had always seemed just a little beyond my grasp. Score another point for CIE.

*CIE backs its courses with this famous Money-Back Warranty: when you complete a CIE license preparation course, you'll be able to pass your FCC exam or be entitled to a full refund of all tuition paid. Warranty is valid during completion time allowed for your course.

"Another thing is that CIE offered a complete package: FCC License and technical school diploma. Completion time was reasonably short, and I could attain something definite without dragging it out over an interminable number of years. Here I eliminated those schools which gave college credits instead of graduation diplomas. I work in the R and D department of a large company and it's been my observation that technical school graduates generally hold better positions than men with a few college credits. A college degree is one thing, but I'm 32 years old, and 10 or 15 years of part-time college just isn't for me. No, I wanted to *graduate* in a year or two, not just *start*.

"When a school offers both resident and correspondence training, it's my feeling that the correspondence men are sort of on the outside of things. I wanted to be a full-fledged student instead of just a tag-a-long, so CIE's exclusive home-study program naturally attracted me.

"Then, too, it's the men who know their theory who are moving ahead where I work. They can read schematics and understand circuit operation. I want to be a good theory man.

"From the foregoing, you can see I did not select CIE in any haphazard fashion. I knew what I was looking for, and only CIE had all the things I wanted.

Two Pay Raises in Less Than a Year

"Only eleven months after I enrolled with CIE, I passed the FCC exams for First Class Radiotelephone License with Radar Endorsement. I had a pay increase even before I got my license and *another* only ten months later.

"These are the tangible results. But just as important are the things I've learned. I am smarter now than I had ever thought I would be. It feels good to know that I know what I know now. Schematics that used to confuse me completely are now easy for me to read and interpret. Yes, it is nice to be smarter, and that's probably the most satisfying result of my CIE experience.

Praise for Student Service

"In closing, I'd like to get in a compliment for my Correspondent Counselor who has faithfully seen to it that my supervisor knows I'm studying. I think the monthly reports to my supervisor and generally flattering commentary have been in large part responsible for my pay increases. My Counselor has given me much more student service than "the contract calls for," and I certainly owe him a sincere debt of gratitude.

"And finally, there is Mr. Tom Duffy, my instructor. I don't believe I've ever had the individual attention in any classroom that I've received from Mr. Duffy. He is clear, authoritative, and spared no time or effort to answer my every question. In Mr. Duffy, I've received everything I could have expected from a full-time private tutor.

"I'm very, very satisfied with the whole CIE experience. Every penny I spent for my course was returned many times over, both in increased wages and in personal satisfaction."

Perhaps you too, like Harry Remmert, have realized that to get ahead in Electronics today, you need to know much more than the "screwdriver mechanics." They're limited to "thinking with their hands" . . . learning by taking things apart and putting them back together . . . soldering connections, testing circuits, and replacing components. Understandably, their pay is limited—and their future, too.

But for men like Harry Remmert, who have gotten the training they need in the fundamentals of Electronics, there are no such limitations. He was recently promoted, with a good increase in income, to the salaried position of Senior Engineering Assistant working in the design of systems to silence submarines. For trained technicians, the future is bright. Thousands of men will be needed in virtually every field of Electronics from two-way mobile radio to computer testing and troubleshooting.

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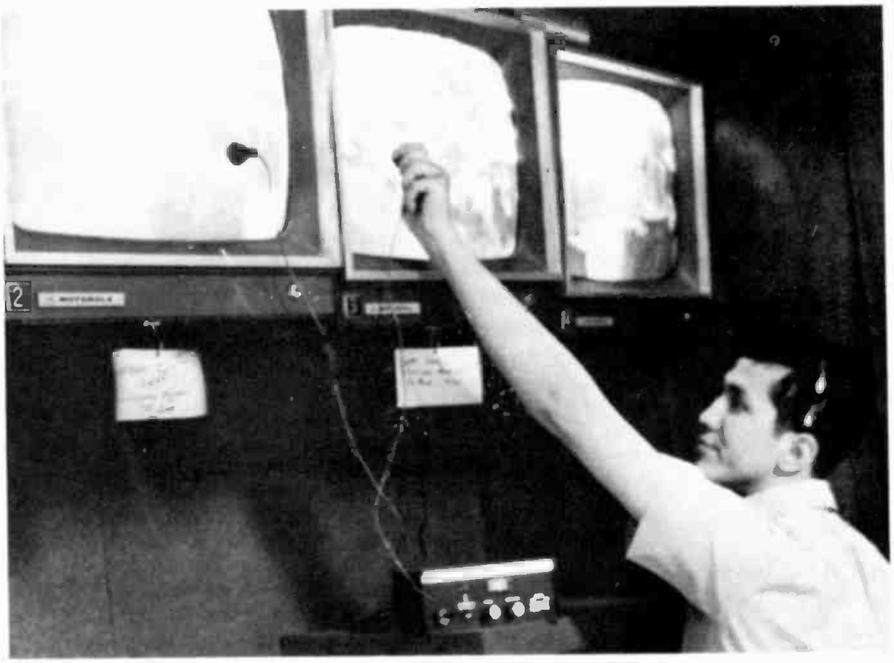
Circle 17 on reader service card

the way a Motorola CCTV system has already made an impressive start on reducing successful burglaries in Hoboken, N.J. Hoboken Police Chief George W. Crimmins says that the system has already "proven itself", and Hoboken Mayor Louis DePascale says that city government wants "all of Hoboken" under the protection of the CCTV cameras.

Prior to the new system, Hoboken tried high-intensity lights with increased patrolling. This was not effective enough.

On paper and in practice, the CCTV system seems simple. Three television cameras are mounted at varying vantage points along streets making up one of Hoboken's most crime-prone neighborhoods. Cables from the three cameras reach back to police headquarters where officers monitor the 19-inch screens for signs of lawlessness first, traffic offenses second.



SENSORS PLACED ON MONITOR SCREENS detect changes in light intensity, indicating presence of some person in the area being watched. This system is particularly useful after sales hours. At Macy's, cameras scan stockrooms, corridors and sales areas for prowlers who stay in store after closing and steal by night. Now, any movement in normally quiet area will be detected and a patrol or guard/dog team will be alerted.

CONTROL CENTER AT MACY'S Herald Square store. Dispatchers sit before radio console and CCTV monitors. Here, they can reach or observe personnel throughout the 21 floors of the store. Center is focal point of the radio system and controls a combination of approximately 50 small 2-way radios and pocket pagers used by security personnel throughout the store. Two smaller monitors for close-ups (inset) are in the console.

Two of the cameras, Motorola S1140B high-performance models—are set in fixed positions where they continuously view the neighborhood street scene. The automatic light compensation for these cameras has a 10,000 to 1 light compensation and 0.5 foot-candles sensitivity.

The third camera, is a Motorola S1170A low-light-level camera. It delivers clear, sharp pictures in bright sunlight or darkness and does this job automatically. Its light compensation range is 200,000 to 1 without adjustment and sensitivity is .005 foot candles. In addition the camera has a motorized 10 to 1 zoom lens, pan and tilt controls and can view 360°.

The Hoboken Police Department communications control center —where the three 19-inch monitors are located—is atop the City Hall, located in the heart of the business district. Dispatchers in the center communicate with patrol cars and beat officers and now view the conduct of citizens on the downtown streets.

If something catches the dispatcher's eye, he can use the low-light-level camera to zoom in on a specific area. If it is something that arouses his attention further, he can use the half-inch video tape recorder to make a permanent record of his observations.

The dispatcher can also pan the street, tilt the camera for different angles and record all this if he wants to do so. The camera can also revolve 360°, so it can follow the subject under observation. This camera works effectively without external light, amplifying available light to keep monitor images clear and sharp. It can also see through fog, haze, smoke, rain and snow. The housings for all three cameras are bulletproof and impervious to efforts to blind them with flashing lights.

In the Hoboken Police Department, the electronic "rookie" is already well received. Officers who know they have the support of an irrefutable witness —the CCTV tape recorder—when they take a case to court, are able to move with more assurance in their rounds. Some criminal actions have already been witnessed as they occurred and in one recent burglary the criminal fled into the range of the CCTV system, neatly depositing himself in the city's jail.

The idea in Hoboken is not to catch more criminals, but rather to discourage criminal activity by convincing potential lawbreakers that they may be seen on the police department's version of "Candid Camera." **R-E**

ALL ABOUT TRANSFORMERS

Transformers are the "heart" of modern-day electricity and electronics. Without them, long-distance power transmission and radio and electronic devices would be impractical. Here's how they work.

by FARL JACOB WATERS

TRANSFORMERS ARE FOUND IN MANY KINDS of electronic or electrical apparatus. All transformers, whether the power type on the utility pole or the "shirt-pocket" radio i.f. type, depend upon *electromagnetic induction*. The reaction to a varying magnetic field, is the development of a voltage or current.

As lines of magnetic force encircle and are "cut" by a conductor, a force (voltage) is developed which causes electrons to move as a current. Inversely, a current through a conductor develops a magnetic field as shown by Fig. 1-a. An alternating current produces a magnetic field that also changes magnitude and direction. As this alternating magnetic field increases and decreases, its lines 'cut' that conductor as well as any other conductor that may be close (Fig. 1-b). Thus, if a conductor carrying alternating current is near a second conductor, a current will be induced into that second conductor.

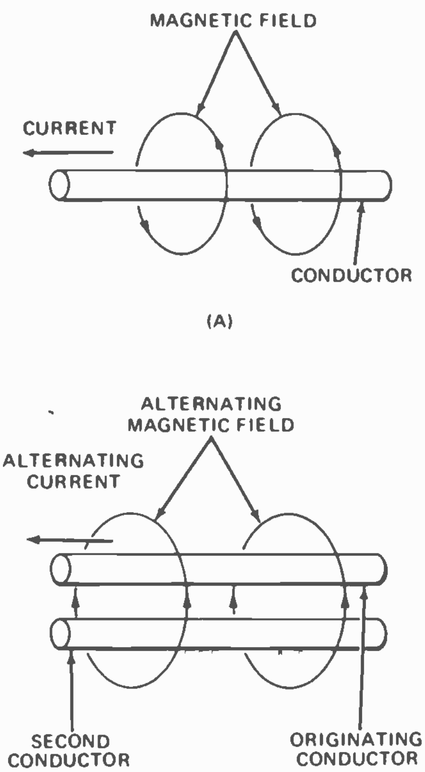


FIG. 1—CURRENT IN CONDUCTOR produces a magnetic field (a). Field from ac generates alternating current in adjacent conductor.

Transformers have conductors coiled as shown by Fig. 2. Alternating current through coiled conductor P (the primary) produces a concentrated magnetic field. That magnetic field also surrounds and "cuts" the turns of conductor S (the secondary) to induce a current into that winding. The density of the magnetic field is dependent upon the primary current I_p and upon the number of turns within that winding N_p.

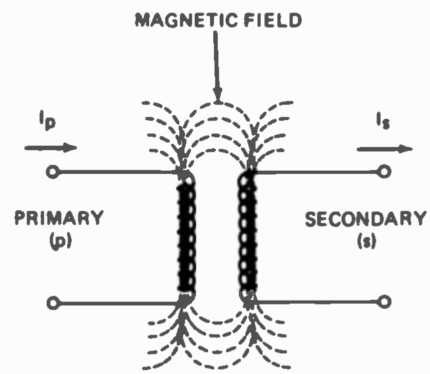


FIG. 2—TRANSFORMER CONDUCTORS are coiled to concentrate field for better magnetic linkage.

$$\text{Magnetic density, } \Theta = N_p I_p$$

This same magnetic density develops the current I_s within secondary winding of N_s turns.

$$\text{Magnetic density, } \Theta = N_s I_s$$
$$\text{then } I_p N_p = N_s I_s$$
$$\text{and } I_p/I_s = N_s/N_p$$

It can also be shown that the primary and secondary voltages, Ep and Es, are related to the number of turns, Np and Ns.

$$E_p/E_s = N_p/N_s$$
$$E_p I_p = E_s I_s$$
$$\text{Primary impedance, } Z_p = E_p/I_p$$
$$\text{Secondary impedance, } Z_s = E_s/I_s$$
$$\text{and } Z_p/Z_s = (N_p/N_s)^2$$

In common language the above equations become:

1. A transformer's voltage ratio, E_p/E_s, is directly related to its turns' ratio, N_p/N_s.
2. A transformer's current ratio, I_p/I_s, is inversely related to its turns' ratio, N_p/N_s.
3. A transformer's impedance ratio, Z_p/Z_s, is directly related to the square of its turns' ratio $(N_p/N_s)^2$
4. A transformer's primary volt-ampere product, E_pI_p, is equal to its secondary volt-ampere product, E_s/I_s.

Therefore, a transformer can be used to change voltage, to change current, or to change impedance.

Losses and limiting factors:

A transformer consists of two or more windings on a magnetic core (Fig. 3). Transformers used to couple rf or i.f. stages require a very low density magnetic field, and

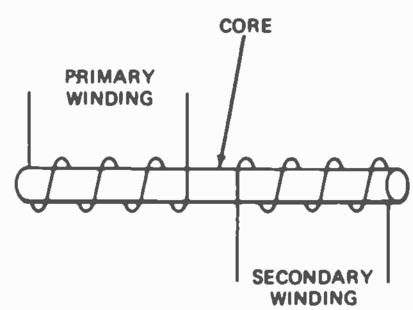


FIG. 3—CLASSIC TRANSFORMER has two or more coils wound on a common core.

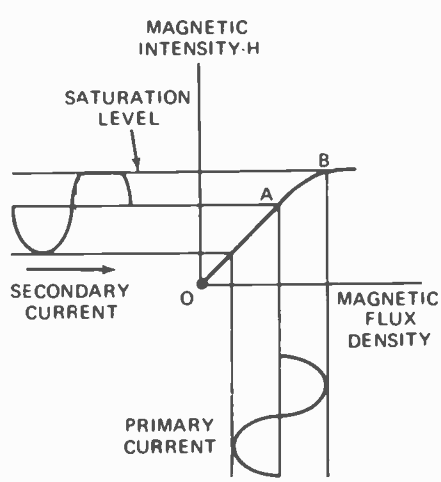


FIG. 4—TOO MUCH PRIMARY CURRENT causes distortion when magnetic core saturates.

are likely to have an air core. Conversely, the power transformer must have a very strong magnetic field and an iron core of sufficient cross-section. Each winding must be of sufficient wire size to avoid excessive voltage and power loss, or occupying excessive space. Iron cores are laminated or powdered to reduce core losses (hysterisis and eddy currents) for an overall efficiency of 90% or better.

Figure 4 shows that the magnetic force increases directly with the increase in current between point O and point A. Between points A and B, the magnetic force increases little with the current increase. In other words, the iron core has acquired a *magnetic saturation* between A and B. Primary current above this saturation level will not induce additional voltage into the secondary. Transformers used in audio amplifiers often carry dc to further limit the saturation level. Audio current exceeding that saturation level will not induce additional voltage into the secondary. Thus, the secondary voltage will not have the same shape as the primary voltage wave—the secondary voltage wave is distorted.

Transformer uses

The first use for transformers that comes to mind is the changing of voltage. Power companies commonly generate power at a low voltage, use transformers to step-up the voltage for transmission, and then step-down the voltage to a safe level for use in our homes. Within electronic apparatus using transistors, it is necessary to step-down the supplied 117 volts to a value of less than 50 volts. Tubes often require voltage greater than 117 volts, and step-up transformers are commonly a part of their associated power supply circuits. Filaments or heaters of electron tubes use lower voltages—5.0, 6.3, 10.0, 12.6—from step-down transformers.

Figure 5 shows a transformer of a full-

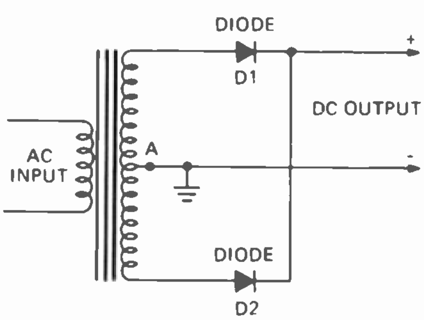


FIG. 5—POWER TRANSFORMER in full-wave rectifier has center tap on secondary winding.

wave rectifier circuit having a center tap at point A. This center-tap divides the secondary voltage to two equal values, and provides a return path for the dc. Push-pull amplifier circuits and discriminators also use transformers with center tapped primaries or secondaries.

Transformers are seldom used for the changing—step-up or step-down—of current. However because of the excessive voltage drop and power loss encountered in usual measuring methods, power companies often use current transformers in series with the transmission line as shown by Fig. 6. So-called "snap-around" meters use this same principle with the line conductor serving as the primary. The coupling of transistor amplifier stages by transformers often steps-up the current, but this is the result of impendance matching.

A transformer, with its impedance ratio (Zp/Zs) equaling the square of its turns' ratio $(Np/Ns)^2$, is a convenient means of changing or transforming impedances. The

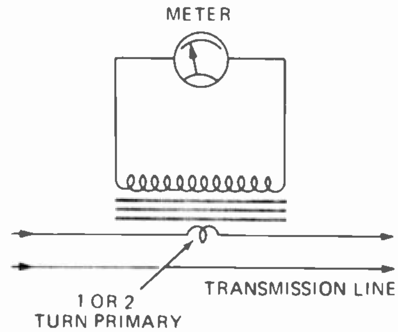


FIG. 6—CURRENT TRANSFORMER has 1- or 2-turn primary and is often used for metering.

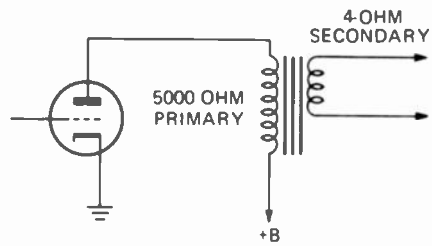


FIG. 7—AUDIO OUTPUT TRANSFORMER matches tube impedance to that of the speaker.

audio amplifier designed to develop its output across 5,000 ohms may be coupled to a speaker having an impedance of 4.0 ohms by a transformer having a turns' ratio of 35.2:1. So if the speaker in Fig. 7 is across 10 turns of the secondary, its 4.0 ohms will appear across 352 turns of its primary as 5,000 ohms ($35.2^2 \times 4$). Impedance transformations, or *impedance matching*, are often made between

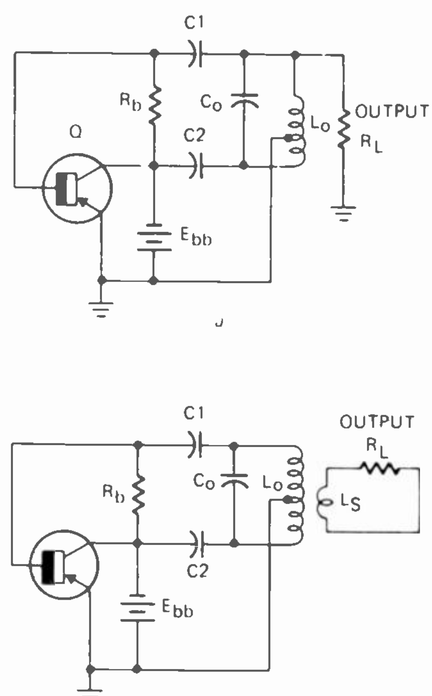


FIG. 8—DIRECT COUPLED OSCILLATOR (a) may not work; transformer coupled circuit (b) minimizes loss of essential feedback.

transistor or tube amplifier stages, between amplifiers and transmission lines, between microphones and amplifiers, between transmission lines of differing impedances, etc.

Power of the automobile engine cannot be directly applied to its wheels, and must be coupled by gear and clutch arrangements. In a like manner, an oscillator circuit directly coupled to its load reduces the power feedback to the input and prevents oscillations. Figure 8-a shows such an oscillator circuit directly coupled to load R_L while the transformer formed by inductors L_o and L_s serves to couple the circuit of Fig. 8-b to its load. The circuit of Fig. 8-b will oscillate while that of Fig. 8-a probably will not.

To eliminate some of the interference on power lines and to add a factor of safety isolation, transformers are often used. Isolation transformers with a 1:1 turns' ratio have a non-magnetic (electrostatic) shield between the primary and secondary windings acting as a barrier to electrostatic fluctuations (Fig. 9). Since one side of the secon-

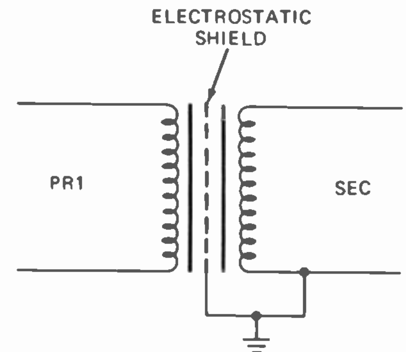


FIG. 9—ELECTROSTATIC (FARADAY) SHIELD prevents coupling through stray capacitance.

dary can be grounded as shown in Fig. 9, there is the added factor of knowing which side of the power line is at ground potential. Isolation-type transformers are also used with audio transmission lines to eliminate undersirable noises as well as being a barrier to direct current.

Transformer ratings

Transformer ratings vary greatly with usage. Power companies use transformers rated in volt-ampere or kilovolt-ampere capacity. Ac circuits commonly have a phase difference between the voltage and the current, and the power consumption is seldom equal to the voltage current (EI) product. Thus, it is essential to rate the power transformer by its maximum voltage-current product. A 1,000-watt load with a 30° phase difference and a power factor of 0.866 across a 115-volt secondary will draw a current of 10.1 ($1,000/115 \times 0.866$) ampere, and the transformer capacity must be 1,160 volt-ampere or 1.16 kilovolt-ampere. Power transformers used in electronic equipment are designed for an 80% power factor, and the true volt-ampere rating is not given.

In addition to the power rating, audio output transformers are also rated with regard to impedance ratio and frequency response. The output transformer has an impedance ratio based upon the speaker impedance at 400 Hz. However, at other frequencies the speaker's impedance differs greatly, and any impedance match is actu-

TABLE 1. AUDIO TRANSFORMERS

TYPES	PRIMARY Z OHMS	SECONDARY Z OHMS	POWER RATING
MICROPHONE OR LINE TO GRID	100	70,000	
	400CT	195,000	
LINE TO LINE OR VOICE COIL	500/1000/ 1500/2000/ 2500/3000	8/16/24/32/ 40/48	
PLATE TO P-P GRID	5000	4/8/16/250/ 500	
	7000	20,000	
	10,000	4/8/16/500	
		2/4/8	
		40,000	
		90,000	
OUTPUT	20	8	10
	48	8/16	5
		3.2/8/16	10
	100	3.2/8/16	10
	400	4/8/16	0.3
	500	4/8/16	0.3
			0.15
	600	4/8/16	0.15
	1250	4/8/16	0.15
	2500	4/8/16	0.3
INTERSTAGE	100	10	0.15
		1000	0.25
		1500	0.3
	500	50	0.16
		500	0.3
		5000	1.0
		50,000	0.15
	5000	7500	0.15
		10,000	0.15
	10,000	200	0.15
		2000	0.15
DRIVERS	20	36	1.0
	100	200	0.5
		100	0.5
	500	200	0.5
	1000	200	0.05

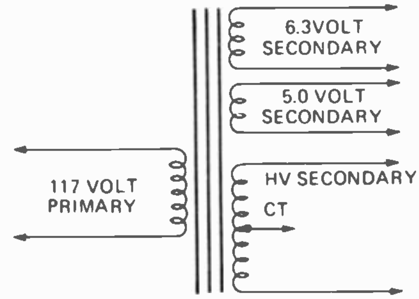
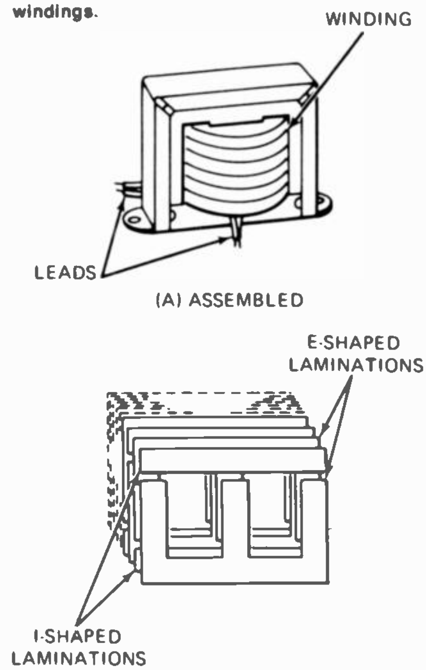


FIG. 10—POWER TRANSFORMER for tube sets has step-up and step-down secondary windings.



(A) ASSEMBLED

(B) EXPLODED VIEW OF CORE

FIG. 11—POWER AND FILAMENT TRANSFORMER CORES are interleaved "I" and "E" segments.

ally a compromise. In turn, the frequency response of the output transformer and speaker combination is also a compromise within reasonable limits up to 12,000 Hz. As well as possible, high-fidelity (hi-fi) equipment makes use of high-frequency feedback and bass-boost systems to compensate for the inadequacies of the transformer-speaker combination.

Inter-stage audio transformers transfer little or no power. While inter-stage transformers used in tube circuits made the use of lower supply voltages possible, that advantage has become insignificant with transistor circuits. Interstage transformers are rated by their impedance ratios which will be a step-up (5,000: 1.0 meg.) in tube circuits and a step-down ratio (10,000:200) in transistor circuits.

Impedance and turns' ratios of i.f. transformers for tube circuits are often not listed by the catalogs. This assumes that i.f. tube circuits are fairly standardized, but most i.f. transformers used in transistor circuits are listed with their impedance ratios.

Type of transformers:

Many early radio receivers used a step-up power transformer to provide 250 to 500 volts for the plate circuits as well as step-down transformers to supply the heaters. Quite often, these step-up and step-down transformers were combined with a single primary winding as shown by Fig. 10. In time, more efficient electron tubes and circuits made the voltage step-up unnecessary, and series-wiring of heaters eliminated the step-down transformer. However, better television receivers used filament transformers to prolong tube life. Figure 11 shows the basic construction of a power or filament transformer with its windings formed on paste-board, and thin E- and I-shaped pieces of this iron core insulated by a coating of iron-oxide (rust). Plate supply transformers typically had secondary voltages up to 930 volts (465 volts each side of the center-tap) at 150 mA., measuring 3 × 4 × 3 inches and weighing nearly 8 pounds.

With transistorized receivers operating on ac, it is necessary to step-down the 117 volts to less than 50 volts. Except for transistorized receivers and record players with large audio outputs, the current drain is low, and the power transformer does not need a heavy magnetic core. Filament and transistor power transformers have ratings of 2.5 to 80 volts at up to 30 amperes.

Audio frequency transformers used in coupling and impedance matching are similar in construction to power transformers. However, in most cases the current and power of audio circuits are small, and the core and windings need not be large. Most coupling and impedance matching audio transformers are rated by their impedance ratios as shown by Table 1. Power ratings are insignificant except for those used as driver and output transformers. Driver stage transformers have power ratings of 0.5 and 1.0 watt while output transfomers may have as much as 35-watt capacity. Although often not listed, another important factor of audio transformers is the frequency response. Figure 12 shows the typical frequency response at A, a very poor response

(Continued on page 74)

MARCONI-

We celebrate the 100th anniversary of the possible. Here is a brief

Guglielmo Marconi

On December 12, 1901, an event took place on a hill overlooking St. John's, Newfoundland, which was destined to have a profound effect on the social, cultural, political, and economic affairs of all people and nations on earth from that day onward. At 12:30 PM on that cold and blustery day, a handsome young man of 27 worked busily at a table on which an unusual collection of electrical equipment was assembled. The building in which the apparatus was housed barely sheltered him from the harsh winds that blew outside.

The young man held a telephone receiver tightly to his ear, listening intently, his features strained. Suddenly, his expression brightened. He beckoned to his assistant, who had been waiting nearby, and handed him the receiver. "Can you hear anything, Mr. Kemp?" he asked.

Kemp took the telephone and pressed it to his ear. He listened for several seconds, then he smiled and nodded affirmatively, handing the receiver back to the young man whose name was Guglielmo Marconi.

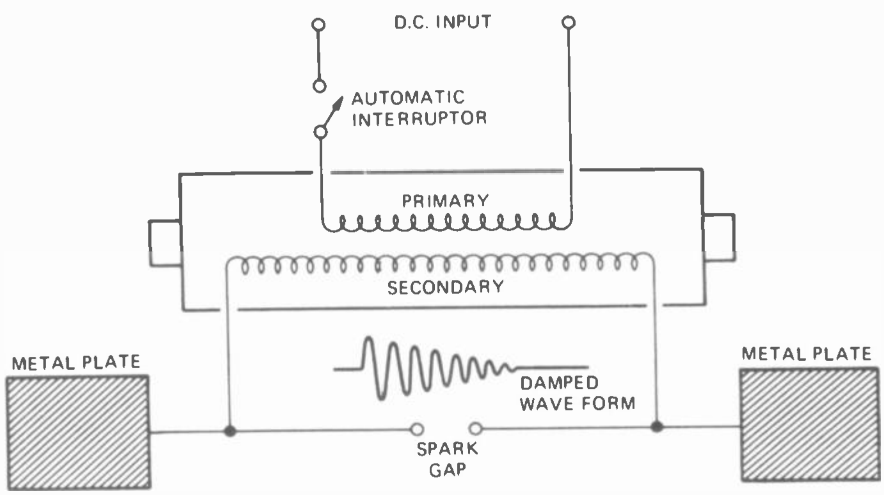
Both had heard the three faint clicks in the receiver, Morse Code for the letter "S." The signal which produced the clicks had traveled over 2000 miles without wires, having been sent toward its frigid St. John's, Newfoundland destination from Poldhu, near Land's End, in Cornwall, England. The two men, Marconi and Kemp, heard the signals again at 1:10 and 2:20 PM the same day, and at 1:28 PM the following day, Friday, December 13th.

The announcement, given to the press on December 16, 1901, startled the world. Electrical signals had been sent across the Atlantic Ocean without the use of connecting wires!! The experiment, one of the more significant steps forward in the course of human history, climaxed seven years of work by the Italian scientist. The world would never be the same again.

GUGLIELMO MARCONI WAS BORN 100 years ago, on April 25, 1874, in Bologna, northern Italy. His father Giuseppe, was an able and well-to-do businessman. His mother, Annie Jameson, was Irish. She had been born in Dublin, the daughter of Andrew Jameson, who operated one of Ireland's largest whiskey distilleries. Annie had come to Italy to study bel canto. There she met, and later married, Giuseppe.

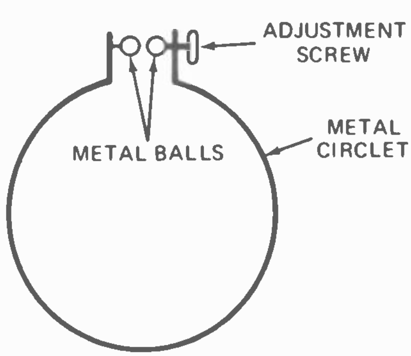
As a child, Guglielmo had few friends. At the age of five, he went to England with his mother for two years, and his first elementary school education was at a private school in Bedford. For several years thereafter, his education was provided primarily by tutors and by his mother, who taught him in English. He went to school in Florence at age 12, and at 13, attended the Leghorn Technical Institute. In his teens, Marconi attended some of Professor Righi's lectures. Augusto Righi was Italy's leading authority

GUGLIELMO MARCONI in his room in the old Barracks Hospital on Signal Hill, St. Johns, Newfoundland. The receiving equipment he used to detect wireless telegraph signals from Cornwall, England—2200 miles away—is on the table.



HERTZ TRANSMITTER

HERTZ RESONATOR OR RECEIVER



HERTZ TRANSMITTER produced a damped spark chain at the gap as interruptor opened and closed. This induced similar spark chain in receiving loop.

on electromagnetic radiation. The lectures stimulated Marconi's interest in electrical phenomena, and by the time he was twenty he had read extensively on the subject.

The turning point in Marconi's life came when, at the age of 20 he read, while on vacation in the Italian Alps, a paper on the experiments of Heinrich Hertz. Using a battery, an induction coil, a switch, and a pair of metal plates with a spark gap between them, Hertz had produced an electrical dis-

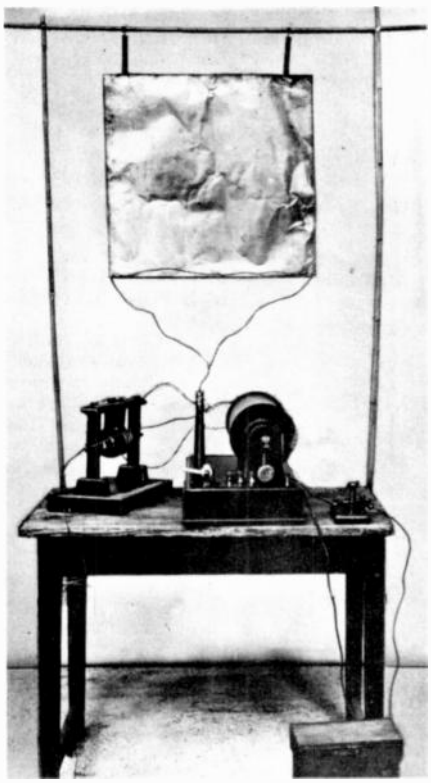
100th ANNIVERSARY

birth of the pioneer who made transatlantic radiotelegraphy chronicle of events leading to the breakthrough

by STANLEY LEINWOLL

charge between the metal plates. The discharge was detected several feet away by a circlet of wire with a small gap in it. When the discharge between the plates occurred, tiny sparks could be observed across the gap in the circlet, indicating that energy had been transferred through space.

Although he knew that a theory had been proposed postulating such waves, Marconi



MARCONI'S FIRST TRANSMITTER in Italy in 1895 looked like this replica.

had not been aware that their existence had been proved experimentally. His imagination fired by the article, young Marconi curtailed his vacation and returned to the family's country estate, the Villa Griffone, outside Bologna. Signora Marconi had given her son a room on the third floor of the estate to use as a workshop and laboratory, and it was in this room that Guglielmo Marconi conducted his first experiments using electromagnetic waves as a means of communicating.

He started by duplicating the apparatus used by Hertz. After several failures, Marconi was successful. Guglielmo's early efforts consisted of modifying the Hertzian apparatus in an attempt to produce bigger sparks at greater distances. He had seen the possibilities immediately: Hertzian waves could potentially be used to transmit and receive messages over great distances without the use of wires!

It was not long before Marconi was able to produce a spark the full length of his room. This done, it became clear to Marconi that further development would have to lie in two directions: to increase the transmission distance of the sparks, and to make these sparks perform a function - to transmit intelligence in some manner. Young Marconi realized that development along these lines would take capital, and he went to his father for it. The elder Marconi was totally against his son's activities initially, but soon saw the commercial possibilities of his son's "wireless" experiments, and he gave the boy a substantial sum of money with which to continue his work.

He started with equipment being used by the others. This included the Hertzian transmitter in the sending circuit, and a receiver which substituted a coherer for Hertz's spark ring. The coherer had been developed by a French physicist, Edouard Branly, who found that if a small glass tube were filled with metal powder, then exposed to electromagnetic waves, the metal particles cohere — that is, their resistance dropped, and they were able to conduct electricity. Branly had used iron filings in his coherer. He used a galvanometer, an instrument designed to detect the flow of electric current, to show the coherer was working.

Although Marconi's new equipment worked, the ranges he obtained with it were comparable to those being achieved by other researchers in the field—a matter of yards at the most. Discouraged, Marconi turned to other electrical research —attempts to pick electricial discharges from thunderstorms using an elevated antenna. A sudden flash of insight inspired Marconi to combine the elevated antenna of the electrical storm experiments with his wireless equipment.

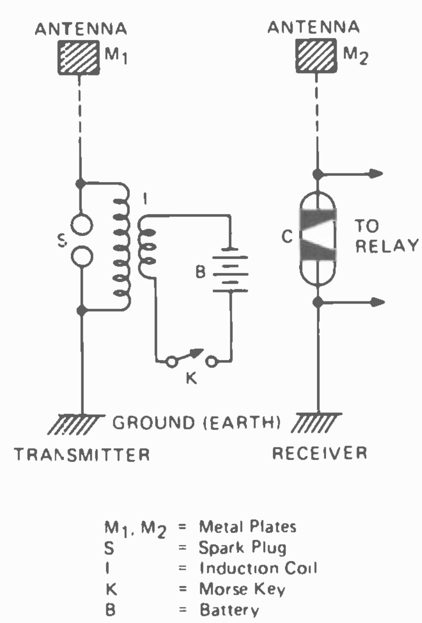
He mounted a copper plate atop a tall mast, and attached it to one end of his Hertzian transmitter. The other end was connected to a copper plate that was buried in the ground. At the receiver, Marconi erected a similar elevated antenna which was connected to one side of a coherer. The other side led to a metal plate in the ground. These modifications led to dramatic increases in the distance to which he could transmit his wireless signals. The grounded antenna, often referred to as a Marconi antenna, was the young inventor's first original contribution to radio, and for many years afterward, the symbol for wireless was an antenna with one end elevated and the other grounded.

The improvement in range was so marked that Marconi had to move his equipment out of doors to continue his experiments. There, he found that the distance he could transmit a signal varied approximately in proportion to the length of the vertical wires, as well as the height of the plates above ground. At this point, Marconi's equipment included a telegraph key and relay, which he had introduced in late 1894 and early 1895 experiments; this enabled him to produce long or short trains of sparks, depending on the length of time the key was depressed. In the receiving circuit, Marconi replaced the galvanometer used by Branly with a battery-operated relay and a Morse inker which recorded the signals being sent. He also introduced a tapper into the coherer circuit. The tapper worked like a hammer in an electric bell. When reception of Hertzian waves caused the coherer's electrical resistance to drop to a low value, an electrical circuit was established between a battery and the tapper. The hammer thereupon gave the coherer a light tap which decohered the metal particles, rendering them nonconducting until another train of waves arrived.

At the time the tapper was introduced, Marconi also introduced an improved coherer. He had found that the Branly tube was too erratic to provide reliable Morse signals, so he devoted considerable time to improving the device. He experimented with 300-400 different combinations of filings and metals before evolving a satisfactory coherer which contained nickel and silver. All of these modifications further improved Marconi's equipment as a communication device.

Each impulse reaching Marconi's receiv-

MARCONI TRANSMITTER AND RECEIVER



GROUNDED TRANSMITTER AND RECEIVER with elevated antenna were the key to greater communications range.

ing equipment produced the same result: the particles cohered, current flowed, the tapper struck the tube containing the particles which decohered, and current stopped flowing. Using this device, Marconi was able to transmit dots and dashes on a continuing basis, over a distance of about one mile. He soon discovered that by placing the receiving equipment on the far side of a hill, signals could still be received, indicating that the radiation was either traveling through or over the hill.

In 1895, at the age of 21, the young Marconi offered his invention to the Italian Ministry of Posts and Telegraphs, which turned it down because it had no particular use for it. Marconi was told that his equipment would be more useful to a maritime nation because it seemed to lend itself more to communication between ships or between ship and shore. At that time, the world's most powerful maritime nation was England, and with his mother's friends and influential acquaintances in that country, it seemed a most logical place for him to take his wireless.

Marconi arrived in London in February of 1896 with two trunks containing his wireless equipment. Customs officials were suspicious of the young Italian immigrant, fearful that he was an anarchist and that his mysterious apparatus was a bomb, and they proceeded to dismantle his equipment completely. They were then unable to put it together again because some of it had been damaged in the process. Before he was able to proceed with demonstrations, therefore, Marconi had to make some hasty repairs and reassemble his equipment.

The first man to see the Marconi wireless operate in England was his cousin, Henry Jameson-Davis, an influential businessman in his own right; plans were immediately made to patent Marconi's invention. On June 2, 1896, Marconi applied for a patent—the first of its kind—for his wireless telegraph equipment. By this time, Marconi had already contacted several prominent engineers in Great Britain, among them William Henry Preece, chief engineer of the British Post Office. Preece had conducted his own research of telegraphy, and had tried to approach wireless by use of induction techniques which were not successful. He was amazed when he learned of Marconi's achievements. Preece, acting as a watchdog for the Post Office, keeping an eye on what might turn out to be a rival system to the existing line-conductor internal telegraph message carrying, offered to assist Marconi in any way he could. Marconi was interested in the Post Office because it was potentially a valuable customer. The two, therefore, formed an association of mutual convenience. Marconi demonstrated his equipment to officials of the Post Office and the War Office in July and August, 1896, transmitting signals to distances of several hundred yards. This brought a request for further demonstrations, and the equipment was moved to Salisbury Plain, where successful communication over a distance of one and three quarters miles was established. Subsequent tests extended the distance covered over Salisbury Plain to four miles, and a test across Bristol Channel extended the range of the equipment to eight miles.

Marconi used his wireless in 1898 to report the Kingstown Regatta yachting races for the Dublin Express. He followed the racing yachts in a tug which had been specially equipped with wireless equipment, sending back to shore a running commentary of race positions and developments in Morse code. This marked one of the first times wireless had been used for journalistic purposes.

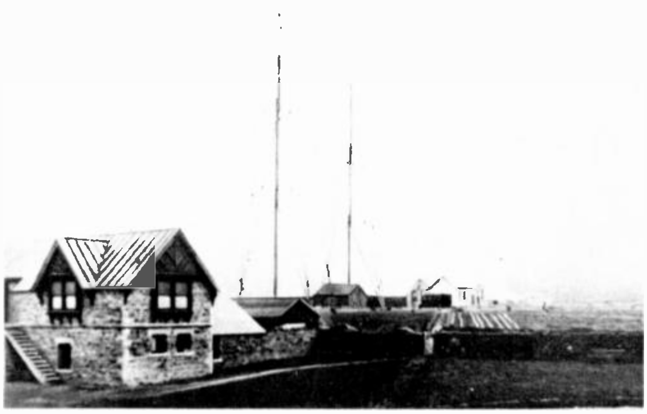
Queen Victoria was so taken with the Kingstown Regatta reporting that she requested that wireless communication be established between her residence at Osborne House, on the Isle of Wight, and the Prince of Wales, who was recovering from an injury aboard the royal yacht Osborne, several miles away. Over 100 messages were exchanged between the queen and the prince, and wide newspaper coverage was given these exchanges.

In 1899, the French Government requested that Marconi conduct tests to determine whether communication between England and the European continent was feasible. The tests, carried out over a 30-mile distance, were a complete success, and were given wide publicity by the many reporters from both countries who witnessed them. At last, wireless was beginning to gain international attention.

In the same year, Marconi came to the United States to conduct a series of tests for the war and navy departments. The American military, satisfied that Marconi's system was the best available, adopted it for use by the army and navy. While in the United States, Marconi gained widespread publicity by reporting the results of the America's Cup yacht races off Sandy Hook.

Although press coverage during Marconi's stay in the United States was excellent, and purchases of Marconi's equipment were made by the U.S. Government, the most significant development of Marconi's visit was the formation, in November, 1899, of Marconi Wireless Telegraph Company of America, which, some two decades later,was to become the Radio Corporation of America.

At 25, Guglielmo Marconi had gained what most men fail to achieve in a lifetime—international recognition and respect, wealth, a place in history. But the task was just beginning, and his greatest moments still lay ahead. By 1900, Marconi was experiencing serious competition from foreign sources, particularly from Germany, where Braun, Slaby, and Arco were notable workers. The head start Marconi had gained was being held, but others were close behind, and he needed some innovation that would give him a significant lead.



FAN-SHAPED TRANSMITTING ANTENNA used at Poldhu, Cornwall, England to send first transatlantic signals to Signal Hill at St. Johns, Newfoundland. The first—a circular array—came down in a seasonal gale.

MARCONI (extreme left) and assistants launch kite that raised antenna used at Signal Hill, Newfoundland to receive the first wireless signals from across the Atlantic Ocean. Storm made reception very difficult.

Frequency selection

One of the biggest problems at that time was co-station interference. Because control of the frequency at which the wireless equipment functioned was virtually nonexistent, it was a frequent occurrence to find that two stations operating in close geographical proximity drowned each other out. There was no way, in 1900, of separating a wanted from an unwanted signal, and since there was no regulation of usage, either geographically or in time, chaotic conditions often arose in which receiving stations could not work efficiently, receiving only a hodge-podge of incoming signals from two or more transmitting stations.

Marconi first addressed himself to the problem by improving his antenna systems, and experimenting with different types of coherers. Some improvement was noted, but it was not enough. It was evident to the young Italian genius that limiting the radiation by narrowing the band of frequencies transmitted was the answer.

The solution to the problem of interference was found by using tuned, or resonant, circuits. The principle of resonance, called "syntony" by Sir Oliver Lodge, who demonstrated it in 1897, made use of virtually identical antennas, inductances, and capacitances in both the transmitter and receiver. Braun had patented a similar device in 1899. But the systems that Lodge and Braun had patented had one serious drawback: very little energy was radiated into space. Two simple yet ingenious innovations by Marconi solved the problem. He coupled the antenna inductively to the transmitter, and made both this inductance, as well as the capacitance in the transmitting circuit, variable. These changes enabled him to tune his transmitting circuit to resonance, and the resulting oscillations radiated considerable energy into space.

Marconi then matched his receiving circuits to those at the transmitter, tuning to the frequency being transmitted. No longer did his wireless equipment radiate a broad band of frequencies. By using syntonic circuits with variable inductances and capacitances, stations could operate in the same vicinity and, simply by varying the values of the circuit components, could transmit and receive with greatly reduced interference. As soon as he was certain that syntony was the answer, Marconi applied for an all inclusive patent on his system. On April 26, 1900, one of the most important patents ever granted, the famous No. 7777, was issued to Marconi by the United States. The stage for one of the great experiments of the age was rapidly being set.

Beyond the horizon

Coincident with the work on "syntonic" or tuned circuits, Marconi had become aware of an apparent paradox in connection with his wireless system. He knew that, according to the well-understood laws governing electromagnetic wave propagation, wireless telegraphy ranges should theoretically never greatly exceed optical distances. This is because radio waves, like light waves, travel virtually in straight lines. Therefore, because of the earth's curvature, they would be expected to leave the surface at a tangent to disappear out into space. While diffraction and refraction effects would increase the range to a little beyond the horizon, no significant extension could theoretically be expected.

Scientists of the day were therefore unanimous in declaring that wireless telegraphy communication would be limited to these just beyond the-horizon distances. Yet Marconi had found that in practice, he was obtaining ranges which were at least twice those that mathematical calculation indicated. He did not know why this should be so, he only knew that it was.

Encouraged by the 60- to 100-mile ranges he was already getting, Marconi decided to gamble by seeing whether the signals could bridge the Atlantic. The audacity of this scheme can be gathered by remembering that all wireless equipment at that time was small and battery-powered, whereas the transatlantic project would demand a huge power plant and antenna system of a kind of never before visualized. Marconi proposed to erect two such stations, one on each side of the Atlantic, with which he hoped to effect two-way communication,and thereby to deal a mortal blow to the cable companies.

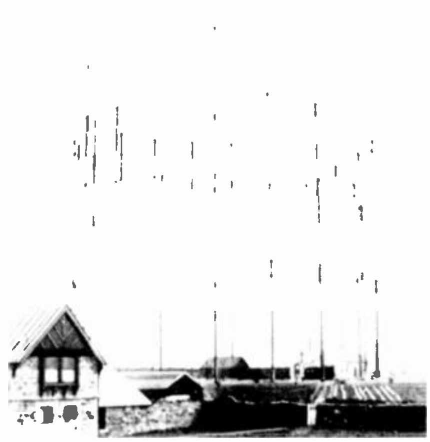
He put his proposal to his board of directors who were far from enthusiastic, for tremendous expenditures were involved and, according to the text books, the scheme could never succeed. At length, however, and with considerable misgivings, the board agreed.

When the news was released, many noted scientists scoffed. The earth was round. Hertzian waves traveled in straight lines, and the signals would be lost in outer space long before they reached their destination. There was no way, they said, that the experiment could succeed. Marconi was stubborn and would not be dissuaded.

To assist him, Marconi engaged the services of an eminent scientist and engineer, J.A. Fleming, who was Professor of Electrical Technology at London University. Fleming, who would later invent the diode dectector, was an expert in the operation of high-power alternating current generators, and was an authority on the work of Maxwell and Hertz as well. He had duplicated Hertz's experiments, and followed closely the work of Marconi.

In mid 1900, a site at Poldhu, on a finger of land just east of Land's End, Cornwall, was chosen for the transmitter site, and construction was begun in October, 1900, the work being carried out secretly. The size of the Poldhu station was massive. In place of previously used battery power supplies, a 32 horsepower generator was installed to drive a 25 kilowatt alternator, whose output was 2000 volts. This voltage was stepped up to 20,000 volts by a transformer.

The antenna system at Poldhu consisted of 20 wooden masts, each 200 feet high, erected in a circle. Circumferential support was provided by horizontal triatics between each mast, and the guy wires anchoring the



FIRST TRANSMITTING ANTENNA at Poldhu — a circular array — was blown down in gale.

masts were broken up and held together with lanyards. From an engineering standpoint, the horizontal support arrangement left much to be desired, because it meant that if one mast were to fall, it would in all probability carry the others down with it. The designers were aware of this shortcoming, but decided the gamble was justified, in view of the relatively low losses the system would have from leakage current. They would need every bit of power possible.

By March, 1901, the Poldhu station was nearly ready, and Marconi, satisfied that things were going well there, sailed with an assistant for the United States. An oceanfront site at South Wellfleet, Cape Cod, Massachussetts was chosen, and Marconi left the construction of the receiving equipment and the receiving antenna system, which was identical to that at Poldhu, to an assistant, and he returned to England.

Preliminary tests conducted in the fall of 1901 from Poldhu to Crookhaven, on the west coast of Ireland, were successful. The distance between these points was 225 miles, well beyond the 186-mile record established from Poldhu several weeks before, and indicated once again that the Hertzian waves were not traveling tangent to the curvature of the earth. Since no other possibility was conceived of at the time, it was generally supposed by Marconi and his associates that the signals were traveling along the surface of the earth.

During the period of these preliminary tests, construction of the Cape Cod station continued while the finishing touches were being put to the Poldhu station. Then, in close succession, a double disaster struck. In September, the worst fears of the antenna designers were realized when a severe gale struck the west coast of England,and the antenna system at Poldhu was totally destroyed, with all 20 masts collapsing, leaving a mountain of twisted debris.

Marconi would not be deterred. He immediately ordered the wreckage to be cleared, and an alternate temporary antenna system erected. It consisted of 54 copper elements arranged in a fan shape, and mounted between two 150-foot wooden masts. Within the month, the site had been cleared, and the second array under test. While the tests on the temporary antenna were being conducted, plans were made to substitute a more powerful, permanent antenna. But the test with the temporary system was going so well that Marconi decided not to wait, but to use the alternative instead. Then, just as Marconi was ready to start his transatlantic tests, the second disaster, identical to the first, befell the Cape Cod antenna. In November, 1901, it collapsed in shambles during a northeastern storm. It seemed that fate was conspiring against the inventor.

Marconi decided that he could not wait for the reconstruction of the stateside system. Instead, he and two associates, George S. Kemp and P.W. Paget, set sail for the point of nearest landfall in the Americas—Newfoundland. They carried with them an assortment of wireless equipment, including different receivers and coherers, and antenna accessories, including large canvas kites, balloons, and varying lengths and thicknesses of wire.

Marconi and his associates landed at St. John's on December 6, 1901, and met with Sir Caverdish Boyle, the governor of Newfoundland, and Sir Robert Bond, the Prime Minister, both of whom promised Marconi all possible assistance. They made available to the party an abandoned barracks hospital which lay on a hill some 600 feet above St. John's harbor, facing Poldhu. The location, now called Signal Hill, was not far from where John Cabot, the discoverer of Newfoundland, first landed.

S . . . S . . S . . . S . . .

By December 9th, Marconi and his assistants had assembled their equipment in a ground floor room of the hospital, and Marconi sent a cable to Poldhu instructing the technicians there to start transmission of test signals on December 11th. They were to send S's—three dots in the Morse code continuously between the hours of 11 AM and 3PM Newfoundland time. The choice of the letter S was made for several reasons. The switching arrangments at Poldhu were not constructed to withstand long periods of operation without considerable wear and tear on the equipment. This was especially so if dashes were to be sent. Furthermore, an automatic transmitting device could be employed if S's were sent. Finally, Marconi felt that three dots would probably be heard

(continued on page 80)

FEMTOWATT—
Here It Comes

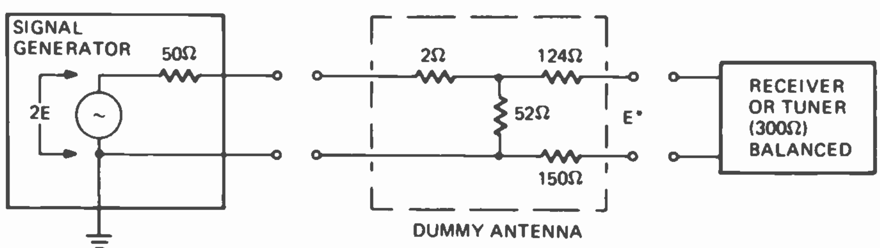
The standards used to rate the performance of FM tuners and receivers have been varied and only loosely followed. A new standard proposed by EIA/IHF meets the needs of today's technology.

by LEN FELDMAN

THE ELECTRONIC INDUSTRIES ASSOCIation (EIA) and the Institute of High Fidelity (IHF) recently held a joint engineering meeting to try to come up with one national (and hopefully, perhaps international) standard for measuring the performance of FM tuners and receivers. Ever since 1958, when the first IHF Tuner Measurement Standards were issued, the hi-fi component manufacturing segment of the audio industry has, for the most part, tried to specify product performance using these measurement standards. Mass-market manufacturers, such as makers of console "package" radio-phonographs and table model FM sets have either used specific portions of the IHF standards, sections of the older (1947 and 1949) IRE FM measurement standards (now the IEEE), or have come up with measurement standards of their own to suit their advertising requirements.

Admittedly, even the IHF standards of 1958 are sadly out of date. For one thing, they make no mention of stereo FM performance or related measurements, since in 1958, stereo FM was still three years away. New drafts of measurement standards developed separately by both the IHF standards committee and the EIA sought to update and clarify FM performance measurements in the light of present-day technology and knowledge.

Undoubtedly, the final approved version or versions will take proper account of such important parameters as stereo separation, stereo signal-to-noise ratio (which is always poorer than the S/N realized in monophonic performance) and stereo harmonic distortion. SCA and 38-kHz carrier product rejection will also appear in the new standards, along with more wide-ranging intermodulation and harmonic distortion measurements in general—all intended to more clearly spell out the relative merits (or demerits) of an FM receiver product so that its performance can be meaningfully and completely compared with competitive products being shopped by the knowledgeable audiophile. Details of these new measurement requirements will be reported on here as the new standards near finalization and issuance. Our purpose this time, however, is to analyze a much more fundamental concept which came under investigation at the joint EIA-IHF meeting—and that has to do with they way in which we measure signal input levels to receivers—be they FM, AM, TV, or other communications types.



* = OPEN CIRCUIT OUTPUT FROM DUMMY ANTENNA AND GENERATOR METER READING. AVAILABLE POWER LOSS = 13.8dB

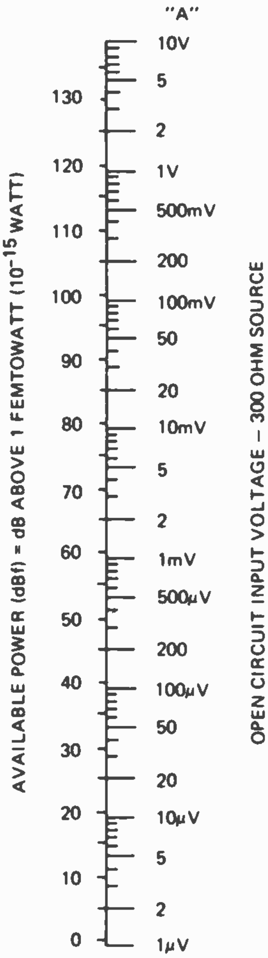
FIG. 1—VOLTAGE RELATIONSHIPS using an FM signal generator matched for use with a receiver having an antenna input impedance of 300 ohms, balanced.

Microvolts vs power

Even though it is intuitively recognized by engineers and technicians alike that a signal induced in the antenna of any communications receiver involves a transfer of *power* to the antenna terminals, some segments of the industry (notably, in the consumer FM and AM receiver field) have traditionally dealt with signal inputs in terms of voltage or, more specifically, microvolts. Obviously, we can easily translate microvolts appearing across a given impedance into microwatts of power. For example, 10 microvolts appearing across an input impedance of 75 ohms may be expressed as 1.3 micro-microwatts (1.3×10^{-12} watts) since power, $P = e^2/R$. However, the same 10 microvolts appearing across a 300-ohm input impedance is equivalent to only 3.3×10^{-13} watts, or ¼ the previous power. Looking at it another way, if a manufacturer rates his FM tuner as having a sensitivity of 2.0 microvolts (referencing a 300-ohm input impedance), another manufacturer might well rate a similar product as having a 1 microvolt sensitivity if he refers his sensitivity to a 75-ohm input impedance, since $(2.0 \times 10^{-6})^2/300 = (1.0 \times 10^{-6})^2/75 = 1.33 \times 10^{-14}$ watts. Few manufacturers of true hi-fi components play this game any more, but the possibility of this abuse does exist, and either statement would be true if the manufacturer bothers to reference the impedance being used in the calculation.

"Hard" and "Easy" microvolts

Continuing to use microvolts rather than power as a reference input signal for tuner or receiver measurements leads to other possible points of confusion. The available power from a typical signal generator (used to measure FM performance) having a source voltage E (quivalent to the induced antenna voltage) and an internal source resistance of R (equivalent to the antenna resistance) is the power which would be delivered to a matched load (the receiver input terminals). It is equal to $E^2/4R$, where E is the open-circuit voltage and R is the generator



FOR TERMINATED VOLTAGE FROM 75 OHM SOURCE, MULTIPLY "A" READING BY 0.25

FOR TERMINATED VOLTAGE FROM 300 OHM SOURCE OR FOR OPEN-CIRCUIT VOLTAGE FROM 75 OHM SOURCE MULTIPLY "A" READING BY 0.5

$E_{oc} = 4 \times 10^{-15} R \times 10^{dBf/10}$

E_{oc} = OPEN CIRCUIT VOLTAGE

R = IMPEDANCE LEVEL

dBf = AVAILABLE POWER FOR A 1 FEMTOWATT REFERENCE LEVEL = $10 \log (E_{oc}{}^2/4 \times 10^{-15} R)$

FIG. 2—NOMOGRAPH for translating microvolt signal-level standards to the dBf available-signal-power rating system.

resistance. The terminated voltage is the voltage delivered to the matched load, and is therefore equal to one-half the open-circuit voltage.

In the diagram of Fig. 1, the generator produces a voltage 2E, internally, and has a 50-ohm source resistance. Most generators are calibrated directly in terms of available power level—that is the power available to a matched load, so that they are direct reading in available power (or signal). Thus, in Fig. 1, the microvolts indicated on the generator's own internal voltmeter would be "E" rather than 2E. The resistors shown in the dummy antenna configuration serve to terminate the output of the generator, and present a "looking back" impedance of 300 ohms required by the 300-ohm antenna terminas of the receiver under test.

Using this kind of dummy antenna and working according to present IHF standards, a technician would consider the signal intensity applied to the receiver to be E/2, rather than the true open-circuit voltage of E. Thus, if the generator meter's reading was 5 microvolts, he would divide this figure by 2, and say that the receiver had only 2.5 microvolts applied. The reasoning, of course, is that half of the internally available "2E" voltage is voltage divided between the internal 50-ohms impedance and the external matching network. A second voltage division takes place between the voltage available across the 52-ohm resistor and the combination of series resistors and the internal impedance of the receiver (which is presumed to be exactly 300 ohms). Bear in mind that the generator's meter already takes into account the first match, and is calibrated to read "E" and not "2E."

This procedure has been labelled as the "soft," "easy," or terminated microvolts approach. Alternatively, "hard" microvolts are used by some to measure receivers, in which the number of microvolts would be the open-circuit microvolts (in this case "E"), or exactly the number of microvolts read by the generator's own meter—without the "divide by two" factor. Thus, if the meter reading is "5 microvolts," one faction might term sensitivity as 5 μV, while those who subscribe to the well-established IHF procedure would designate the same receiver's sensitivity as 2.5 μV.

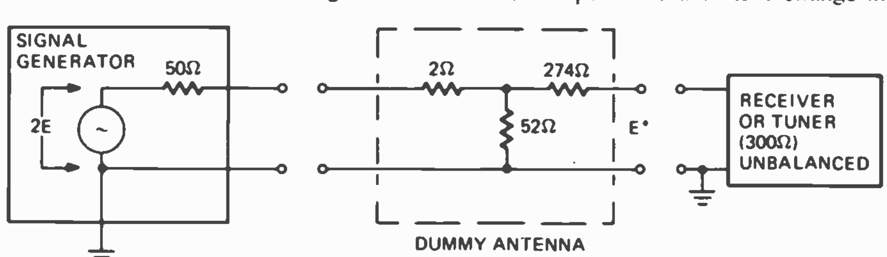
Enter the femtowatt

The joint IHF-EIA committee has suggested that henceforth all input signal levels should be expressed in terms of available power, to avoid confusion over whether receiver sensitivity expressed in microvolts is in "open-circuit" or "terminated" microvolts. In addition to resolving the 6-dB ambiguity of "hard" vs "easy" microvolts, expression of receiver input levels in available power has been accepted for many years as being the more fundamental measure of receiver input level. It would be particularly advantageous when comparing measurements in receivers designed for different source impedances (as, for example, 75-ohm coaxial lines or 300-ohm lines).

To make the scale a convenient one, the reference level that has been selected is one femtowatt (1×10^{-15} watt). 0 dBf, using this reference, works out to an open-circuit voltage of approximately 1.1 microvolt, and +120 dBf corresponds to 1.1 volt, both referred to a 300-ohm impedance level. The nomograph of Fig. 2, along with the accompanying notes, will enable the reader to translate any relationship between available power, open-circuit microvolts, and terminated microvolts at both the 300-ohm and the 75-ohm impedance levels. Typical sensitivity figures for today's state-of-the-art component tuners and receivers might be expected to fall at around 10 dBf, using this system. As can be seen from Fig. 2, this would correspond to an open-circuit voltage of 3.4 μV at 300 ohms, or a terminated voltage (similar to that used in the present IHF specs) of 1.7 μV.

Calibration of generators

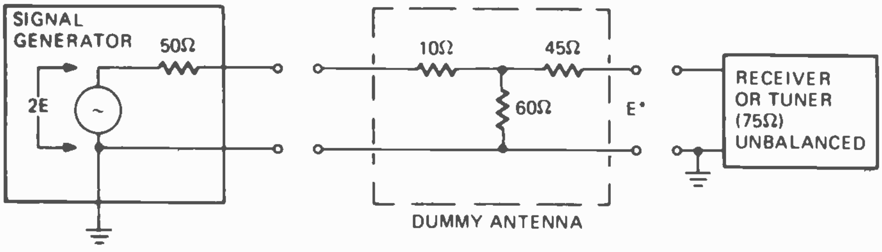
Some FM generators are already calibrated in some form of decibel scale, but this should not be confused with the new femtowatt 0-dB reference. For example, one well-known generator is calibrated with a dB scale in which 0 dB is 1 volt, and a change of 20 dB corresponds to a 10 to 1 change in



* = OPEN CIRCUIT OUTPUT FROM DUMMY ANTENNA
AVAILABLE POWER LOSS = 13.8dB

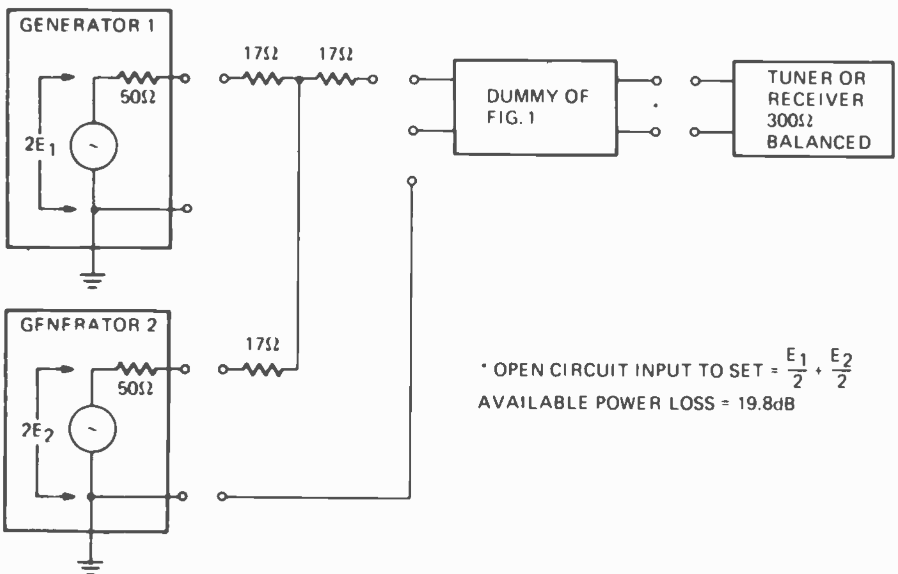
FIG. 3—DUMMY ANTENNA for matching signal generator to unbalanced 300-ohm antenna inputs on FM tuners and receivers. The dummy antenna should be shielded to avoid stray pickup.

voltage. This scale would show a 1000-µV signal as −60 dB (the minus sign is in fact omitted on the actual scale). Still other generators have adopted a reference of 0 dB = 1 µV while others choose the 0-dB point as



* = OPEN CIRCUIT OUTPUT FROM DUMMY ANTENNA
AVAILABLE POWER LOSS = 7.8dB

FIG. 4—THE DUMMY ANTENNA presents the signal generator and receiver or tuner under test with a resistance approximating their respective output and input impedances.



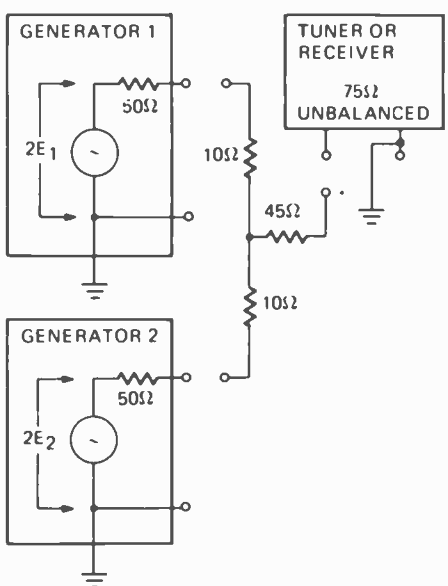
* OPEN CIRCUIT INPUT TO SET = $\frac{E_1}{2} + \frac{E_2}{2}$
AVAILABLE POWER LOSS = 19.8dB

FIG 5—TWO-GENERATOR SETUP like this is required the old and the proposed standards when measuring selectivity and capture ratio of a tuner with a 300-ohm balanced input.

1000 µV, or 1 mV. Measurements using this reference generally speak of "so many dBmV." None of the above scales corresponds to the one now being suggested by IHF-EIA, and it will be necessary to affix a proper scale to your existing FM generator scale if the new system is adopted.

Once this is done, however, the scale will apply for all receiver measurements, and you will simply have to allow for the power loss of the dummy antenna used.

A dummy antenna consists of a network which presents to the receiver the source impedance for which that receiver was designed. The standard 300-ohm dummy antenna presents a balanced 300-ohm source impedance. Since provision for a 75-ohm balanced or unbalanced input is frequently provided on some tuners or receivers, appropriate dummy antennas will have to be used in such cases. The ideal dummy antenna is loss-free, and transforms the generator impedance directly to 300 ohms or 75 ohms. When such a dummy antenna is used, the generator is direct reading in available power (once the new scale has been designed and affixed to the generator). If resistive pads are used for making the impedance match, the loss in available power would have to be subtracted from the generator reading to find the power available to the receiver. A few examples of dummy antennas for various configurations, together with corresponding available power loss, are shown in Figs. 1, 3, 4, 5, and 6. The latter two are required in making measurements such as capture ratio and selectivity, in which the use of two FM generators is required both in the old and newly suggested standards.



* OPEN CIRCUIT INPUT TO SET = $\frac{E_1}{2} + \frac{E_2}{2}$
AVAILABLE POWER LOSS = 13.8dB

FIG. 6—TYPICAL MATCHING NETWORK used between two FM generators and a tuner or receiver with a 75-ohm unbalanced antenna circuit.

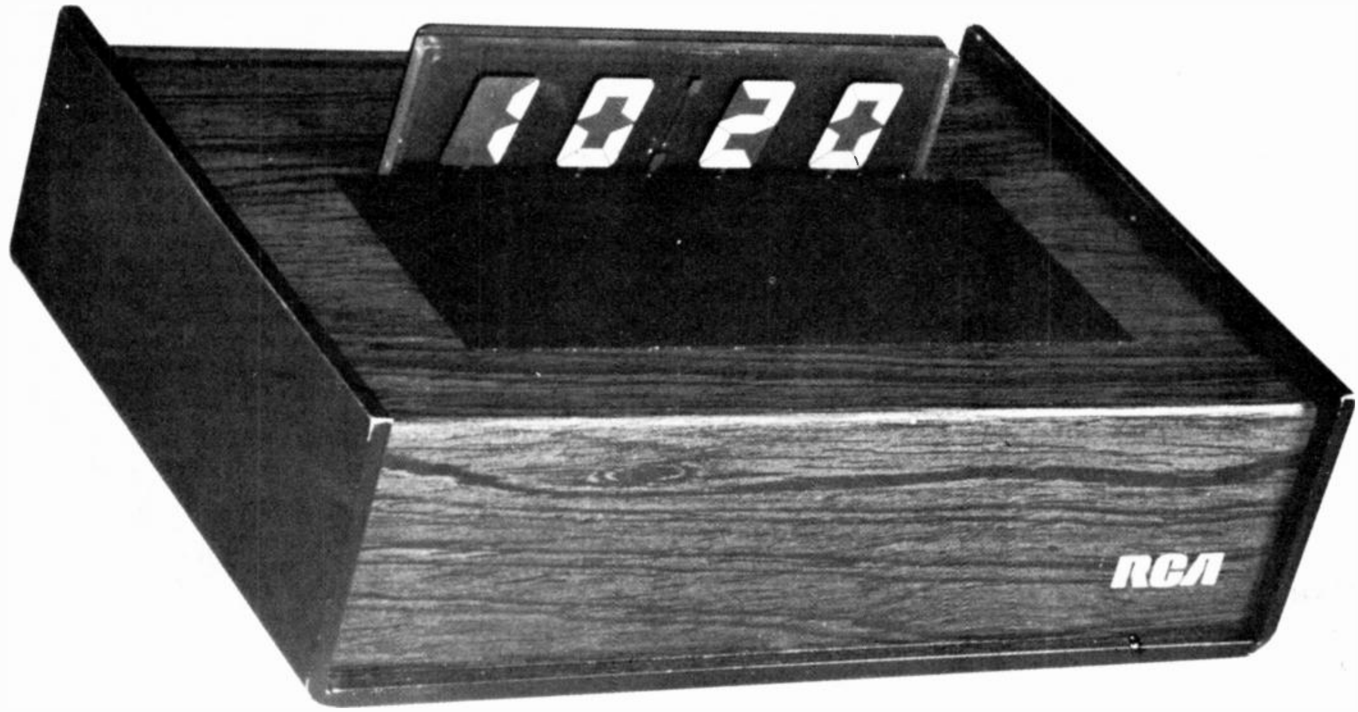
Standard input levels

Many of the presently required standard measurements made on FM tuners and receivers (such as distortion, separation, signal-to-noise, etc.), in accordance with exisiting IHF measurement standards, require standard input signal levels of 1000 µv or 1 mV. It has been suggested that the new standard mean level for these measurements be done at an available power level of 60 dBf. As can be seen from the nomograph of Fig. 2, this would correspond to an open-circuit input voltage of about 1100 microvolts (referred to a 300-ohm impedance level). For just about any tuner or receiver we can think of, this slight change in signal level would not materially affect measured results previously made at the 1000-µV level, and the figure of "60 dBf" is a convenient and easily remembered one. Similarly, for those measurements (such as capture ratio and AM suppression) that were previously required to be made at a signal level of 100 microvolts, a power level of 40 dBf would be substituted, corresponding to about 100 µV for 300-ohm impedance levels. This minor change, too, would not be expected to materially affect readings and performance ratings.

As of this writing, a final draft of the new combined FM measurement standards is being prepared. As noted, the new standard is far more comprehensive in scope than anything previously attempted with respect to FM performance measurements. As approval becomes imminent, we will report on some of the specifics and on some of the new parameters that IHF members will have to report in their published specifications. In the meanwhile, the femtowatt, or power concept of signal input, may take a bit of getting used to on the part of engineers and technicians who have become accustomed to less meaningful signal level references, but once adopted, the system should prove simple, unambiguous, and easy to use. After all, we're all going to have to get used to the metric system before long, too — simply because it makes more sense than the system of measurement will be replacing. **R-E**

WHAT IS A FEMTO?

Femto is a prefix meaning 10^{-15}. The proper symbol denoting femto is a lower case f. Be careful not to confuse it with F for Farad.



Liquid-Crystal Clock

Build it from a kit for $89.95. It runs on one set of pen light batteries for a year. Crystal oscillator makes it accurate.

WE FIRST BROACHED THE IDEA OF A practical IC digital clock using low-power CMOS IC's driving a liquid-crystal digital readout in **Radio-Electronics**, one year ago, in the April 1973 issue. At that time we presented a construction article on just such a clock. Unfortunately, both the IC's and the readout were hard to come by, and their prices were staggering. Anyone building the clock now has one of the most expensive digital clocks our readers ever built.

Now, just one year later, we are pleased to report on a new liquid-crystal clock kit, that is very similar to the clock project we presented. It's the RCA model KC-4014 and will be available from RCA distributors across the United States for $89.95.

This is a complete kit with all parts and construction details. IC's, liquid crystal display, two-sided circuit board, case, oscillator crystal, even the batteries are included.

An interesting clock

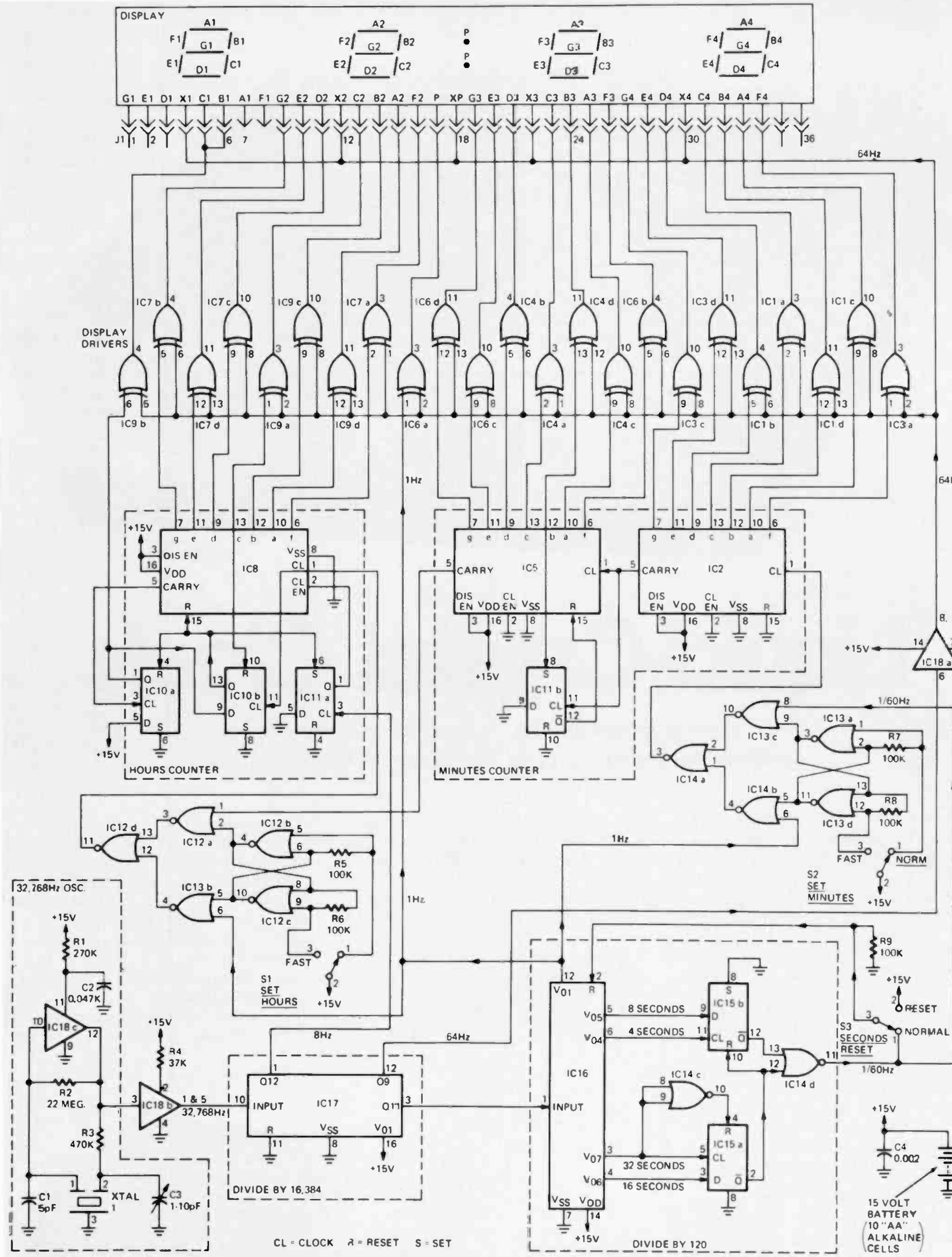
The liquid-crystal display provides a 4-digit readout that tells the hour and minute. The colon between the hours and minutes blinks off the seconds. There are 18 CMOS IC's mounted on one side of a two-sided circuit board that has plated-through holes. The readout plugs into a special set of contacts that the builder solders to the board.

All parts except for the three time-setting switches mount directly on the circuit board. The switches are attached to the rear of the clock case and connected with ordinary hookup wire to the circuit board.

The oscillator crystal is in a minuature TO-8 type case. There is one special feature of this device that deserves special notice. When you take a close look at it you'll see that the top of the crystal case is transparent. This is done because the crystal is trimmed to its precise frequency after it is in its case. It's done with a laser.

The liquid crystal display is highly visible, as you can see in the photos

LOOKING FROM the rear you can see the three time-set switches and the crystal oscillator frequency adjustment.



COMPLETE SCHEMATIC OF THE CLOCK. CMOS IC's and liquid-crystal readout combine to make this completely portable unit that requires no ac hookup.

IC TYPES

IC1, IC3, IC4, IC6, IC7, IC9—KD2134
IC2, IC5, IC8—KD2135
IC10, IC11, IC15—KD2136

IC12, IC13, IC14—KD2137
IC16—KD2138
IC17—KD-2140
IC18—KD2139

READOUT—KD-2133
OSCILLATOR CRYSTAL—KD2141
List of RCA distributors who have this clock kit will be published by RCA next month.

and on this month's cover. This is true even when light levels are low. The reflective type display, with the back plate and black felt in front of it provides maximum visibility.

Why batteries?

Battery operation makes this clock completely portable and independent of the ac line. As a result you can use it anywhere, indoors or out. Battery powered digital clocks have been built before, but the major problem has always been the life of the battery. Normally, between the current drain of the IC's and the power required by the display, batteries will only last for a relatively short time. Some battery powered clocks are set up so the time display is turned on only when you want it, to conserve power.

In this clock we see only CMOS IC's. They, in conjunction with the liquid-crystal display (another power-saving device) make it possible. For more information on CMOS IC's see the article "CMOS—Why Is It So Good" by Don Lancaster in the December 1973 issue of **Radio-Electronics.**

If you are looking for full circuit operation of this clock we suggest you take a look at the April 1973 issue where we presented the original story "Battery-Powered IC Digital Clock" by Steve Leckerts.

R-E Puts it all together

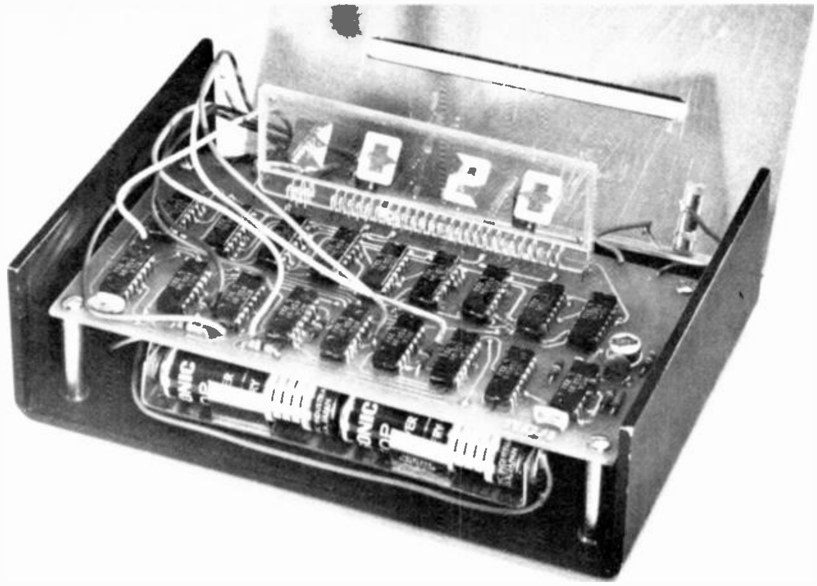
Assembling the kit is a snap. The parts plug into the board and are soldered into place. Since the board has plated through holes you only have to solder on one side.

The one thing we did notice, is that this is not a quick 1 - 2 - 3 assembly job. There are 19 IC's and that means an awful lot of soldered connections that must be made. The biggest problem we had was making sure that we didn't create solder bridges between the IC connections. We do suggest that when you build your clock you double check each time you complete soldering one set of IC connectors. A solder aid brush and a hot iron are all you need to cure this potential problem.

It is vital that you use a small iron —one with small tip size that is. A 1/16-inch tip is excellent for the job. But except for this one caution, normal printed circuit assembly techniques will see you through.

After you've got all the parts on the board the batteries are plugged into place and the board fastened down over them. There's more than enough clearance, but make sure you trim all leads projecting from the bottom of the circuit board to avoid shorts.

With the circuit board in place the cover is fitted in place over the top and fastened down. Now it's just a matter of setting the clock to the proper time.



WITH THE TOP COVER REMOVED you can see all the inner workings. Digital readout plugs into the circuit board. It is a reflective liquid crystal display.

TEN PEN LIGHT CELLS IN BATTERY CLIPS, located under the circuit board, power this clock. As battery replacement is not frequent compact stacking is practical.

This is done using the three rear-panel switches.

If you find your assembled clock is not keeping precise time, you will have to adjust the oscillator frequency with the adjustment capacitor. This can be done with or without equipment. With a frequency counter you simply set the oscillator up to provide the exact frequency specified in the instructions. Using a communications receiver tuned to WWV, you can adjust the oscillator precisely in a matter of minutes. Without equipment you simply adjust the oscillator capacitor and wait a few hours to judge the result.

We tried setting up the clock without the counter and found that it took about four days to get the adjustment on the nose. Since then we've had the clock operating for about three months and find no significant drift. **R-E**

THE IR FINDER

Infrared radiation is widely used in security countermeasures and in scientific, military and industrial applications. You can get to know what it's all about with this simple IR detector

by FORREST MIMS

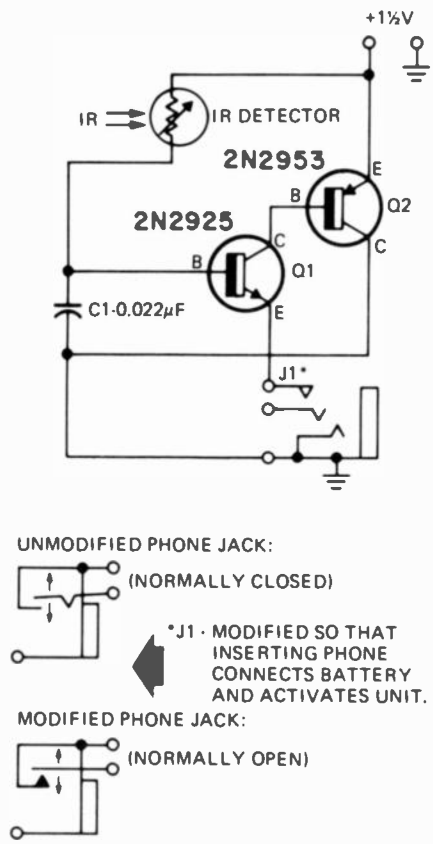
THE IR FINDER IS A SENSITIVE, VERSATILE infrared detection system that can be assembled in less than an hour, once the necessary parts have been collected. A variety of infrared detectors can be used with the unit. The completed instrument has many experimental and practical applications.

The heart of the IR Finder is a simple 2-transistor oscillator whose frequency is varied by an infrared sensitive photoconductive cell or thermistor. Infrared rays falling on the detector alters its resistance, changing the oscillator's output frequency. Normally, the output of the system is a low-frequency buzz. But when the unit is pointed toward a source of infrared, a high-pitched tone is heard.

The prototype IR Finder was installed in a small plastic flashlight case for convenience, and to take advantage of a built-in parabolic reflector. Using a parabola to collect the infrared is important for two reasons. First, it focuses more radiation on the detector. Second, a reflector is more efficient than a lens, since most kinds of glass absorb infrared. In essence, the reflector is to the detector what an antenna is to a radio.

While the flashlight I used is available from many distributors for about $1.20, the IR Finder can easily be installed in any convenient container. If you are using a flashlight case like the one in the photographs, begin construction by opening the flashlight and removing the battery contact from the top side of the back of the case. This makes room for a miniature phone jack. Leave the two battery contacts on the lower side of the case in place, as the unit's power supply cell will be inserted in this space later. Install the phone jack by carefully drilling a ¼-inch hole in the rear of the case in the space formerly occupied by the battery clip.

Following the parts layout in the photo, assemble the oscillator circuit. Solder the leads directly to one another to form a self-supporting structure. There are only three components to install, so a conventional circuit board is not necessary. Use insulation, if necessary, to prevent leads from shorting. Do *not* trim excess lead lengths from the components at this point.



CIRCUIT OF THE INFRARED DETECTOR

PARTS LIST

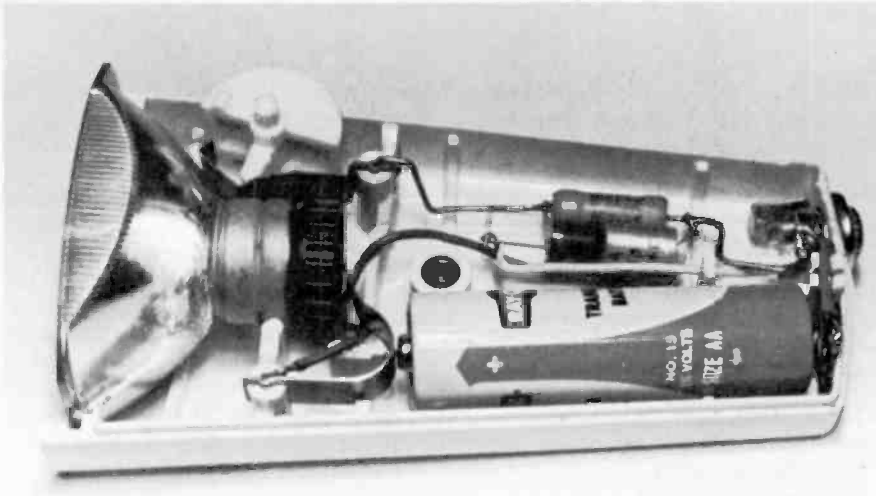
B1 — 1.5-volt AA cell
C1 — 0.022 µF
J1 — miniature phone jack
Q1 — 2N2925 or equivalent
Q2 — 2N2953 or equivalent
IR1 — Infrared detector (see text)

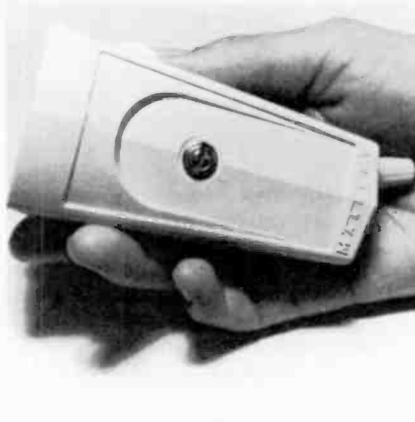
Magnetic earphone, hookup wire, solder, flashlight (Mallory or Radio Shack), PR-4 lamp (supplied with flashlight), etc.

When the components are soldered together, solder 2-inch lengths of hookup wire to the appropriate leads of Q1 and Q2 so they will reach the phone jack and detector contact. Then trim all excess lead lengths except from C1. Bend the leads of C1 as shown in the photo, and insert them in the appropriate spaces in the flashlight switch and phone jack. It isn't necessary to solder the two leads inserted into the contact holes as the friction should be great enough for a good electrical contact. Complete the electrical assembly by soldering the leads connected to the negative battery terminal and phone jack.

The IR Finder is completed by installing a detector. The prototype uses a small lead sulfide (PbS) cell purchased from Radio Shack as part of an infrared detector package. The cell sensitive to a range of wavelengths extending from about 1 to 3 microns at room temperature. Other detectors can be used as well—so long as their resistance varies with temperature or infrared. For example, a thermistor with a room temperature resistance that falls somewhere between 10,000 and 100,000 ohms can be used, but its response time will be much slower than the PbS cell. For near-IR detection at about 0.75 microns, an inexpensive cadmium selenide (CdSe) detector such as the Clairex CL603, CL703, or CL903 can be used.

The parabolic reflector of the plastic flashlight makes for a convenient detector installation. Remove the PR-4 lamp from the holder, and carefully break and remove the glass bulb. Be sure to protect your eyes from flying glass. A good technique is to wrap the bulb in several layers of tissue, and crack it with gentle pressure from a pair of pliers.





THE HAND-HELD IR FINDER. Pointing it at heat raises the note in the earphone.

INSIDE THE IR FINDER. Battery contact is removed so earphone jack can be installed.

When the glass has been removed, carefully remove the filament with tweezers, wrap the detector leads around the filament support, and solder them in place. Trim any excess lead lengths when complete. The photo shows both thermistor and lead sulfide detectors attached to PR-4 lamp bases. Both have been used in the prototype IR Finder.

TWO TYPES OF DETECTORS can be mounted equally well on the lamp base.

AUTHOR'S WIFE DEMONSTRATES with a visible source, which also emits infrared rays.

When the detector assembly is completed, insert it in the lamp receptacle in the parabolic reflector, and replace the reflector in the flashlight case. Turn on the device by pushing forward on the flashlight switch, and plugging in the earphone. When the IR Finder is pointed toward an incandescent lamp, a high-pitched tone should be heard in the earphone. The tone's frequency will vary as the IR Finder is pointed away from the lamp.

The sensitivity of the IR Finder depends on the detector used. The PbS (lead sulfide) cell, for example, will easily respond to a candle flame more than 50 feet away. The PbS and thermistor detector will also respond to a hot stove, soldering iron, and even a warm auto engine. Sensitivity of the PbS cell is outstanding, particularly since its very small active area (only about 0.1 mm^2) permits only a small amount of the IR collected by the reflector to be detected. A more efficient reflector system should improve performance considerably.

Other detectors give similar results. Cadmium sulfide and cadmium selenide cells will also detect a candle at about 50 feet, but they respond more to the flame's visible light than to the infrared. Consequently, results with these inexpensive detectors will probably be best with the room lights turned off. The PbS cell and thermistor will respond nicely to the candle flame in bright ambient illumination.

Now that you've built the IR Finder—or at least are preparing to—don't put it on the shelf after experimenting with it for a few hours. Keep it handy; it's a great gadget for locating miscellaneous warm objects (ranging from hot water pipes to overheated electronic components), and it's an interesting conversation piece to demonstrate to friends and associates who have not yet been turned on to the invisible world of infrared. **R-E**

ELECTRONIC CASINO

by WALLER M. SCOTT

NOTE TO READERS
This is not a construction article! We have not seen an assembled version of the Electronic Casino. However, this story does contain enough information to enable a reader who expects to do a bit of experimenting to build the unit. If you do build your own version of the Electronic Casino, we'd appreciate receiving a glossy photo of the assembled unit and will publish it in our Letters column. —**Editor**

THIS IS A CONTINUATION OF AN ARTICLE that began last month. You'll need the March issue for diagrams of the power supply and audio amplifier used for the sound effects of each game.

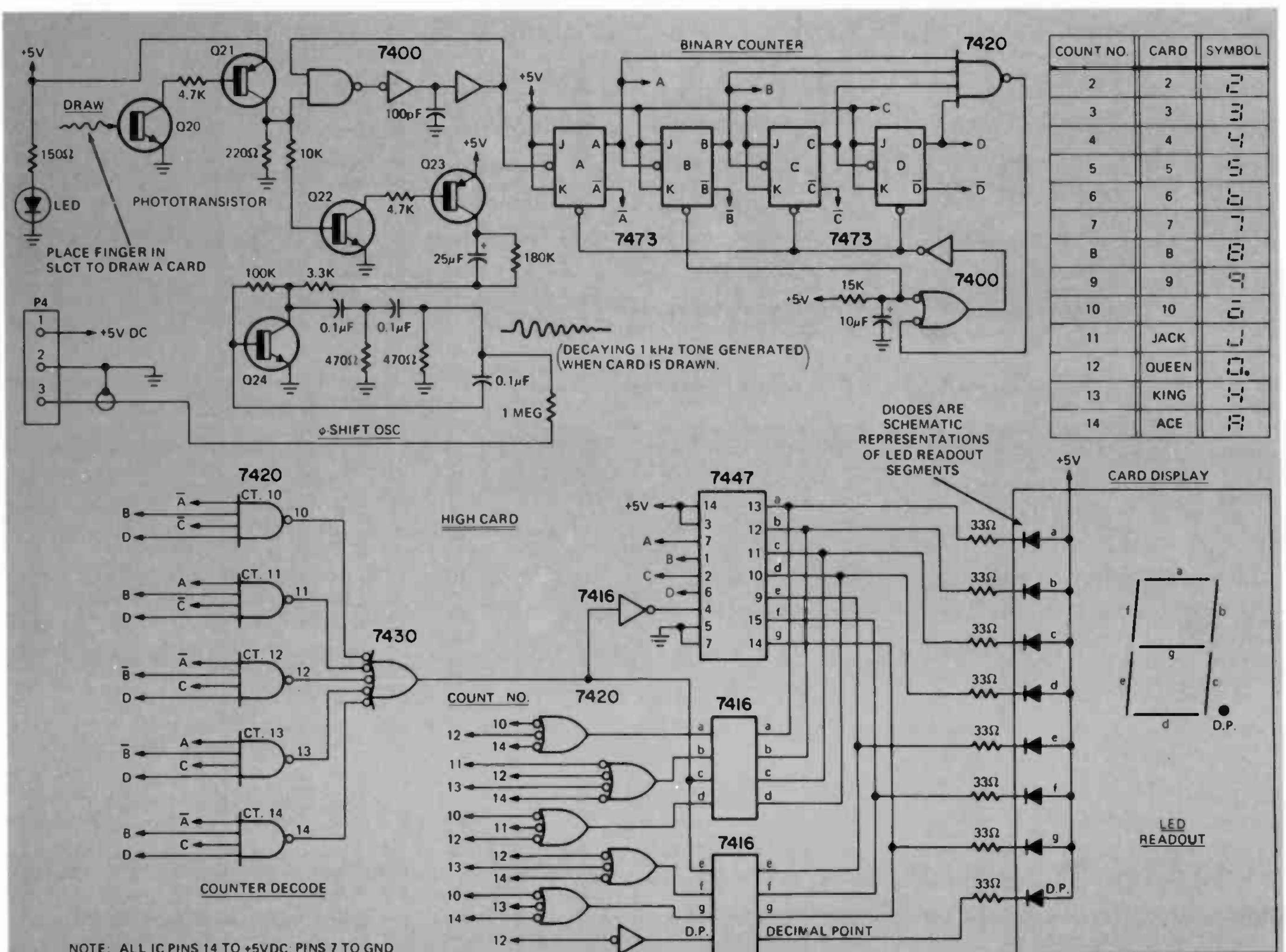
High card

Fig. 6 describes an electonic deck of cards used in a game of High Card. Cards 2 through ace can be drawn; however, no indication of suit is provided.

Instead of depressing a switch, this game is played by inserting a finger or other object into a slot in the panel containing a LED and phototransistor. The LED is normally on which keeps the phototransistor turned on through the optical coupling between the two. When an object breaks the light path in this photosensor, Q20 turns on control transistor Q21 which starts a familiar three gate oscillator. The output of this three-gate oscillator clocks a 15-counter which has 13 states for the 13 cards and 2 states which are reset states. The counter is reset to state 1 when the game is turned on. No card number is displayed at this time. After the first card is drawn by triggering the photosensor with a finger, the oscillator clocks the counter at a several MHz rate. The counter goes through the sequence 2,3,4, ... 12,13,14,2,3, ... over and over. Count number 15 exists for only a few nanoseconds while the counter is reset back to count 2.

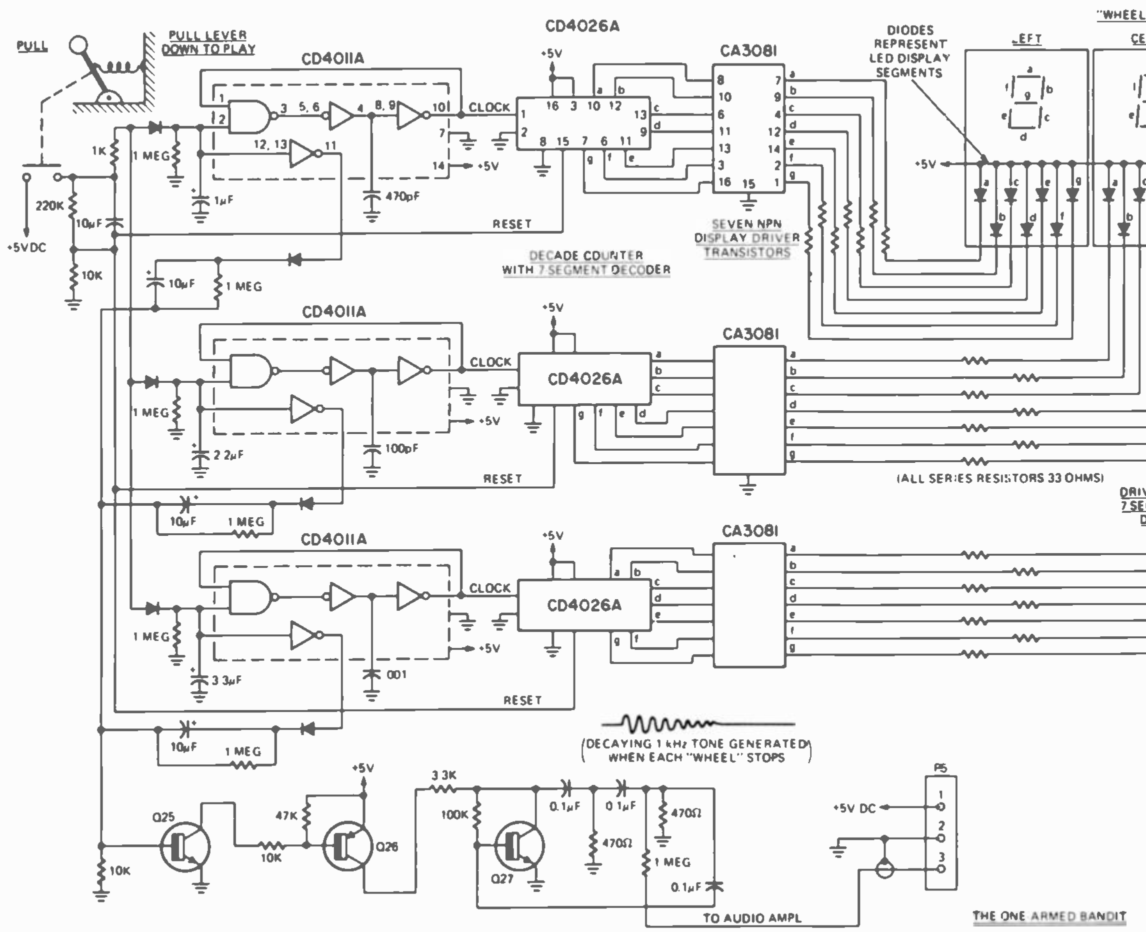
The A,B,C, and D flip-flop outputs are decoded according to the particular count number in the repeating sequence. Counts 2 through 9 correspond to cards 2 through 9. These counts are decoded by a 7447 7-segment decode/driver integrated circuit. A 7-segment LED display is driven by the 7447 to display the characters representing cards 2 through 9. Cards 10 through ace are decoded by TTL gates and through 7416 display drivers, display the special characters representing cards 10 through ace.

At the time the oscillator starts sorting through the "deck of cards" Q22 and Q23 are turned on energizing the circuit of Q24 which is a phase-shift oscillator operating at approximately 1



COUNT NO.	CARD	SYMBOL
2	2	
3	3	
4	4	
5	5	
6	6	
7	7	
8	8	
9	9	
10	10	
11	JACK	
12	QUEEN	
13	KING	
14	ACE	

FIG. 6.—HIGH CARD—a game that indicates any one of the 13 cards of a suit at random. At the flick of a finger, the "card" drawn appears on a 7-segment readout.



SCORING	
NO	POINTS
999	100
888	75
777	50
666	25
555	15
444 THRU 111	10
99	5
88	3
77 THRU 11	2
0	50
00	100
000	300

FIG. 7—THE ONE-ARMED BANDIT simulates the old familiar slot machine, in sight and sound. You don't need coins, just add the power supply and amplifier shown last month.

KHz. The output of this oscillator is coupled to the audio amplifier. The 1-kHz tone decays in amplitude as the 25-μF capacitor (in series with the collector of Q23) charges up. Thus the tone is heard immediately upon inserting a finger in the slot to DRAW a card.

This "deck of cards" could be used for the game of "21", as well as high card, and perhaps others. One thing nice about this card game—you never have to shuffle the cards!

The one-armed bandit

The circuit of Fig. 7 depicts a desparado who is famous for relieving you of your coins. In this economy version the Bandit can be awakened by merely pulling the big lever marked PULL—no coins required.

CMOS (Complimentary Metal-Oxide Semiconductor) logic circuits are used in this game. These IC's require only a few microwatts of power per gate function. High noise immunity and availability of complex function IC's are other advantages.

Upon pulling the lever and closing the PULL switch, three separate 3-gate oscillators are started. The output pulses of these oscillators are at different frequencies and are used to drive three decade counters. These counters continue counting 0-1-2- . . . . 8-9-0, etc. until the switch is opened and the three separate timing capacitors discharge. For example, when the 1-μF capacitor discharges, the HIGH is removed from the first 3-gate oscillator input and oscillation stops.

Each decade counter chip contains a BCD to 7-segment decoder. The decoded decimal number, represented in binary form by the counter, is fed from the device in the form of *a—g* segment drive signals to an LED display. The three oscillator/counter chains drive three different displays representing the left, center, and right wheels of a slot machine. The timing capacitor values are chosen to cause the left "wheel" to stop first, then the center, and the right last.

A phase-shift oscillator is switched on by a CMOS gate and control transistors Q25 and Q26 just as each oscillator stops. This oscillator provides a decaying 1-kHz tone to the audio amplifier when each "wheel" stops. A suggested scoring chart is provided in Fig. 6 to aid in playing the One-Armed Bandit game.

Undoubtedly, by now, some of the more ingenious among you have wondered how to convert this circuit to one which requires coins for operation and pays off in same. To paraphrase all good textbooks, this conversion is left as an exercise to the gambler!

Summary

The various schematics show resistor and capacitor values as well as TTL part numbers, the CMOS IC's are identified with RCA part numbers. Other sources of these IC's are becoming available. All diodes can be small-signal types with appropriate PIV and current ratings, except for the power supply diodes. Transistors are small-signal switching types except for the +5Vdc series pass transistor and solenoid driver which should be Motorola MJE520's, or similar npn power transistors. Depending on circuit layout and wiring, the various flip-flop IC's may require bypass capacitors across their supply voltage and ground pins. Generally, layout is not critical and the Casino can be built in a variety of forms. If you are so inclined, you can add or substitute games of your own design to the five described here.

The Electronic Casino should provide many hours of entertainment while constructing it in breadboard or more permanent fashion. Afterward you will have an electronic gadget which will create considerable interest and provide amusement for yourself, your family, and even your non-electronic friends. **R-E**

R TV IS HERE!

Build it yourself... the perfect way to learn all about the exciting field of digital electronics!

It's part of a complete at-home program!

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There's a lot more to digital electronics than just the numbers! True, that's what you see on more and more products like digital calculators, clocks and watches. But behind the numbers lies a fantastic technology that's creating higher standards of accuracy and dependability. The versatility of digital electronics has begun another industrial revolution. Its growth and applications are giving us new and better ways of doing things and spectacular products like this new Bell & Howell digital color TV!

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Step-by-step TV Troubleshooters Guide

A TV set with multiple troubles can be a "dog" if you don't use the right approach. Let's look a simultaneous sync, agc and color ills.

by STAN PRENTISS

JUST IN CASE YOU'VE FORGOTTEN, there are still some vacuum-tube color TV's around, and there will be some for at least another ten years. But the newer ones have their tubes and transformers, deflection and convergence assemblies mounted just a little closer together, and circuit board components buried a little further underneath. So with boards that don't unplug, hot tubes, and less working space, servicing these hybrid or all-tube receivers can become a chore. But the right tools and a considered approach can overcome many handicaps.

For instance, a "friend" brought in a 1967 RCA CTC22 (Fig. 1) that had the usual "minor" troubles such as no horizontal and vertical sync, agc that would cut off but not saturate, no color, and a brightness control whose rotation had positively no effect. He swore all tubes had been checked, dc voltages were good, and that just a little "twiddling" would turn the beast into a winner. I agreed that certainly something could be done. But instead of using a voltmeter, we put in a tube mount following the video detector, and 'scoped the first video amplifier and the sync, agc, and chroma driver V203. We found both a cathode-shorted 5GH8A and no output. The tube was replaced, but apparently damage had been doubly done, for the same troubles continued, and we still could not control sync or luminance, or produce color.

The approach

Now the worst possible action in such a situation is to begin pulling tubes, probing with voltmeters, and otherwise aimlessly killing time. What needs doing is to find the problem circuit as quick as possible, *then* select stage and components for checks in the likely area. The easiest way, of course, is with a well-calibrated dc oscilloscope, preferably with accurate, stable, triggered sweep. And the first point to look at is TP201, just following the video detector. Here you can determine if the signal has normal amplitude—that is, has approximately a ratio of 30 percent for sync pulses and 70 percent for video (fully modulated)—and whether there is clipping, smear (high-frequency information where it shouldn't be), ripple (low-frequency sinewave-type interference

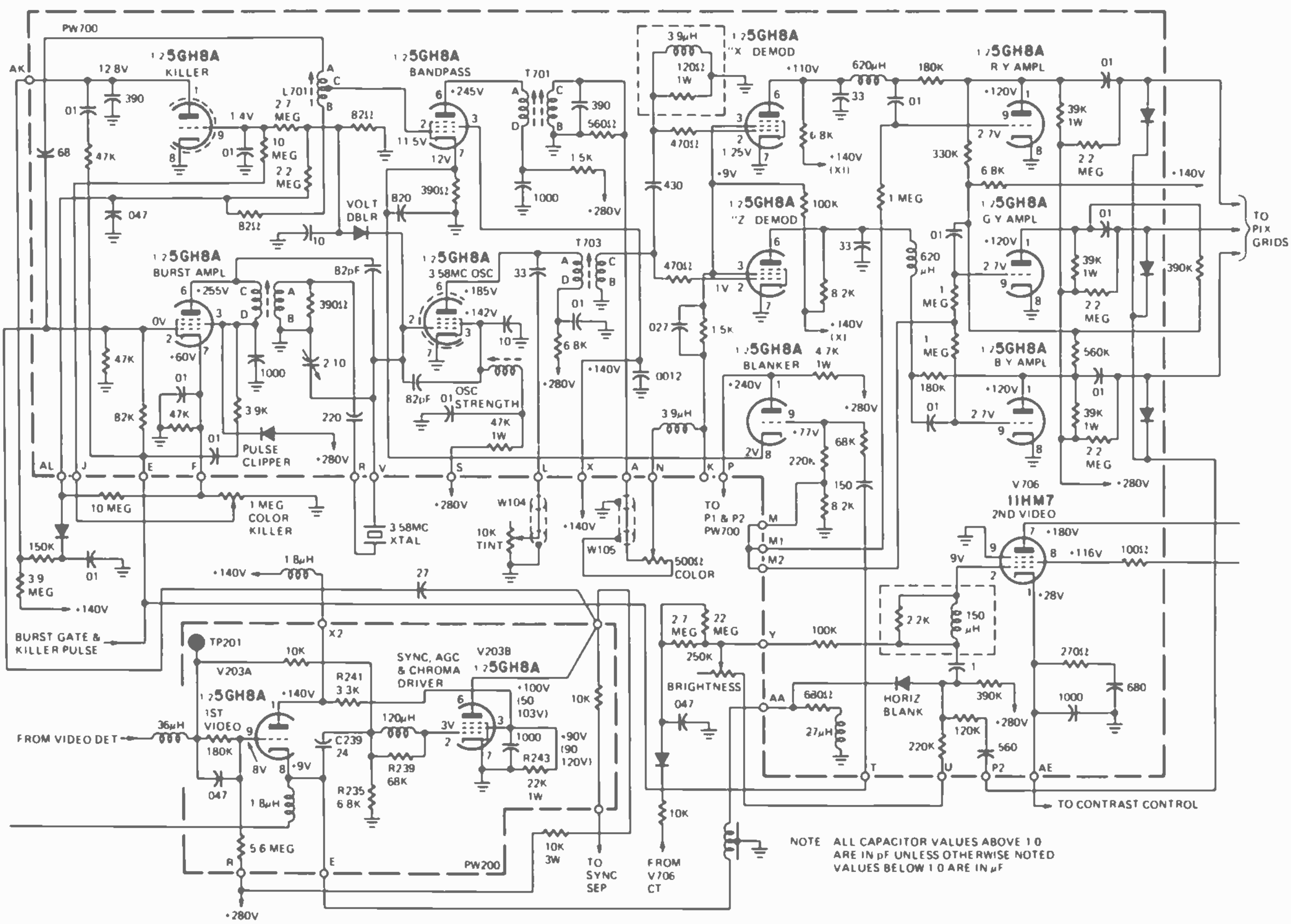


FIG. 1—RCA CTC22 LUMINANCE AND CHROMA SUBSYSTEMS. The trouble was due to a shorted V203B (sync, agc, and chroma driver).

weave, usually from the power supply), or sync compression, which ordinarily means agc problems.

In the Y1W1 trace (Fig. 2), you can see none of these, even at the grid of the sync, agc, and chroma driver V203B, although the dc level is more than 3 volts negative, while the schematic shows only 0.3 volts positive. (But this voltage is probably *static* and taken without incoming signal.) C239, R235, and R239 probably generate some self bias; so, we'll pass this negative situation by for the time being. In the plate circuit of V203B, however, with its 10-K, 3-W load resistor, no video shows (Y2W1, Fig. 1), but the 100-volt-per-division dc has risen to 280 volts, the value of the receiver's dc prime power supply. With no ripple, adequate value, and steady state, there is obviously nothing wrong with B+ . . . .Nonetheless, the V203B tube is not conducting.

Evaluation

Like any careful technician would, let's see what the screen grid, its divider, and bypass capacitor have to offer. RCA's dc readings say it should be between 90 and 120 volts. And here you read (on your dc scope) O volts! Do you jump on this right away? Not by a long shot! What's the voltage at the plate of V203A? It turns out to be 165. This indicates immediately that the pin 3 1-watt screen divider is probably open, since the 140-volt supply is less loaded, and therefore has risen 20 percent.

Before we move too fast, though, remember that brightness is frozen, agc offers short range, and sync remains poor. If R243 is actually open, would one resistor cure *all* these problems? Chroma, sync, and agc would certainly benefit, but the brightness control is nothing more than a negative dc bias for the grid of the second video amplifier, derived by diode rectification from the heater of the V706 video amplifier, and may not respond unless the video level itself changes radically when the sync, agc, and chroma driver fault is repaired. At any rate, let's see . . . . And remember that not one portion of the receiver has yet been disturbed except for the exchange of a single tube—the 5GH8A—for a new one, to see if sync and chroma would return to normal. The tube mount and new tube remain in place.

So the next step is to remove both tube and mount, and look around. The first thing we see is a 1-watt resistor burned to a crisp, located "conveniently" as always, just *under* the large video detector and third i.f. transformer shielding. Another ½-watt resistor alongside is little more than gray carbon ash. A look at their positions on the PW200 board reveals they are the R243 screen bypass and R241, the

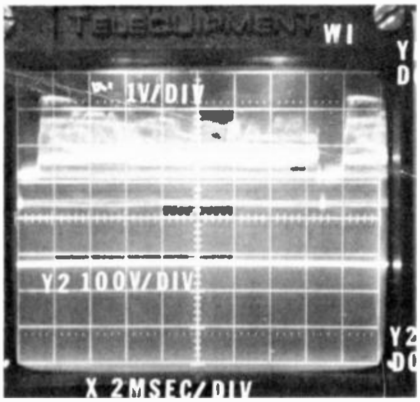


FIG. 2—V203B, SIGNAL IN AND OUT.

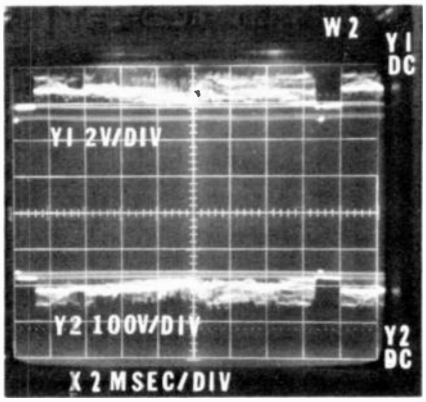


FIG. 3—GRID AND PLATE SIGNALS on V203B after burned resistors were replaced.

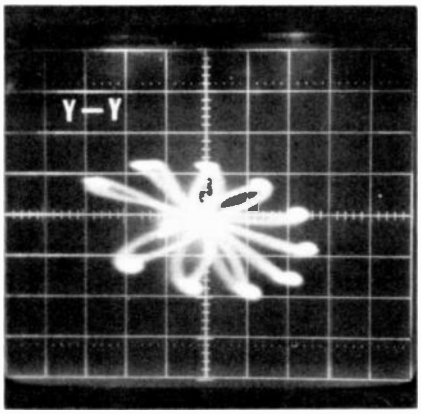


FIG. 4—FIRST VECTORSCOPE PATTERN.

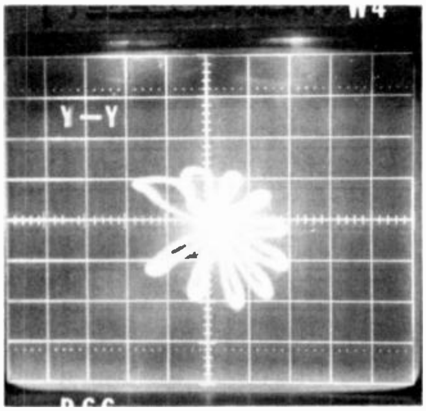


FIG. 5—PATTERN AFTER ADJUSTMENT.

other portion of the series divider to the 140-volt bus. Obviously this is the seat of the problem, and both require replacing. A cathode short can do remarkable damage.

The repair

Since complete chassis removal is not easy, bottom and top retaining screws can be backed out, and a little discreet prying will uncover the upper right and center subsection. Then, if the leads of the damaged resistors are clipped close to their bodies, a certain amount of solder-coated copper lead remains. A hot soldering iron and a pair of long-nose pliers can now be used on the *component* side of the board to push the cut leads through far enough to be identified. Then, tinned and shortened replacement resistor leads inserted in the pc board can now be easily located on the board's *circuit* side and soldered securely in place. The "pry" is then removed, safety insulation (hot chassis) checked, the tuner-to-chassis ground resoldered, and the usual dozen screws replaced.

But how about the 1,000-pF bypass capacitor that shunts R243—do you have to haul that out and check it too? Not at all! With your new 5GH8A sitting in the tube mount, simply put the dc oscilloscope to pin 3, and see what happens. If you have at least between 90 and 120 volts, there is no further problem at this terminal unless you see *excessive* signal. A 0.001-μF capacitor isn't going to remove all video here, so a modest remnant is all right.

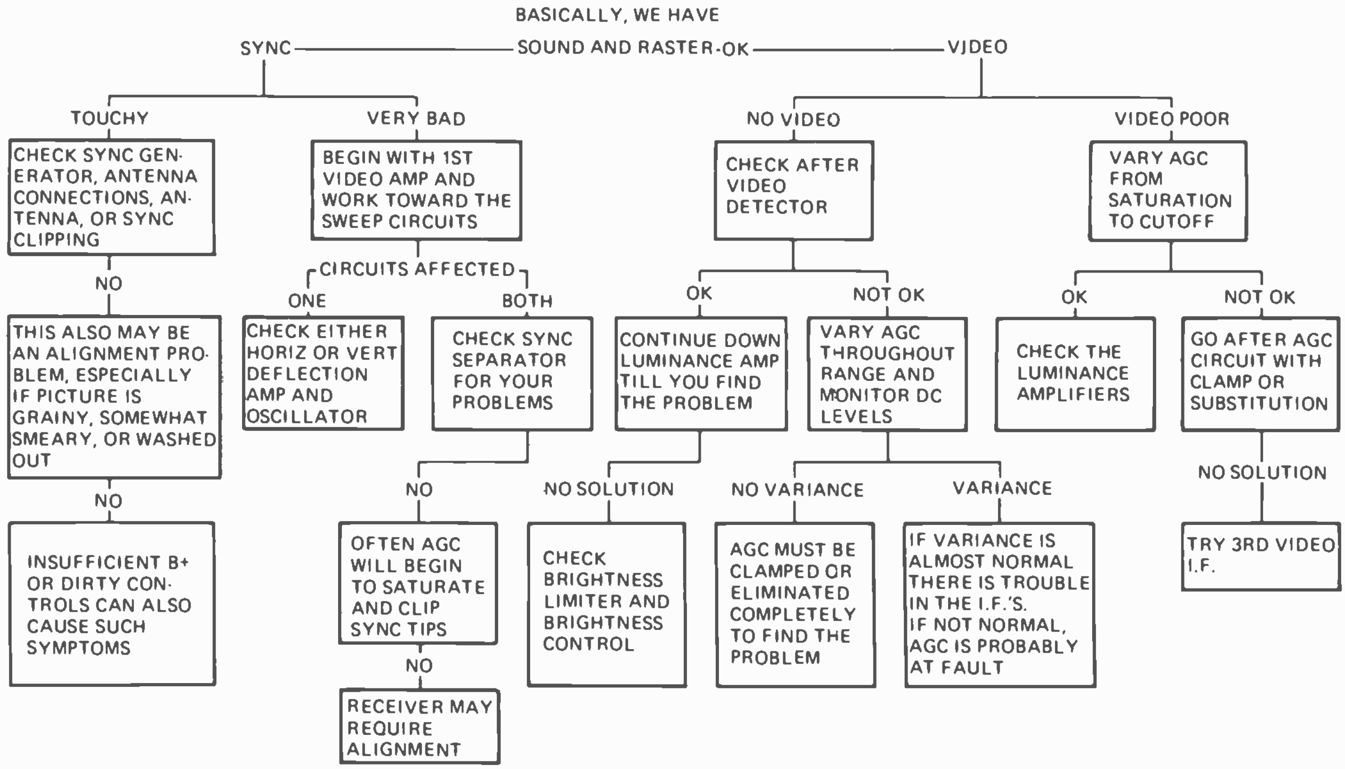
The resulting waveforms for grid and plate of V203B now appear in Fig. 3 (W2). The Y1W2 top is 2 volts per division, and the Y2W2 bottom is 100 V/div. The only possible fault that can now be found might be the amplitude of the sync pulse portion of Y2W2. However, both vertical and horizontal sweeps are steady, and there is no reason to believe there are further problems, at least in this stage. Further, agc will now swing from saturation to cut off, and remove all picture information at either end.

The color portion, however, does take a few extra moments to merge from something nearly purple to normal flesh tones. Since there's no width problem, this often means slow warm-up of the picture tube or a second set of 5GH8A RGB−Y amplifiers. With a new set installed, the receiver turned on properly, color appeared and remained in satisfactory phase and amplitude, and focus plus overall luminance seemed ample. There was one other consideration, however . . . . Are the chroma circuits aligned?

Using a vectorscope

In modestly priced tube receivers such as this one, burst transormers firing ringing-crystals are often used to excite either a 3.58-MHz subcarrier

TROUBLE-FINDING CHART—SYNC AND CHROMA



amplifier or oscillator, with the tint function simply an RC control about the oscillator itself. Now, if the tint potentiometer will turn flesh tones from natural to green at one extremity of rotation and to lavander at the other, you have the usual 30-degree plus swing on either side of control mechanical center, and nothing further need be done. If an adjustment is necessary, set the tint control at center, and twiddle the burst transformer for flesh tones *while the receiver is on the air*. The T703 3.58-MHz output transformer seldom, if ever, needs adjustment, and then only for an ac-dc null. In this case, with only one bandpass transformer, all that needs tender adjustments are chroma take-off coil L701 and double-tuned bandpass transformer T701.

But we must use an oscilloscope/vectorscope that won't load the high-impedance tube outputs, and a color bar generator that hasn't got "crawlies," color bars that run up and down, or broad striped bars instead of narrow, clean ones. Here we used a new Sencore Color King IV and a Telequipment (Tektronix) D66 with Y-Y instead of X-Y inputs so that both Y channels are phase-matched and have identical and adjustable gains, plus the same 10-meghom impedance when used with the usual 10X low-capacitance probes. Further, since this receiver is an R−Y and B−Y system, with luminance and chroma matrix in the picture tube, no removal of luminance information is necessary, as in RGB receivers where *both* luminance and chroma go to the cathodes of the picture tube already mixed.

Our initial pattern on a channel 3 input appears as in W3 (Fig. 4). The objective of the entire procedure is to get relatively symmetrical, straight-sided petals out of the pattern with *absolutely no crossovers*. Initially, be *positive* your fine tuning places the magenta fourth bar from the left—the first color bar is usually hidden—exactly on target with tint control at mechanical center. Then go to chroma take off L701 and T701, and twiddle these two for best pattern.

If the initial pattern as shown in W3 looks this good on single bandpass transformer receivers, you could stop right here and not do a lick more. But there is a crossover in petal No. 1 (extreme left), and you may be able to reshape all petals symmetrically and delete crossovers at the same time with some careful manipulation of the bottom and top cores of T701, you're pretty close when the pattern in W4 (Fig. 5) is completed. A visual check of the color bars on the CRT still shows the fourth magenta bar where it should be, the tint control rotatable through its green to lavender range, producing flesh tones at center. **R-E**

READER COMMENTS WANTED

We'll soon complete the listing of substitutes for semiconductors with 2N type numbers and will then start on foreign types. We can begin with either European types like the AC105 and BC107 or Japanese types such as the 2SA152. Please let us know whether you want the European or Japanese listings first.

R-E's Substitution guide for replacement transistors PART XIV

compiled by

ROBERT & ELIZABETH SCOTT

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

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

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

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

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

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

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

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

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

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

WOR—Workman Electronic Products, Inc., Box 3828, Sarasota, Fla. 33578

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

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

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	WOR	ZEN
2N2987	NA	T-714	GE-18	NA	NA	PTC 144	HEP-714	NA	NA	NA	NA	NA
2N2988	NA	T-714	GE-18	NA	NA	PTC 144	HEP-714	NA	NA	NA	NA	NA
2N2989	NA	T-714	GE-18	NA	NA	PTC 144	HEP-714	NA	NA	NA	NA	NA
2N2990	NA	T-714	GE-18	NA	NA	PTC 144	HEP-714	NA	NA	NA	NA	NA
2N2991	NA	NA	NA	NA	NA	NA	HEP-714	NA	NA	NA	NA	NA
2N2992	NA	NA	NA	NA	NA	NA	HEP-714	NA	NA	NA	NA	NA
2N2993	NA	NA	NA	NA	NA	NA	HEP-714	NA	NA	NA	NA	NA
2N2994	NA	NA	NA	NA	NA	NA	HEP-714	NA	NA	NA	NA	NA
2N2995	NA	NA	NA	NA	NA	NA	HEP-714	NA	NA	NA	NA	NA
2N2996	RS276-2003	T-3	GE-51	ICC-3	TR-17	PTC 107	HEP-3	SK 3006	NA	NA	WEP-637	ZEN 301
2N2997	RS276-2003	T-3	GE-51	ICC-3	TR-17	PTC 107	HEP-3	NA	NA	NA	WEP-637	ZEN 301
2N2998	RS276-2003	T-3	GE-51	ICC-3	TR-17	PTC 107	HEP-3	NA	NA	ECG 160	WEP-637	ZEN 301
2N2999	NA	T-636	NA	NA	TR-17	PTC 107	NA	NA	NA	ECG 160	WEP-637	NA
2N3000	NA		NA	NA	NA	NA	HEP-630	NA	NA	NA	NA	NA
2N3001	NA	NA	NA	NA	NA	NA	HEP-R1001	NA	NA	ECG 5400	NA	NA
2N3002	NA	NA	NA	NA	NA	NA	HEP-R1002	NA	NA	NA	NA	NA
2N3003	NA	NA	NA	NA	NA	NA	HEP-R1003	NA	NA	NA	NA	NA
2N3004	NA	SR-1005	NA	ICC-R1005	NA	NA	HEP-R1005	NA	NA	NA	NA	NA
2N3005	NA	NA	NA	NA	NA	NA	HEP-R1001	NA	NA	ECG 5400	NA	NA
2N3006	NA	NA	NA	NA	NA	NA	HEP-R1002	NA	NA	ECG 5401	NA	NA
2N3007	NA	SR-1003	NA	NA	NA	NA	HEP-R1003	NA	NA	ECG 5402	NA	NA
2N3008	NA	SR-1003	NA	NA	NA	NA	HEP-R1005	NA	NA	ECG 5404	NA	NA
2N3009	RS276-2009	T-50	GE-20	ICC-50	IRTR-64	PTC 136	HEP-50	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 100
2N3010	RS276-2011	T-56	GE-61	ICC-56	IRTR-24	PTC 136	HEP-56	SK 3039	RT-113	ECG 108	WEP-56	ZEN 104
2N3011	RS276-2011	T-56	GE-20	ICC-56	IRTR-24	PTC 136	HEP-56	SK 3039	RT-113	ECG 108	WEP-56	ZEN 104
2N3012	Rs276-2023	T-52	GE-21	ICC-52	IRTR-24	PTC 127	HEP-52	SK 3114	RT-115	ECG 159	WEP-717	NA
2N3013	RS276-2011	T-56	GE-20	ICC-56	IRTR-64	PTC 136	HEP-56	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 104
2N3014	RS276-2011	T-56	GE-20	ICC-56	IRTR-64	PTC 136	HEP-56	SK 3122	RT-102	ECG 123A	WEP-735	ZEN 104
2N3015	NA	T-729	GE-17	NA	NA	PTC 121	HEP-S3001	NA	RT-100	NA	WEP-51	NA
2N3016	NA	NA	NA	NA	NA	NA	HEP-S3002	NA	NA	NA	NA	NA
2N3017	NA	NA	NA	NA	NA	NA	HEP-S3004	NA	NA	NA	NA	NA
2N3018	NA	NA	NA	NA	NA	NA	HEP-S3004	NA	NA	NA	NA	NA
2N3019	NA	T-714	GE-18	ICC-714	NA	PTC 125	HEP-714	NA	NA	NA	NA	NA
2N3020	NA	T-706	GE-27	NA	NA	PTC 144	HEP-714	NA	NA	NA	NA	NA
2N3021	NA	TS-3031	GE-69	NA	NA	NA	HEP-246	NA	NA	NA	NA	NA
2N3022	NA	TS-3031	GE-69	NA	NA	NA	HEP-246	NA	NA	NA	NA	NA
2N3023	NA	TS-3031	GE-69	NA	NA	NA	HEP-246	NA	NA	NA	NA	NA
2N3024	NA	TS-3031	GE-69	NA	NA	NA	HEP-705	NA	NA	NA	NA	NA
2N3025	NA	TS-3031	GE-69	NA	NA	NA	HEP-705	NA	NA	NA	NA	NA
2N3026	NA	TS-3031	GE-69	NA	NA	NA	HEP-705	NA	NA	NA	NA	NA
2N3027	NA	SR-1001	NA	ICC-R1001	NA	NA	HEP-R1001	NA	NA	ECG 5400	NA	NA
2N3028	NA	SR-1002	NA	ICC-R1002	NA	NA	HEP-R1002	NA	NA	ECG 5401	NA	NA
2N3030	NA	SR-1001	NA	ICC-R1003	NA	NA	HEP-R1003	NA	NA	ECG 5402	NA	NA
2N3031	NA	SR-1002	NA	ICC-R1002	NA	NA	HEP-R1002	NA	NA	ECG 5401	NA	NA
2N3032	NA	NA	NA	NA	NA	NA	HEP-R1003	NA	NA	ECG-5402	NA	NA
2N3033	NA	NA	NA	NA	NA	PTC-125	NA	NA	NA	NA	NA	NA
2N3034	NA	T-714	GE-18	NA	IRTR-53	PTC 123	NA	NA	NA	NA	WEP 243	NA
2N3035	NA	T-714	GE-18	NA	TR-21	PTC 153	NA	SK 3039	RT-113	ECG 108	WEP 56	NA
2N3036	NA	T-714	GE-18	NA	IRTR-87	PTC 123	HEP-714	NA	NA	NA	NA	NA
2N3037	NA	T-714	GE-18	NA	IRTR-87	PTC 123	HEP-S0001	NA	NA	NA	NA	NA
2N3038	NA	T-714	GE-18	NA	IRTR-87	PTC 123	HEP-S0001	NA	NA	NA	NA	NA
2N3039	NA	T-715	GE-21	ICC-715	TR-28	PTC 103	HEP-715	NA	NA	NA	WEP 717	ZEN 106
2N3040	NA	T-716	GE-21	ICC-716	TR-28	PTC-103	HEP-716	NA	NA	NA	WEP 717	ZEN 107
2N3043*	NA	T-728	GE-10	ICC-728	TR-24	PTC 121	HEP-728	NA	NA	NA	WEP 735	ZEN 114
2N3044*	NA	T-728	GE-10	ICC-728	TR-24	PTC 121	HEP-728	NA	NA	NA	WEP 735	ZEN 114
2N3045*	NA	T-728	GE-10	ICC-728	TR-24	PTC 121	HEP-728	NA	NA	NA	WEP 735	ZEN 114
2N3046*	NA	T-729	GE-10	ICC-729	TR-24	PTC 121	HEP-729	NA	NA	NA	WEP 735	ZEN 115
2N3047*	NA	T-729	GE-10	ICC-729	TR-24	PTC 121	HEP-729	NA	NA	NA	WEP 735	ZEN 115
2N3048*	NA	T-729	GE-10	ICC-729	TR-24	PTC 121	HEP-729	NA	NA	NA	WEP 735	ZEN 115
2N3049*	NA	T-716	NA	ICC-716	TR-20	PTC 103	HEP-716	NA	NA	NA	WEP 717	ZEN 107
2N3050*	NA	T-716	NA	ICC-716	TR-20	PTC 103	HEP-116	NA	NA	NA	WEP 717	ZEN 107
2N3051*	NA	T-716	NA	ICC-716	TR-20	PTC 103	HEP-716	NA	NA	NA	WEP 717	ZEN 107
2N3052*	NA	TS-3020	GE-63	NA	TR-25	PTC 144	HEP-S0004	NA	NA	NA	WEP 243	NA
2N3053	RS276-2018	T-714	GE-63	ICC-S3011	IRTR-87	PTC 144	HEP-S3011	SK 3024	RT-114	ECG 128	WEP 243	NA
2N3054	RS276-2017	T-703	GE-66	ICC-703	TR-57	PTC 112	HEP-703	SK 3026	RT-154	ECG 175	WEP 701	NA
2N3055	NA	T-704	GE-14	ICC-704	IRTR-36	PTC 140	HEP-704	SK 3027	RT-131	ECG 130	WEP 247	NA
2N3056	NA	T-714	GE-18	NA	IRTR-87	PTC 144	HEP-714	NA	NA	NA	NA	NA
2N3057	NA	T-714	GE-18	ICC-714	IRTR-87	PTC 110	HEP-714	NA	NA	NA	WEP S3021	NA
2N3058	RS276-2023	T-52	GE-21	ICC-52	NA	PTC 103	HEP-52	SK 3114	RT-115	ECG 150	WEP 717	NA
2N3059	RS276-2023	T-52	GE-67	ICC-52	NA	PTC 127	HEP-52	SK 3114	RT-115	ECG 159	WEP 717	NA
2N3060	RS276-2023	T-52	GE-67	ICC-52	TR-28	PTC 123	HEP-52	SK 3114	RT-115	ECG 159	WEP 717	NA
2N3061	NA	TS 3031	GE-67	NA	TR-28	PTC 103	HEP-739	NA	NA	NA	NA	NA
2N3062	RS276-2023	T-52	GE-21	ICC-52	IRTR-88	PTC 127	HEP-52	SK 3114	RT-115	ECG 159	WEP 717	NA
2N3063	NA	T-51	GE-21	NA	IRTR-88	PTC 127	NA	NA	NA	NA	NA	NA
2N3064	NA	T-51	GE-21	NA	IRTR-88	PTC 127	NA	NA	NA	NA	NA	NA

NA=NOT AVAILABLE

(turn page)

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	WOR	ZEN
2N3065	NA	T-51	GE-21	NA	IRTR-88	PTC 127	NA	NA	NA	NA	NA	NA
2N3066	NA	T-801	GE-FET-1	NA	NA	PTC 151	NA	SK 3112	NA	ECG 133	WEP 801	NA
2N3067	NA	T-801	GE-FET-1	NA	NA	PTC 151	NA	SK 3112	NA	ECG 133	WEP 801	NA
2N3068	NA	NA	NA	NA	NA	NA	NA	SK 3112	NA	ECG 133	WEP 301	NA
2N3069	NA	T-802	GE-FET-1	ICC-802	NA	PTC 151	HEP-802	NA	NA	NA	WEP 802	ZEN 123
2N3070	NA	T-802	GE-FET-1	ICC-802	NA	PTC 151	HEP-802	SK 3112	NA	ECG 133	WEP 801	ZEN 123
2N3071	NA	T-802	GE-FET-1	ICC-802	NA	PTC 151	HEP-802	SK 3112	NA	ECG 133	WEP 801	ZEN 123
2N3072	RS276-2023	T-52	GE-67	ICC-52	TR-28	PTC 127	HEP-52	SK 3114	RT-115	ECG 159	WEP 717	NA
2N3073	RS276-2023	T-52	GE-21	ICC-52	TR-20	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	WEP 717	NA
2N2074	RS276-2003	T-3	GE-9	ICC-3	TR-17	PTC 109	HEP-3	SK 3006	NA	ECG 160	WEP 637	ZEN 301
2N3075	RS276-2004	T-253	GE-9	ICC-253	IR-17	PTC 109	HEP-253	SK 3006	RT 118	ECG 100	WEP 254	ZEN 304
2N3077	NA	T-713	GE-18	ICC-713	TR-21	PTC 121	HEP-713	SK 3124	RT-114	ECG 128	WEP 243	NA
2N3078	NA	T-713	GE-18	ICC-713	TR-21	PTC 121	HEP-713	SK 3124	RT-114	ECG 128	WEP 717	NA
2N3081	RS276-2021	T-51	GE-67	ICC-51	NA	PTC 103	HEP-51	SK 3114	RT-115	ECG 159	WEP 717	ZEN 101
2N3082*	NA	T-729	GE-17	NA	NA	PTC 121	HEP-718	SK 3039	RT-108	ECG 107	WEP 720	NA
2N3083*	NA	T-729	GE-17	NA	NA	PTC 121	HEP-718	SK 3039	RT-108	ECG 107	WEP 720	NA
2N3084	NA	T-802	GE-FET-1	ICC-802	NA	PTC 151	HEP-802	SK 3112	NA	ECG 133	WEP 801	ZEN 123
2N3085	NA	T-803	GE-FET-1	ICC-802	NA	PTC 151	HEP-802	SK 3112	NA	ECG 133	WEP 801	ZEN 123
2N3086	NA	T-802	GE-FET-1	ICC-802	NA	PTC 151	HEP-802	SK 3112	NA	ECG 133	WEP 801	ZEN 123
2N3087	NA	T-802	GE-FET-1	ICC-802	NA	PTC 151	HEP-802	SK 3112	NA	ECG 133	WEP 801	ZEN 123
2N3088	NA	T-802	EG-FET-1	ICC-802	NA	PTC 151	HEP-802	SK 3112	NA	ECG 133	WEP 801	ZEN 123
2N3089	NA	T-802	GE-FET-1	ICC-802	NA	PTC 151	HEP-802	SK 3112	NA	ECG 133	WEP 801	ZEN 123
2N3100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N3107	NA	TS-3002	GE-18	ICC-S3002	IRTR-87	PTC 144	HEP-S3002	NA	NA	NA	WEP S3002	NA
2N3108	NA	TS-3002	GE-18	ICC-S3002	IRTR-87	PTC 144	HEP-S3002	NA	NA	NA	WEP S3002	NA
2N3109	NA	TS-3001	GE-18	ICC-S3001	IRTR-87	PTC 144	HEP-S3001	NA	NA	NA	NA	NA
2N3110	NA	TS-3001	GE-18	ICC-S3001	TR-25	PTC-144	HEP-S3001	NA	NA	NA	NA	NA
2N3112	NA	T-803	NA	ICC-803	NA	NA	HEP-803	NA	NA	NA	NA	NA
2N3113	NA	T-803	NA	ICC-803	NA	NA	HEP-803	NA	NA	NA	NA	NA
2N3114	NA	T-714	GE-27	ICC-714	IRTR-78	PTC 110	HEP-714	SK 3104	RT-110	ECG 154	WEP S3021	NA
2N3115	RS276-2009	T-53	GE-20	ICC-53	TR-21	PTC 136	HEP-53	SK 3122	RT-102	ECG 123A	WEP 735	ZEN 102
2N3116	RS276-2009	T-53	GE-20	ICC-53	TR-21	PTC 136	HEP-53	SK 3122	RT-102	ECG 123A	WEP 735	ZEN 102
2N3117	RS276-2009	T-55	GE-18	ICC-55	TR-21	PTC 123	HEP-55	SK 3124	RT-114	ECG 128	WEP 243	ZEN 103
2N3118	NA	T-714	GE-18	ICC-714	IRTR-87	PTC 110	HEP-714	NA	NA	NA	WEP S3021	NA
2N3119	NA	T-714	GE-27	ICC-714	IRTR-78	PTC 111	HEP-714	NA	NA	NA	WEP S3021	NA
2N3120	NA	T-53	GE-67	ICC-53	IRTR-88	PTC 127	HEP-53	SK 3025	RT-115	ECG 129	WEP 242	ZEN 102
2N3121	RS276-2021	T-51	GE-21	ICC-51	TR-20	PTC 103	HEP-51	SK 3114	RT-115	ECG 159	WEP 242	ZEN 101
2N3122	RS276-2009	T-53	GE-18	ICC-53	IRTR-63	PTC 144	HEP-53	SK 3122	RT-102	ECG 123A	WEP 735	ZEN 102
2N3123	NA	NA	NA	NA	NA	NA	HEP-S3011	NA	NA	NA	NA	NA
2N3124	NA	NA	NA	NA	NA	NA	HEP-625	NA	NA	NA	NA	NA
2N3125	RS276-2006	T-232	NA	ICC-232	IRTR-35	PTC 105	HEP-232	SK 3014	RT-127	ECG 121	WEP 232	ZEN 326
2N3126	NA	T-230	GE-3	NA	IRTR-35	PTC 138	HEP-625	NA	NA	NA	NA	NA
2N3127	NA	T-3	NA	ICC-3	TR-17	PTC 107	HEP-3	NA	NA	ECG 160	WEP 637	ZEN 301
2N3128	NA	T-729	GE-17	NA	NA	PTC 123	HEP-722	SK 3124	RT-102	ECG 123A	WEP 735	NA
2N3129	NA	T-729	GE-17	NA	NA	PTC 123	HEP-729	SK 3122	RT-102	ECG 123A	WEP 735	NA
2N3130	NA	T-709	NA	NA	NA	PTC 123	HEP-S0007	SK 3122	RT-102	ECG 123A	WEP 735	NA
2N3131	NA	NA	NA	NA	NA	NA	HEP-S0004	NA	NA	NA	NA	NA
2N3132	RS276-2006	T-232	GE-16	ICC-232	TR-01	PTC 105	HEP-232	SK 3009	RT-127	ECG 121	WEP 232	ZEN 326
2N3133	RS276-2021	T-51	GE-21	ICC-51	TR-19	PTC 103	HEP-51	SK 3025	RT-115	ECG 129	WEP 242	ZEN 101
2N3134	RS276-2021	T-51	GE-67	ICC-51	TR-19	PTC 141	HEP-51	SK 3025	RT-115	ECG 129	WEP 242	ZEN 101
2N3135	RS276-2021	T-51	GE-21	ICC-51	TR-19	PTC 103	HEP-51	SK 3114	RT-115	ECG 159	WEP 717	ZEN 101
2N3136	RS276-2021	T-51	GE-67	ICC-51	TR-20	PTC 103	HEP-51	SK 3114	RT-115	ECG 159	WEP 717	ZEN 101
2N3137	RS276-2011	T-56	GE-11	ICC-56	IRTR-64	PTC 133	HEP-56	SK 3039	RT 108	ECG 107	WEP 720	ZEN 104
2N3138	NA	TS-5003	GE-66	ICC-S5003	IRTR-66	NA	HEP-S5003	NA	NA	NA	NA	ZEN 210
2N3140	NA	TS-5003	GE-66	ICC-S5003	IRTR-66	NA	HEP-S5003	NA	NA	NA	NA	ZEN 210
2N3142	NA	TS-5003	GE-66	ICC-S5003	IRTR-66	NA	HEP-S5003	NA	NA	NA	NA	ZEN 210
2N3144	NA	TS-5003	GE-66	ICC-S5003	IRTR-66	NA	HEP-S5003	NA	NA	NA	NA	ZEN 210
2N3146	NA	T-230	GE-3	NA	NA	PTC 138	NA	NA	NA	NA	NA	NA
2N3147	NA	NA	GE-3	NA	NA	PTC 138	NA	NA	NA	NA	NA	NA
2N3148	RS276-2003	T-3	GE-1	ICC-3	TR-17	PTC 109	HEP-3	NA	NA	ECG 160	WEP 637	ZEN 301
2N3152	NA	TS-3021	NA	ICC-S3021	NA	NA	HEP-S3021	NA	NA	NA	WEP S3021	ZEN 208
2N3153	RS276-2003	T-3	GE-62	ICC-3	NA	PTC 129	HEP-3	NA	NA	ECG 160	WEP 637	ZEN 301
2N3154	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2N3163	NA	T-248	NA	ICC-248	TR-29	NA	HEP-248	NA	NA	NA	NA	NA
2N3164	NA	TS-5002	NA	ICC-S5002	NA	NA	HEP-S5002	NA	NA	NA	WEP WS5005	NA
2N3165	NA	TS-5005	NA	ICC-S5005	NA	NA	HEP-S5005	NA	NA	NA	WEP WS5005	NA
2N3166	NA	TS-5005	NA	ICC-S5005	NA	NA	HEP-S5005	NA	NA	NA	WEP WS5005	NA
2N3167	NA	TS-5008	NA	ICC-S5008	NA	NA	HEP-S5008	NA	NA	NA	WEP WS5005	NA
2N3168	NA	TS-5002	NA	ICC-S5002	NA	NA	HEP-S5002	NA	NA	NA	WEP WS5005	NA
2N3169	NA	TS-5005	NA	ICC-S5005	NA	NA	HEP-S5005	NA	NA	NA	WEP WS5005	NA

*Indicates a dual transistor for high-speed switching, diff amplifier etc. Likely to be a matched pair. Use two of the type specified, matching when necessary, on a curve tracer or lab-type transistor checker.

NA=NOT AVAILABLE

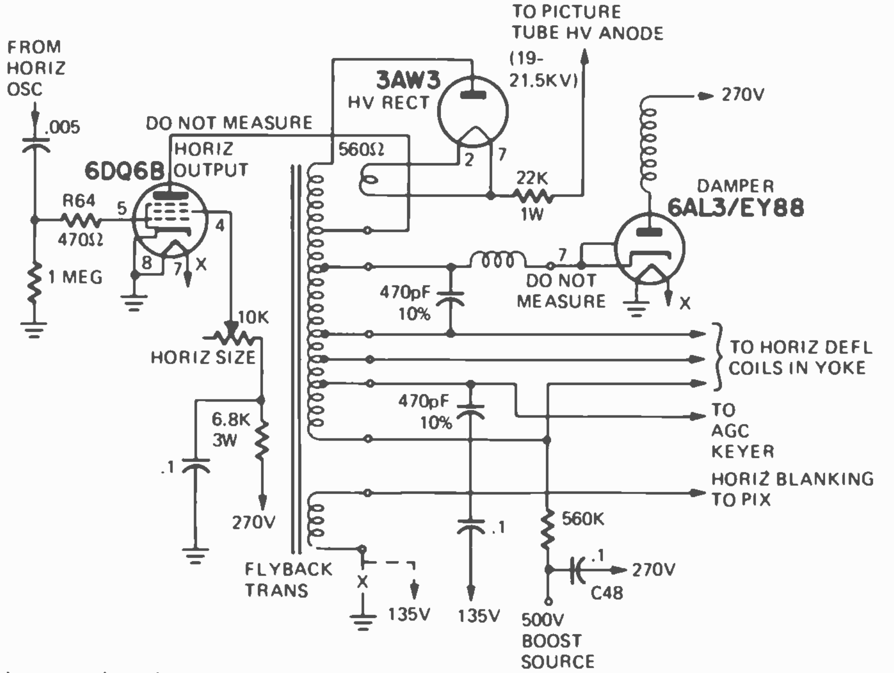
(continued next month)

(continued from page 27)

boost *filter*; note that the boost goes through 560k before it gets there.

If you'll check that 10-μF electrolytic capacitor in the +135 volt line, you'll find that it's *open*! This puts the 12K resistor "in series" with the boost pulse, and raises the impedance so much that you don't develop any boost voltage. I found about 75 to 80 volts p-p of hash on the one I had, indicating that the capacitor was wide open.

Without boost voltage (which is the *plate* voltage of the 6DQ6 horizontal output) you won't get enough output; you'll have half the high voltage and half the sweep width. This *is* a rather unusual circuit, but the basic *reactions* are just the same. R-E



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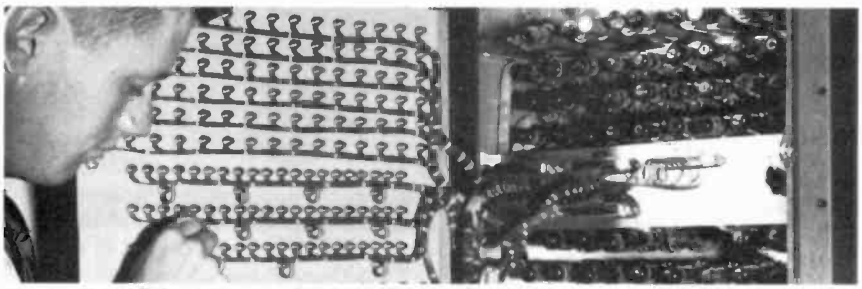
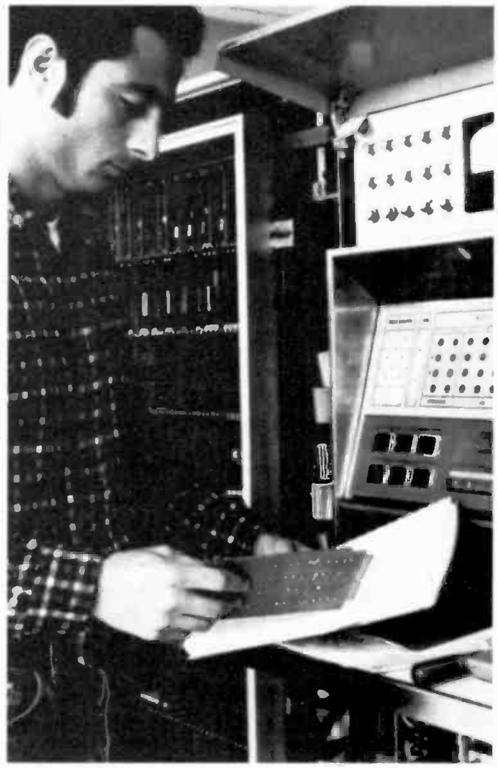


Master Technician: Communications Electronics



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ALL ABOUT TRANSFORMERS
(continued from page 45)

at B, and an ideal response at C. The typical transformer response varies less than 2.0 dB between 100 and 10,000 Hz, and is acceptable for most uses.

For replacement purposes, the "universal" audio output with many taps for impedance variation has been popular for many years. Figure 13 shows a similar transformer

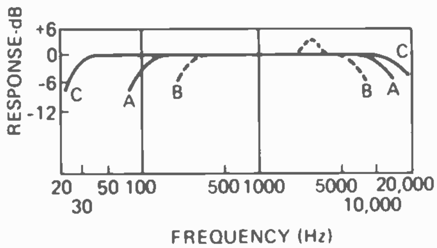


FIG. 12—FREQUENCY RESPONSE of three grades of af transformers. Curve A is typical, C is h-fi and B is acceptable for narrow-band communications equipment.

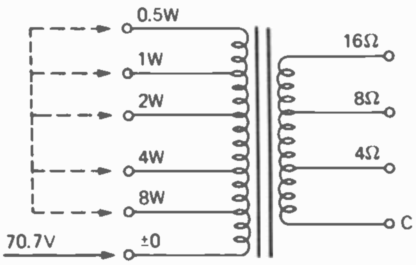


FIG. 13—PA MATCHING TRANSFORMER designed to distribute speaker power as needed.

that has recently become popular with 70.7-volt audio distribution systems. With this system, the output of an audio power amplifier at 70.7 volts (or 25 volts) can be divided in any desired manner among any number of speakers. And those speakers may have any combination of impedances.

Although meeting the definition of a transformer, the two windings used to inductively couple stages of radio frequency amplification are seldom referred to as being a transformer. Naturally this is one reason that most receivers use a hetrodyne system to develop the intermediate frequency (i.f.). With standardization of the intermediate frequencies at 455 kHz., 4.5 MHz., 10.7 MHz., and 40 to 48 MHz. for the various broadcast services, it becomes simple to design and construct transformer units. Such i.f. transformer units usually include capacitors, resistors, or other inductors associated with the resonant and amplifying circuits. For example, the converter of a standard broad-

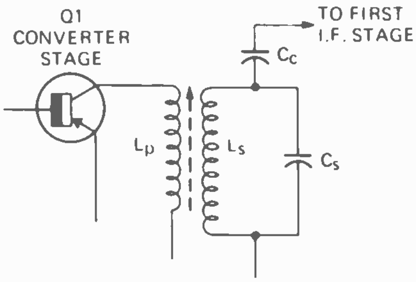


FIG. 14—I.F. TRANSFORMER with untuned primary is common in transistor AM receivers.

cast receiver feeds into an untuned primary of an i.f. transformer as shown by Fig. 14. Also included within this transformer unit is the capacitor C_S of Fig. 14 which resonates with the secondary inductor L_S. The i.f. transformer feeding into the FM discriminator (Fig. 15) also has a capacitor

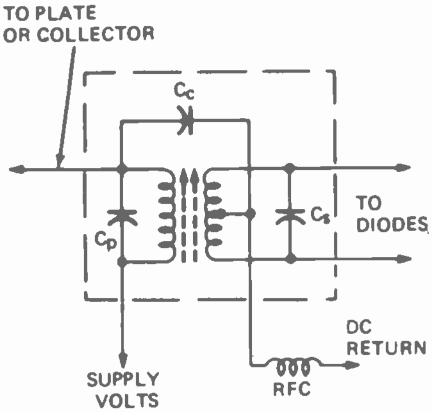


Fig. 15—FM DISCRIMINATOR TRANSFORMER has tuned windings and capacitance coupling to the secondary center tap.

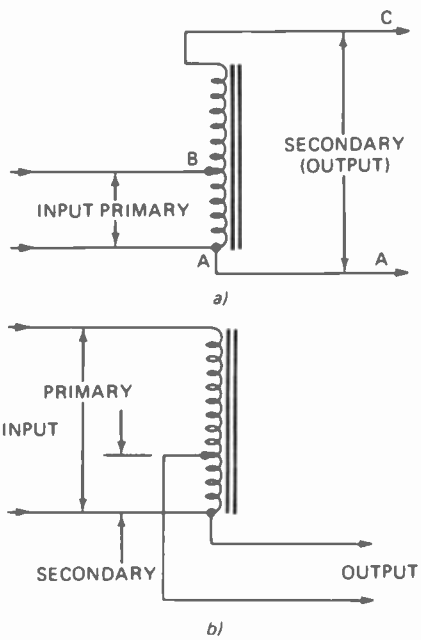


FIG. 16—AUTO TRANSFORMER may be step-up (a) or step-down (b), depending on connections.

coupling the high side of the primary to the secondary center-tap as well as an rf choke.

TV receivers make use of a special transformer in developing the very high voltage (up to 30,000 volts) accelerating the electron beam toward the picture tube screen. This is the horizontal output or flyback transformer. It has only one winding, and is a type of autotransformer. In Fig. 16-a, a small portion of this single winding is the primary of a step-up transformer. With the entire winding of the autotransformer in Fig. 16-b used as the primary to develop the magnetic field, it becomes a step-down type. Sawtooth voltages fed into the primary (between A and B of Fig. 16-a) produce a high voltage across the secondary between A and C. Actual flyback transformers have other secondary windings providing filament voltage for the high-voltage rectifier as well as horizontal deflection current. R-E

 Circle 22 on reader service card

new products

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

TRANSISTOR AND FET TESTER, *TF26 Touch Tone Cricket.* Just hook the test leads to the three elements in any pattern and push the buttons. The "Cricket" chirps, indicating a good test. Good/bad levels are indicated on meter.

meter tells you good or bad for replacement without removal from circuit. Out-of-circuit leakage test in microamps is included.

Lead storage compartment and sliding meter cover included in unbreakable acrylic case. 10 x 5½ x 3½ in., 4 lbs., $140.00—**Sencore,** 3200 Sencore Drive, Sioux Falls, S.D. 57107.

Circle 31 on reader service card

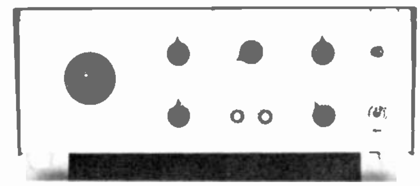
TV TUNER SUBBER, *model Mark IV-A.* New model of *Subber Mark IV* comes complete with batteries plus wall plug-in transformer and in-built power supply. Change-over to battery operation is automatic when ac transformer is disconnected.

Unit substitutes for tuner; also substitutes for 40-MHz i.f. signal at any point in i.f. chain up to final i.f. stage. Receiver operates normally

without overriding agc line with fixed bias supply. Low-impedance output circuit matches older bandpass coupling i.f. inputs, late model link coupled inputs, and any input in i.f. chain to final i.f. stage. Output level is high; output bandwidth is maintained. $54.95.—**Castle Television Tuner Service, Inc.,** 5710 North Western Avenue, Chicago, Ill. 60645.

Circle 32 on reader service card

FUNCTION GENERATOR, *model Mk1* features decade frequency ranges from 10 Hz to 1 MHz, dc offset control; 20 volts p-p maximum output; variable plus calibrated attenuator, output amplitude flat over entire frequency range; auxiliary TTL output on rear panel; FM or VCO operation through rear panel jack; independent controls; waveform symmetry constant over frequency

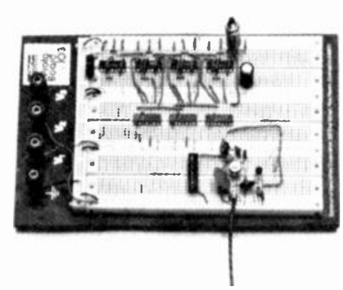


range.

Dial accuracy: ±5% of full scale. Variable attenuator: 0 to 20 dB, minimum, calibrated attenuator 3 positions —normal (0 dB), −20 dB, and 40 dB. Output impedance is 600 ohms; sinewave distortion less than 3% from 10 Hz to 100 kHz, less than 5% from 100 kHz to 1 MHz. Power requirements: 117 Vac, 50-60 Hz, less than 10 W. 11 x 4 x 8½ in., kit $135.00; assembled $195.00.—**American Circuits and Systems, Inc.,** P.O. Box 149, Planetarium Station, New York, N.Y 10024.

Circle 33 on reader service card

BREADBOARDING SYSTEM, *Proto Board 103.* Allows user to build, plug-in, modify, wire, test, add, or remove circuits quickly, using twenty four 14-pin DIP's, without solder or patch cords. Input/output and processing circuits separate



by using different power buses and separate sockets for every part of the design. Each section can be tested independently because user can break up power and ground lines. Extra IC's or components can be plugged-in and interconnected with No. 22 AWG solid hook-up wire.

Board uses multiple QT sockets and bus strips as interconnecting components for expanding or contracting a system. There are 2,250 solderless plug-in tie points. Socket array consists of three QT-59S's with 1,770 tie points (354 terminals with 5 tie points each), distribution matrix (bus strips) consists of three QT-59B's with 480 tie points (8 buses of 50 tie points each). There is one QT-47B with 80 more tie points (2 buses of 40 tie points each). 6 x 9 x ⅛ inches; $59.95.—**Continental Specialties Corp.,** 325 East Street, P. O. Box 1942, New Haven, Conn. 06509.

Circle 34 on reader service card

EXCITER/TRANSMITTER, *B-910 & B-910T.* 10-watt educational FM broadcast transmitter and FM exciter. Phase-lock techniques control the FM oscillator operating at one-half the assigned frequency. Features low FM noise, −68 db or better, af distortion at 0.3%, and ±0.5%

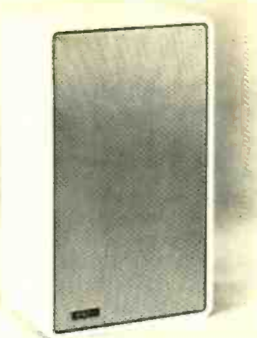
frequency response. Permits immediate conversion to stereo and/or SCA multiplex by inserting optional modules.

Automatic protective circuitry provides indication of phase lock condition, plus carrier interruption if center frequency should shift 100 kHz or more from assigned operating frequency. Metering of all supply and phase lock control voltages, relative rf output, and semi peak audio input voltages is provided. *B-910* exciter $1,995.00; *B-910T* transmitter $2,33).00.—**McMartin Industries, Inc.**, 605 North Thirteenth Street, Omaha, Neb. 68102.

Circle 35 on reader service card

LOUDSPEAKER SYSTEM, *Advent 2* is housed in molded cabinet composed of inner shell of high-density polyurethane, bonded to outer shell of thermoplastic.

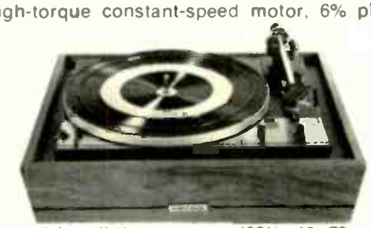
Uses acoustic suspension woofer and 2 direct radiator tweeters. Resonance is 58 Hz; nominal crossover point is 1500 Hz; impedance



is 8 ohms; recommended minimum power is 10 watts per channel. 11½" x 19" x 7¼": $58.00.—**Advent Corp.**, 195 Albany Street, Cambridge, Mass. 02139.

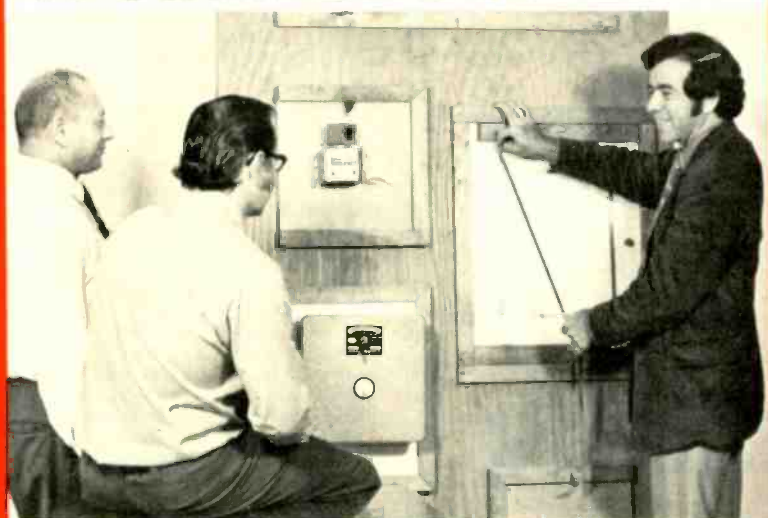
Circle 36 on reader service card

AUTOMATIC TURNTABLE/CHANGER, *model Dual 1216*, has 1-piece die-cast platter that weighs 4 lbs. Same anti-skating system used in other Dual models. Other features include high-torque constant-speed motor, 6% pitch

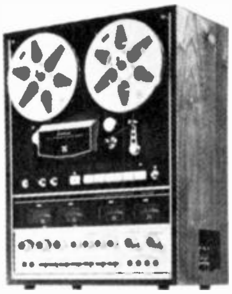


control for all three speeds (33⅓, 45, 78 rpm), silicone damped cue control, and elevator-action changer spindle. Pickup arm tracks as low as 0.75 grams.—**United Audio Product, Inc.**, 120 South Columbus Avenue, Mt. Vernon, N.Y. 10553.

Circle 37 on reader service card



TAPE DECK, *QD-5500* has record and playback in 4- and 2-channel modes. Auto reverse operates for 2-channel playback and record. Three-motor design; capstan motor is 4-pole/8-pole hysteresis type; reel motors are 6-pole induction types. Low-distortion, high-linearity record/play preamp uses 3-stage direct-coupled negative-feedback design with wide dynamic range. Four microphone and 4 line inputs allows 3-way mixing. Has independent 4- and 2-channel outputs; 6-position record selector switch. Cue button moves tape against playback head when machine is in either fast mode.



Transport mechanism operates via pushbuttons and electromagnetic relays with built-in delay circuit to prevent undue pressure on tape; automatic shut-off stops reel motion when tape is wound on either reel or when tape breaks; tape shifters move tape away from head surface during fast operation. Frequency response at 3¾ ips of 30 to 12,000 Hz ±3 dB, and 20 to 20,000 Hz ±3 dB at 7½ ips. Signal-to-noise ratio is 60 dB. Wow and flutter is less than 0.12% at 3¾ ips, and 0.07% at ½ ips. Channel separation is better than 50 dB at 1,000 Hz. 16⅝ x 21⅞ x 10⅝ in.; 53.4 lbs.; $749.50.—**Sansui Electronics Corp.,** 55-11 Queens Blvd., Woodside, N.Y. 11377.

Circle 38 on reader service card

OP-AMP DESIGNER, *OA-2,* is used in linear work and CMOS digital circuitry. Updated version of the *OA-1* features heavier current capacities on all three power supplies (175 mA on the +/−15-volt supplies and 500 mA on the +5-volt) with current limiting throughout.

Has sensitive null detector and full function generator with external frequency adjustment. Interconnections are solderless, and use SK-10 socket and BP-22 breadboarding pins incorporated in the design. Kit $89.95; assembled unit $139.295—**E&L Instruments, Inc.,** 61 First Street, Derby, Conn. 06418.

Circle 39 on reader service card

MULTI-PURPOSE RECTIFIER, *series MPR.* Eight-pin octal base plug-in rectifiers can be programmed into various rectifier configurations such as center-taps, bridges, voltage multipliers, halfwave elements, etc.

Consists of four voltage types with each type containing four independent, electrically isolated diode elements. Basic peak reverse voltages (per type number, per element) at 500, 1,000, 1,500, and 2,000 volts are available. Rectified current output currents from 0.05 to 3.0 amperes average. All diode elements have 50-ampere peak single cycle surge current rating. Price (1-4 qty.): *MPR105* (500 volts*) $4.85; *MPR110* (1,000 volts*) $7.35; *MPR115* (1,500 volts*) $9.60; *MPR120* (2,000 volts*) $12.25. (* = voltage ratings per element when programmed into either single-phase bridge, dual center-tap or quadrupler configurations.)—**Rectifier Components Corp.,** 1112 Lousons Road, Union, N.J. 07083. R-E

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new lit

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

RADIO & TV COIL REPLACEMENT GUIDE, *No. 174.* 100-page catalog contains cross-reference directory for all known domestic and foreign color and black & white TV sets, auto and home radios. 30,000 replacement coils for 375 manufacturers' names are listed.—**Bell Industries,** J.W. Miller Div., 19070 Reyes Avenue, Compton, Calif. 90224.

Circle 41 on reader service card

XQ COMPONENTS CATALOG. 19-page catalog illustrates Cambion components, including terminals, jacks, plugs, handles, battery holders, IC sockets, IC breadboards, coils, chokes, and an assortment of others. Postcard on last page enables the reader to send away for the company's other catalogs.—**Cambion,** Dept. XQ, 145 Concord Avenue, Cambridge, Mass. 02138. **R-E**

Circle 42 on reader service card

Circle 26 on reader service card

Circle 27 on reader service card

MARCONI

(continued from page 49)

most easily in the presence of heavy atmospheric noise.

On December 10th, an antenna was sent up, carried by a large kite, in preparation for the tests which were to commence the following day. The operation went smoothly. On December 11th, the weather deteriorated. The wind increased steadily, and by mid-morning a full gale was blowing. Attempts to send an antenna aloft met with failure, and a kite and balloon were lost in the severe winds that lashed the hillside; no signals were heard that day.

The next day, December 12, 1901, the weather continued harsh, and a full gale continued to rage. In spite of the weather, an antenna carried by a kite was sent to an altitude of 400 feet, and Marconi began his listening vigil in the hospital room. But the howling winds made the motion of the kite highly erratic, dipping and soaring like a terrified bird. These sporadic movements altered the angle the antenna made with the earth, as a result of which the characteristics of the antenna were in a constant state of flux. Marconi heard nothing.

He had substituted a telephone receiver for the Morse inker which he had been using. The latter would have given Marconi a printed record of the experiment, but was not as sensitive to signals as the human ear.

Marconi had also replaced his syntonic receiver with an older model. Different types of coherer were employed; one of these was to so-called Italian Navy coherer which had been developed by a lieutenant in the Italian Navy, Louigi Solari; it consisted of a glass tube with a plug of iron at one end and carbon at the other, with a globule of mercury between. The device is of particular historic interest because it appears to be a forerunner of the semiconductor rectifiers brought into use nearly half a century later. Semiconductors employ dissimilar materials to rectify current, and the mercury, coated by an oxide layer, constituted the elements of the rectifier.

Marconi listened intently, growing more discouraged by the moment. Suddenly, at 12:30 PM on December 12th, he heard the signals! Uncertain at first, he continued to listen. Soon, there was no doubt. The faint but unmistakable signals were there, and Kemp was shortly to confirm their presence. The series of dots could only be coming from Poldhu, some 2000 miles to the east. Marconi's second assistant, Paget, was ill on December 12th, and was not present; he would regret the illness the rest of his life.

On the following day, signals were heard again faintly for a brief period, in spite of a howling storm that raged. By December 14th, however, it had become apparent that obtaining evidence on the inker was not feasible with the equipment at hand, and that no better receiving apparatus could be erected because of the terrible weather conditions. Marconi then had to decide whether to announce the results to the world. There

Circle 28 on reader service card

Circle 29 on reader service card

were, after all, no objective witnesses to the accomplishment. After cabling London with the results, Marconi advised the press on December 16th.

Marconi was immediately involved in several stormy controversies. On December 16th, the Anglo-American Telegraph Company, which had a monopoly on message-carrying activities throughout Newfoundland, threatened legal action if the experiments were not terminated at once. Marconi decided not to contest the action, which could have been costly and timeconsuming. The United States or Canada had no such monopolies in existence, and since no significant outlay for receiving equipment had been made in Newfoundland, there did not seem to be much purpose in fighting.

The second, and more far-reaching, controversy involved the accuracy of Marconi's report. In the absence of proof of his claim, many prominent scientists throughout the world expressed doubt about what he actually heard, believing that what he thought were signals could have been caused by heavy static.

It should be pointed out that to this day, a number of responsible and respected scientists believe that no signals were actually heard on December 12, 1901, and that the story was a "myth." Several reasons have been given to support the contention, the most important of which were the primitive nature of the receiving equipment and the wavelength of the signal. Although the exact wavelength was not measured at the time of the experiment, Marconi himself has stated it was about 366 meters (820 kHz).

(continued on page 83)

next month

MAY 1974

■ New Projection Color TV

This set, available now, delivers a color TV picture that measures 4 feet by 5 feet. It costs $2500. We show how it works and what it will be like to service.

■ Inside MATV Antennas

Forest Belt tells what's new and what's different in these special-purpose TV antennas.

■ What's New In Automotive Electronics

New circuits and devices are common in today's automobile. Both add-on and orginal-equipment items are described in this article.

■ Designing Active Bandpass Filters

Don Lancaster shows how to design an inductor-free high-Q bandpass filter circuit. Use it for electronic music in percussion and bell circuits, as well as for audio filtering.

■ New Noise-Reducing Circuit For FM Tuners

It's in the new line of Pioneer equipment and it works. Get the details in this story by R-E's Contributing High-Fidelity Editor

PLUS:
Appliance Clinic
Service Clinic
R-E's Transistor Replacement Guide

MAY ISSUE ON SALE APRIL 16, 1974

MARCONI
(continued from page 80)

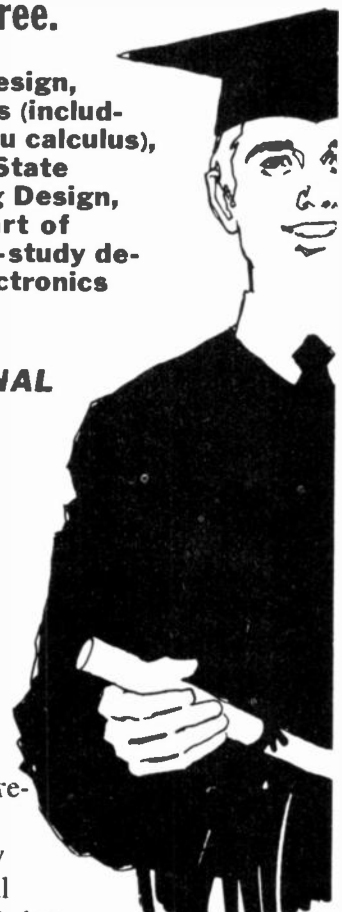
In light of our present knowledge of propagation phenomena, the tests took place at the worst possible time, because both the transmission site and the receiving site were in daylight. There is little possibility that the frequency of 820 kHz could propagate over 2000 miles during daylight because absorption by the ionosphere during those hours is at a maximum, and even powers of the order of thousands of kilowatts would not deliver a significant signal over the Atlantic in that frequency range.

G.R.M. Garratt has theorized that reception of the signals did not take place at the frequencies for which the equipment was designed, but at much higher frequencies: the Poldhu transmitter probably radiated considerable higher order harmonics which would be capable of being propagated over a daylight path, since absorption by the ionosphere decreases as the transmission frequency is increased. In view of the fact that radio amateurs of today are frequently capable of signalling across the Atlantic using powers of the order of watts, it is quite likely that Marconi actually heard the historic series of dots on that bleak and dreary day, but on a frequency in the 10,000 to 15,000-kHz range, in the short-wave portion of the electromagnetic spectrum.

Most of the doubts were dispelled less than three months later, when Marconi sailed across the Atlantic from Southampton to New York aboard the liner Philadelphia. The ship was equipped with Marconi's latest syntonic receiving equipment and an antenna lashed to a specially constructed 150-foot mast aboard the ship. A Morse inker recorded signals as they were received, and the captain of the ship verified all observations.

As the ship sailed on, signals continued loud and clear. At a distance of 700 miles, they were being recorded in broad daylight. Beyond that, the Poldhu transmitter could only be heard at night. This was the first observation of the curious nighttime effect which radio amateurs were to observe countless times—that signals traveled much greater distances at night than during the day.

During most of Marconi's historic voyage, signals were being received before witnesses. Poldhu's S's were recorded to a distance of 2099 miles, almost precisely the distance between Poldhu and St. John's. There could no longer be any doubt. The miracle of long distance communication without wires had come to pass. Much of the miracle lay in the fact that this was only the beginning! **R-E**



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The Heathkit Digital Color TV is the culmination of the most extensive engineering project in Heath history. Its advances in technology, quality and performance are astounding.

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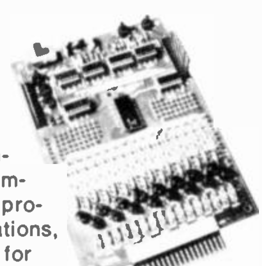
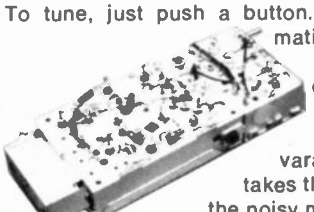
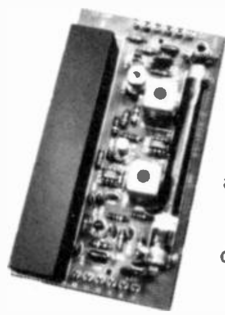


Digital logic circuitry selects channels, via an electronic digital counter and computer-like programming board. You program up to 16 stations, in any sequence, for automatic recall —intermix UHF with VHF, even repeat a station in the cycle. You'll never switch through a "dead" channel again.



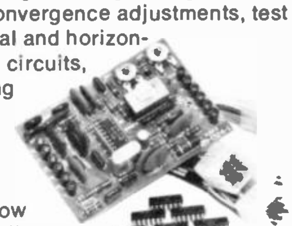
To tune, just push a button. It's automatic, all electronic and completely silent. A solid-state varactor tuner takes the place of the noisy mechanical "thunker", corroding contacts, humming motors and mechanical linkages. You'll never have a tuner cleaned again.

Yet another "first" is the unique fixed-filter IF amplifier. Unlike the IF in conventional TVs, this one never needs instrument alignment! The picture retains its brilliance and clarity year after year without periodic IF servicing. And, because this Heath-designed IF produces an ideally shaped and broader bandpass, you get truly superior reception. Especially valuable with cable service or in urban areas where the high density of stations causes adjacent channel interference.



No matter how you look at it, the Heathkit Digital Color TV shows you improvement, innovation, invention. Things like digital volume control (with remote) to raise or lower sound level in a series of small steps. An output jack for reproducing TV audio through your hi-fi while controlling volume at the TV or TV remote. And the optional digital remote control package that really takes advantage of the on-screen readout. The 100% solid-state chassis that uses more integrated circuits than any other TV around... 33 in all, with clock and remote. The most advanced 25" (diagonal) picture tube available gives you a brighter, more vivid picture with greater contrast, reduced glare and reflection. Dual VHF antenna inputs with built-in baluns for 300-ohm twin lead, true 75-ohm for cable and coax hook-up.

And only Heathkit TV comes with a full complement of self-service instruments. Such as the digital design dot generator, purity and convergence adjustments, test meter, vertical and horizontal centering circuits, pincushioning corrections. The service manual included shows you how to use them all. The Heathkit Digital Color TV is a technological wonder, but it is also an easier kit-form TV to build. More modular circuit boards plus more prefabricated wiring harnesses and cables hold point-to-point connections and chassis-mounted components to the minimum. It may well be the most rewarding kit-building experience of your life!



You can order the Heathkit GR-2000 Digital Color TV with the optional on-screen digital clock (it can be set for 4- or 6-digit readout), ultrasonic remote control, and any of four beautiful factory assembled and finished cabinets. Mail order price for chassis and tube $649.95. Remote control, $79.95 mail order. Clock, $29.95 mail order. Cabinets start at $139.95

Send the attached card for your *FREE HEATHKIT CATALOG* describing the amazing new Heathkit Digital Color TV in detail. If card has been removed, write: Heath Company, Dept. 20-4, Benton Harbor, Mich. 49022.

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Circle 100 on reader service card

SECURITY SYSTEM

(continued from page 35)

Installation and operation

The electronics package should be mounted out of sight in a convenient location near the front door or other most often used entrance. A 12-volt lantern battery should be mounted nearby and connected by a short length of No. 18 twisted pair "bell-wire". Any small 8-ohm weatherproof speaker can be used with the alarm although those designed for siren applications are most efficient. Connections should be made with No. 18 or larger wire.

All switches used in the closed circuit loop should be of the magnetic reed variety. These are available from most electronic suppliers in molded plastic housing with companion molded magnet assemblies. Adhesive conductive tape, fine wire zig-zagged across skylights, etc., can be wired in series with the switches.

When leaving the house, close all doors and windows. Push the TEST button to check circuit continuity. Turn the unit on. Open the front door (or any other switched door). Walk through the door and lock it behind you. The alarm is now set and ready to make an awful lot of noise 15 seconds after the next opening of any door or window. **R-E**

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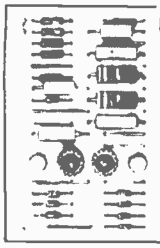

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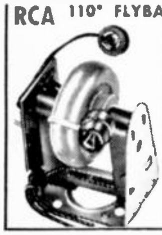

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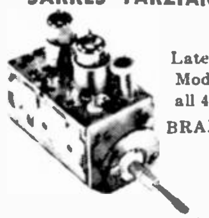

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- ☐ 2 — PHOTO TRANSISTORS, with darlington amp, 2N5777, GE $1
- ☐ 4 — PHOTO CELLS, Clairex, pancake, 30K-70 ohms $1

- ☐ 1 – 2N3055 npn, 100W, 15A, TO-3, transistor $1.
- ☐ 5 – ER900 TRIGGER DIODES for SCRs & Triacs $1.
- ☐ 2 – FET'S 2N5457 N channel 5000 umhos, TO-92 plastic $1.
- ☐ 10 – 1N914 fast switch diodes, silicon, 4 nanoseconds $1.
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- ☐ 40 – ITT MICRO MINI RECTIFIERS silicon porcelain to 1KV* $1.
- ☐ 30 – WORLD'S SMALLEST RECT. & zeners, 1W, assorted volts* $1.
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- ☐ 2 – 6000 PIV 50 mil epoxy rectifiers, axial leads* $1
- ☐ 10 – BENDIX 25 WATT "pellet" power transistors, silicon* $1
- ☐ 1 – PHOTO ELECTRIC FET, 10,000 uhmos, n channel $1
- ☐ 4 – 80 WATT, 2N1488, silicon, TO3, 60 Vco, npn $1
- ☐ 4 – 1000 HFE DARLINGTON Transistors, TO-18 case $1.
- ☐ 1 – 2N5036 HI-PWR plastic trans 100 vceo, 7 amp 85 watts $1.
- ☐ 4 – 2N5296 HOBBY, 35 watts, plastic powers, NPN $1.
- ☐ 4 – 2N6109 HOBBY, 40 watts, plastic powers, PNP $1.
- ☐ 5 – PLASTIC 35W powers, npn, silicon, hobby 2N6121 $1.
- ☐ 5 – PLASTIC 35W powers, pnp, silicon, hobby 2N6124 $1.
- ☐ 2 – MOS FETS, N channel 10K umos 3N128, TO-18, RCA $1.
- ☐ 2 – MOS FETS, DUAL GATE, N chan, 3N187, TO-18, RCA $1.
- ☐ 2 – MOS FETS, DUAL GATE, N chan, 3N140, TO-18, RCA $1.
- ☐ 4 – RCA 2N3600 NPN, UHF transistors, tv-fm, TO-18, 1000mc $1.
- ☐ 1 – 300V PLASTIC POWER TAB transistors, 6A $1.

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- ☐ 3-1-WATT AUDIO AMPLIFIERS, Westinghouse, TO-5 $1.
- ☐ 15-709 FLAT PAK OP AMPS, 100% good $1.
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- ☐ 4-DUAL 709, dip pak, op amps, untested $1.
- ☐ 10 – RCA CA-3000 OP AMPS, TO-5 case* $1.
- ☐ 8 – 723 VOLTAGE REGULATORS, TO-5* $1.
- ☐ 4 – PHASE LOCK LOOPS, hobby 565, 560, 561* $1.
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- ☐ 10 – 709 LINEAR AMPS, 741's too, DIP'S* $1.
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- ☐ 10-"C" MOS IC's, 74C and CD4000 series, DIP pak* $1.
- ☐ 10-MINI DIPS, OP AMPS, 709, 741, 301, 307, hobby* $1.
- ☐ 3 – VOLTAGE REGULATORS, LM309K, hobby, TO-3* $1.
- ☐ 10 -SIGNETIC OP AMP, 531, 533, 536, 550, 555, DIPs, TO-5* $1.
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- ☐ 5-MONSANTO MAN-3, .12" charac. red, 1 or more segs missing. $1.

*Reflective bar segments, while Monsanto all LED segments.

Potter & Brumfield KAP RELAYS Your choice 3 for $7.50 **$2.98**

☐ 115 VAC 3PDT
☐ 12 VDC 3PDT

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

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• Plastic case • Red needle indicators

☐ VU, front mtg. plus 3 minus 20 db.

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GENERAL TELEPHONE DATA ENTRY KEYBOARD

Used in calculators, touch-tone, encoding, programming devices. **10 PUSH BUTTONS (0 to 9)** & 2 uncommitted. All switches have 2 separate poles & 6 separate busses — totalling 6 busses & 24 poles. . . . Any combination of which can be used! Size: 3x2 1/2x1". Easy for panel mtg. too. ☐ **$8.88**

GI "GLASS AMP II" SPACEAGE FEATURES

Type	PIV	Sale
☐ 1N4245	200	$.14
☐ 1N4246	400	.22
☐ 1N4247	600	.39
☐ 1N4248	800	.49
☐ 1N4249	1000	.59

Meets critical JAN specs. A glass "ball of silicon strength" that meets JAN specs, high reliability, withstands avalance power surges to 1K watts. ONE amp ratings with 2 amp capabilities. Axial leads.

EPOXY FULL WAVE SILICON BRIDGE RECTIFIERS

PIV	2 Amp	6 Amp
50	☐ $.69	☐ $.88
100	☐ .79	☐ .99
200	☐ .95	☐ 1.25
400	☐ 1.19	☐ 1.50
600	☐ 1.35	☐ 1.75
800	☐ 1.59	☐ 1.95
1000	☐ 1.79	☐ 2.25

Code: 2 amp TO-5 case; 6 Amp 1/2 x 1/2 x 3/16 sq

LOWEST PRICES EPOXY SILICON RECTIFIERS

PIV	2Amp*	2Amp	3Amp
50	☐ $.05	☐ $.05	☐ $.08
100	☐ .06	☐ .06	☐ .12
200	☐ .07	☐ .07	☐ .15
400	☐ .09	☐ .09	☐ .22
600	☐ .12	☐ .12	☐ .28
800	☐ .15	☐ .15	☐ .39
1000	☐ .18	☐ .18	☐ .45

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• Factory Marked. Order by type number! Spec sheets on request "ONLY". Buy 100 — Take 20%

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☐ SN7401	.24	☐ SN7437	.49	☐ SN7472	.41	☐ SN74112	.95	☐ SN74163	1.75
☐ SN7402	.24	☐ SN7438	.52	☐ SN7473	.49	☐ SN74113	.95	☐ SN74164	2.10
☐ SN7403	.24	☐ SN7440	.24	☐ SN7474	.49	☐ SN74114	.95	☐ SN74165	2.10
☐ SN7404	.26	☐ SN7441	1.19	☐ SN7475	.85	☐ SN74121	.61	☐ SN74166	1.85
☐ SN7405	.26	☐ SN7442	1.12	☐ SN7476	.53	☐ SN74122	.69	☐ SN74173	1.85
☐ SN7406	.45	☐ SN7443	1.12	☐ SN7478	.85	☐ SN74123	1.05	☐ SN74174	2.20
☐ SN7407	.49	☐ SN7444	1.25	☐ SN7480	.6$	☐ SN74125	1.45	☐ SN74175	2.60
☐ SN7408	.27	☐ SN7445	1.19	☐ SN7481	1.25	☐ SN74126	1.45	☐ SN74176	1.85
☐ SN7409	.28	☐ SN7446	1.29	☐ SN7482	.99	☐ SN74139	1.25	☐ SN74177	1.85
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☐ SN7411	.31	☐ SN7448	1.35	☐ SN7485	1.15	☐ SN74145	1.19	☐ SN74180	1.10
☐ SN7413	.89	☐ SN7450	.27	☐ SN7486	.49	☐ SN74148	4.50	☐ SN74181	4.10
☐ SN7415	.49	☐ SN7451	.31	☐ SN7489	3.10	☐ SN74150	1.19	☐ SN74182	1.05
☐ SN7416	.49	☐ SN7453	.31	☐ SN7490	.85	☐ SN74151	1.00	☐ SN74185	2.50
☐ SN7417	.49	☐ SN7454	.43	☐ SN7491	1.35	☐ SN74152	4.95	☐ SN74192	1.55
☐ SN7420	.24	☐ SN7455	.31	☐ SN7492	.85	☐ SN74153	1.39	☐ SN74193	1.50
☐ SN7421	.55	☐ SN7460	.27	☐ SN7493	.85	☐ SN74154	1.69	☐ SN74194	1.55
☐ SN7422	.31	☐ SN7461	.27	☐ SN7494	1.05	☐ SN74155	1.29	☐ SN74195	1.10
☐ SN7425	.50	☐ SN7462	.35	☐ SN7495	1.00	☐ SN74156	1.45	☐ SN74196	1.25
☐ SN7426	.33	☐ SN7464	.43	☐ SN7496	1.00	☐ SN74157	1.45	☐ SN74197	1.10
☐ SN7430	.24	☐ SN7465	.43	☐ SN74106	.95	☐ SN74158	1.45	☐ SN74198	2.35
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IC'S FOR EXPERIMENTERS $1.00

Money Back Guarantee! Factory Marked!

☐ SN7400	20 for $1.	☐ SN7475	5 for $1
☐ SN7404	20 for $1.	☐ SN7476	10 for $1
☐ SN7413	5 for $1.	☐ SN7490	5 for $1.
☐ SN7441	5 for $1.	☐ SN74107	10 for $1.
☐ SN7442	5 for $1.	☐ SN74121	10 for $1.
☐ SN7444	5 for $1.	☐ SN74123	10 for $1.
☐ SN7445	5 for $1.	☐ SN74154	5 for $1.
☐ SN7447	5 for $1.	☐ SN74181	3 for $1.
☐ SN7448	5 for $1.	☐ SN74192	5 for $1.
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SALE! 6 AMP QUADRACS *With jumbo "Top Hat" heat sink

Money-Back GUARANTEE on all items

PRV	SALE
☐ 25	$ .88
☐ 50	1.25
☐ 100	1.95
☐ 200	2.49
☐ 400	2.98
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☐ 74C00	$ .77
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☐ 74C20	.77
☐ 74C42	1.95
☐ 74C73	1.50
☐ 74C74	1.30
☐ 74C76	1.50
☐ 74C107	1.25
☐ 74C151	1.95
☐ 74C154	1.95
☐ 74C157	1.95
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	Sale
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8-Track tape transport with complete stereo playback system less audio amplifier. Operates off 12 VDC Wow & flutter proof. Use 739 preamp & ready to go. Uses 8-track tape. Wt. 3-lbs.

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- ☐ 14-Pin, DIP $.45
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NATIONAL 'OP' AMPS

BUY ANY 3 — TAKE 10%

Type		Sale
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☐ LM-301	Hi-performance amp	.41
☐ LM-302	Voltage follower	.91
☐ LM-305	Pos. V. reg.	1.19
☐ LM-307	Super 741	.41
☐ LM-308	Hi-Q Fet Type Op Amp	1.19
☐ LM-309H	5V 200 mil V. reg.	1.19
☐ LM-309K	5V 1-amp V. reg.*	1.85
☐ LM-311	Comparator	1.19
☐ LM-319	Hi-Speed Dual comp	1.98
☐ LM-320	Minus 5V 1-amp V.R.*	1.75
☐ LM-320	Minus 12V 1-amp V.R.*	1.75
☐ LM-320	Minus 15V 1-amp V.R.*	1.75
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☐ LM-370	AGC squelch op amp	1.19
☐ LM-371	R-F, I-F, op amp	1.25
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☐ LM-380	2-watt audio amplifier	1.69
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*TO-3 case, — others TO-5

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☐ 531 Hi slew rate op-amp (TO-5)	$2.50
☐ 532 Micro power 741 (TO-5)	2.50
☐ 533 Micro power 709 (TO-5)	2.50
☐ 536 FET Input op amp (TO-5)	2.95
☐ 550 Precision 723 voltage reg. (DIP)	1.17
☐ 555 Timer 2 u Seconds to 1-hr. (A)	1.25
☐ 556 5 Times faster than 741C	2.10
☐ 558 Dual 741 (A)	1.00
☐ 560 Phase lock loops (DIP)	2.95
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☐ 566 Function generator (TO-5)	2.95
☐ 567 Tone decoder (A)	2.95
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☐ 704 TV sound IF system	1.50
☐ 709C Operational amp (A)	.33
☐ 710C Differential amp (A)	.47
☐ 711C Dual diff. comp (A)	.47
☐ 723C Voltage regulator (A)	.75
☐ 733 Diff. Video Amp	1.75
☐ 741C Frequency compensator 709 (A)	.44
☐ 741CV Freq. comp 709 (Mini DIP)	.49
☐ 747C Dual 741C (A)	.89
☐ 748C Freq. adj. 741C (A)	.69
☐ 753 Gain Block	1.75
☐ 739 739 Dual stereo preamp	1.98
☐ 741 741 Dual 741C (TO-5)	.89
☐ PA265 5-Watt voltage regulator	1.50
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☐ CA3065 Video Audio system	1.05
☐ 75451 Dual peripheral driver	.44
☐ 75453 Dual peripheral driver	.44
☐ 75491 Quad seg driver for LED readouts	1.65
☐ 75492 Hex driver w/col. out 250 ma. For LED readouts	1.85

(A) TO-5 or DIP dual in line pak

BUY ANY 3 — TAKE 10%

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PRV	1A	3A	8A**	25A*	100A*	250A*
15	☐ $.15	—	—	—	—	—
30	☐ .25	☐ $.39	—	—	—	—
60	☐ .39	☐ .52	☐ $.55	☐ $.95	☐ $2.25	☐ $5.50
100	☐ .49	☐ .69	☐ .60	☐ 1.25	☐ 2.95	☐ 6.95
200	☐ .69	☐ .89	☐ .69	☐ 1.95	☐ 3.95	☐ 8.50
400	☐ .95	☐ 1.19	☐ 1.25	☐ 2.50	☐ 5.95	☐ 10.50
600	—	—	☐ 1.50	☐ 2.96	☐ 7.95	☐ 12.50

*Stud. **Plastic, power tab. Others TO-18,5.

HIGH POWER STUD RECTIFIERS

PIV	50A	250A
50	☐ $.69	☐ $4.50
100	☐ .85	☐ 6.50
200	☐ 1.19	☐ 8.25
400	☐ 1.45	☐ 9.95
600	☐ 1.75	☐ 10.50
800	☐ 2.25	☐ 11.50
1000	☐ 2.65	☐ 12.50

STUD & TO-5 TRIACS

PRV	3A*	6A*	15A	25A
50	☐ $.25	☐ $.30	☐ $.75	☐ $.95
100	☐ .49	☐ .40	☐ .95	☐ 1.15
200	☐ .49	☐ .70	☐ 1.19	☐ 1.50
300	☐ .59	☐ .90	☐ 1.50	☐ 1.90
400	☐ .69	☐ 1.10	☐ 1.90	☐ 2.25
500	☐ .79	☐ 1.50	☐ 2.25	☐ 2.75
600	☐ .99	☐ 1.75	☐ 2.50	☐ 2.95

*In TO-5 case, others stud

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Circle 82 on reader service card

Market Center continues on page 98

INTERNATIONAL ELECTRONICS UNLIMITED

APRIL SPECIALS

TTL (DIP)		
7402	Quad 2-input NOR gate	5/$1.00
7410	Triple 3-input gate	5/$1.00
7437	Quad 2-input NAND buffer	3/$1.00
7438	Quad 2-input NAND buffer O.C.	3/$1.00
7460	Dual 4-input expander	4/$1.00
7476	Dual J-K flip-flop	$ .45 ea.
7490	Decimal counter	1.10 ea.
74121	One shot monostable multivibrator	.49 ea.

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380	2 watt audio amplifier	1.50 ea.
75451	Dual peripheral driver	.39 ea.
75453	(351) Dual peripheral driver	.49 ea.

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74C00	Quad 2-input NAND gate	$ .79 ea.
74C02	Quad 2-input NOR gate	.79 ea.
74C107	Dual J-K flip-flop with clear	1.25 ea.
74C160	Decade counter with sync. clear	2.75 ea.

4000 Series (DIP)		
4001	Quad 2-input NOR gate	.59 ea.
4009	Hex buffer (inverting)	.89 ea.

MM5312 Digital clock chip — 28 pin — any readout — 4 digit Ipps BCD with 4 MAN3M LED Complete with data . . . $11.95/set

TTL

7400	$ 25	7447	$1 45	74123	$1.15
7401	25	7448	1 50	74125	69
7402	25	7450	.29	74126	95
7403	25	7451	.32	74141	1.25
7404	.29	7453	.32	74145	1 25
7405	.27	7454	.45	74150	1 25
7406	55	7455	32	74151	1 05
7407	.53	7460	.30	74153	1 45
7408	.29	7461	.30	74154	1 75
7409	.29	7464	.45	74155	1.35
7410	.25	7465	.45	74156	1.50
7411	35	7470	50	74157	1 50
7413	95	7472	45	74161	1 65
7415	50	7473	55	74163	1 80
7416	50	7474	.55	74164	2 95
7417	50	7475	95	74165	2 95
7420	25	7476	.55	74166	1 95
7421	32	7478	89	74173	1 95
7422	32	7483	1.25	74175	1 95
7423	37	7485	1 20	74176	95
7425	39	7486	55	74177	95
7426	35	7489	3.25	74180	1.15
7427	39	7490	1 25	74181	4 25
7430	25	7491	1 40	74182	1 10
7432	30	7492	1 05	74190	1.65
7437	50	7493	1.05	74192	1 65
7438	55	7494	1 10	74193	1 65
7440	25	7495	1 05	74194	1 65
7441	1 25	7496	1 05	74195	1 15
7442	1 15	74100	1.65	74196	1 35
7443	1 25	74105	55	74197	1 15
7444	1 30	74107	55	74198	2.50
7445	1 25	74121	65	74199	2.50
7446	1 45	74122	55		

Low Power TTL

74L00	$ 40	74L51	$ 40	74L90	$1 75
74L02	40	74L55	.60	74L91	1 50
74L03	.40	74L71	60	74L93	1 75
74L04	40	74L72	.60	74L95	1 75
74L06	40	74L73	.80	74L164	2 95
74L10	40	74L74	.80	74L165	2 95
74L20	40	74L78	.80	85L52	2.95
74L30	40	74L85	1 25	86L75	2.95
74L42	1 75	74L86	95		

High Speed TTL

74H	$ 40	74H21	$ 47	74H60	$ 45
74H01	40	74H22	.47	74H61	45
74H02	40	74H30	40	74H62	.45
74H04	45	74H40	40	74H72	60
74H08	45	74H50	45	74H74	70
74H10	40	74H53	.47	74H76	70
74H20	40	74H55	47		

8000 Series TTL

8054	$ 45	8200	$ 2.95	8554	$ 2.95
8060	30	8210	3.95	8570	2.95
8091	69	8214	1.95	8600	1 15
8092	69	8219	1.95	8810	95
8093	69	8220	1 95	8812	1.25
8094	69	8230	2.95	8822	2 95
8121	1 05	8280	.95	8830	69
8122	1 05	8288	1.05	8831	2.95
8123	1 75	8520	1.45	8832	2.95
8130	2.50	8551	1.95	8836	.69
8182	1 75	8552	2.95	8880	1.50

ALL DIP PKGS.

Specify spec. sheets required with order. Add $ .50 per spec sheet for items less than $1.00 ea.

CMOS

74C00	$ .85	74C76	$1.70	74C163	$3.25
74C02	.85	74C107	1.50	74C164	3.50
74C04	.95	74C151	2.90	74C173	2.90
74C10	.85	74C154	3.50	74C192	3.25
74C20	.85	74C157	2.25	74C193	3.25
74C42	2.15	74C160	3.30	74C195	3.00
74C73	1.70	74C161	3.25	80C97	1.50
74C74	1.50	74C162	3 25		

Specify Specs Required with order

4000 Series — RCA Equivalent

CD 4001	$ 65	CD 4012	$ .65	CD 4022	$2.75
CD 4002	.65	CD 4013	1.50	CD 4023	65
CD 4009	1.00	CD 4016	1.50	CD 4025	65
CD 4010	.65	CD 4017	2 95	CD 4027	1.35
CD 4011	65	CD 4019	1.35	CD 4030	.65
				CD 4035	2 85

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Memories

1101	256 bit RAM MOS (2501)	$2.50 ea.
1103	1024 bit RAM MOS	7.95 ea.
5260	1024 bit RAM 16 pin Low power consumption	5.95 ea.
7489	64 bit RAM TTL	3.25 ea.
8223	Programmable ROM	6.95 ea.

Linear

LM300	Pos V Reg (super 723)	TO-5	$ .95 ea.
LM 301	Hi performance AMPL	TO-5 or MINI DIP	.45 ea.
LM 302	Voltage Follower	TO-5	.95 ea.
LM 304	Negative Voltage Regulator	TO-5	1.25 ea.
LM 305	Positive Voltage Regulator	TO-5	1.25 ea.
LM 307	Op AMP (super 741)	TO-5 or MINI-DIP	.45 ea.
LM 308	Micro Power Op Amp	TO-5 or MINI-DIP	1.25 ea.
LM 309H	5 V Regulator	TO-5	1.25 ea.
LM 309K	5 V 1A Regulator	TO-3	1.95 ea.
LM 310	Voltage Follower Op Amp	TO-5	1.45 ea.
LM 311	Hi perf. Voltage Comparator	TO-5 or MINI-DIP	1.25 ea.
LM 319	Hi Speed Dual Comparator	DIP	1.65 ea.
LM 320	-5.2 V Negative Regulator	TO-3	1.95 ea.
LM 320	-12 V Negative Regulator	TO-3	1.95 ea.
LM 320	-15 V Negative Regulator	TO-3	1.95 ea.
LM 339	Quad Comparator	DIP	1.95 ea.
LM 340T	Positive Voltage Regulator (6V, 8V, 12V, 15V, 18V or 24V)	TO-220	2.25 ea.
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LM 372	AF-IF Strip-detector	DIP	.85 ea.
LM 373	AM/FM/SSB Strip	DIP	3.60 ea.
LM 376	Pos. Volt Regulator	MINI DIP	65 ea.
LM 380	2 Watt Audio AMPL	DIP or MINI-DIP	1.75 ea.
LM 382	Low Noise Dual Pre-Amp	DIP	2.25 ea.
LM 550	Precision Voltage Regulator	DIP	.95 ea.
LM 703	RF-IF Amp	MINI-DIP	.59 ea.
LM 709	Operational AMPL	TO-5 or DIP	.45 ea.
LM 711	Dual Differential Comparator	DIP	.39 ea.
LM 723	Voltage Regulator	DIP	.75 ea.
LM 739	Dual Hi Performance Op AMP	DIP	1.25 ea.
LM 741	Comp. Op AMP	TO-5 or MINI-DIP	.65 ea.
LM 747	Dual 741 Op AMP	TO-5 or DIP	.95 ea.
LM 748	Freq Adj 741	MINI-DIP	.45 ea.
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LM 1304	FM Multiplex Stereo Demod.	DIP	1.50 ea.
LM 1307	FM Multiplex Stereo Demod.	DIP	.95 ea.
LM 1458	Dual Comp. Op. Amp.	MINI-DIP	.75 ea.
LH 2111	Dual LM211 Volt. Comparator	DIP	2.95 ea.
LH 3065	TV-FM Sound System	DIP	.75 ea.
LM 3075	FM Det. — LMTR and Audio Pre-Amp.	DIP	.85 ea.
LM 3900	Quad Amplifier	DIP	.75 ea.
LM 3905	Precision Timer	MINI-DIP	95 ea.
LM 7524	Core Memory Sense AMPL	DIP	1.95 ea.
LM 7525	Core Memory Sense AMPL	DIP	.95 ea.
LM 7535	Core Memory Sense AMPL	DIP	.95 ea.
LM 9601	Retriggerable One Shot	DIP	.95 ea.
LM 75451	Dual Peripheral Driver	MINI-DIP	.49 ea.
LM 75452	Dual Peripheral Driver	MINI-DIP	.49 ea.
LM 75453	(LM 351) Dual Peripheral Driver	MINI-DIP	.69 ea.

Specify TO-5, DIP or MINI-DIP Package

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NE 561	Phase Locked Loop	DIP	2.95 ea.
NE 562	Phase Locked Loop	DIP	2.95 ea.
NE 565	Phase Locked Loop	DIP	2.95 ea.
NE 566	Function Generator	MINI DIP OR TO-5	2.95 ea.
NE 567	Tone Decoder	MINI DIP OR TO-5	2.95 ea.

Specify TO-5, Dip or Mini-Dip Package

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MCD 2	Diodes	1.15 ea.
MCT 2	Transistor	1.15 ea.

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MM5016	512 bit dynamic shift regnter	DIP-TO-5	.25 ea.
MM5019	Dual 256 bit mask prog. shift register	TO-5	.25 ea.
MM5050	Dual 32-bit static shift register	TO-5	.35 ea.
MM5054	Dual 64/72/80 bit static shift register	DIP	.35 ea.

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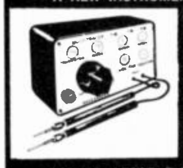

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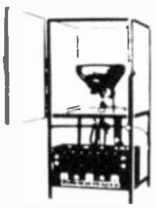

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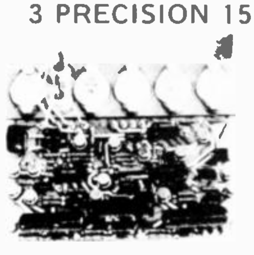

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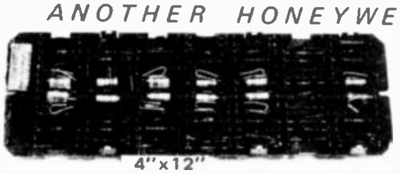

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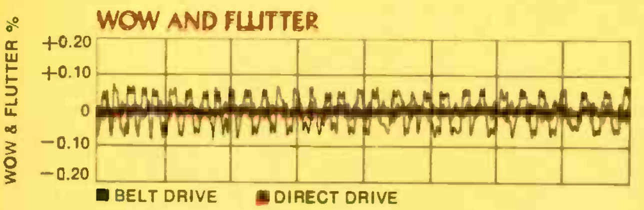

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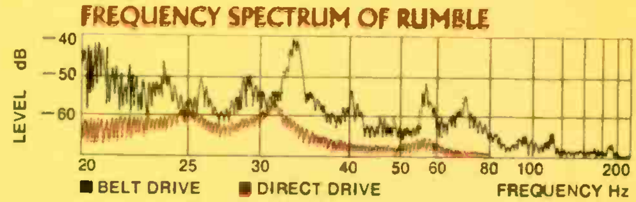

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