Electronics World

MARCH, 1963
50 CENTS

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SCEPTRON
A Sound-Operated
Fiber-Optic "Brain Cell"

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NEW E-V
MARQUIS
300

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The Quality . . . Features . . . Engineering Excellence You Expect from Scott at Unexpected Prices!

New Scott FM Stereo Tuner Kit

$109.95

From the famous Scott engineering laboratories . . . an amazing low priced FM Stereo tuner kit that performs like higher priced Scott units. All the exclusive Scott features you want and need are included: "Time-Switching" multiplex circuitry, Wide-Band design, Sonic Monitor stereo indicator, precision tuning indicator, and separate level controls for perfect channel balancing. Scott engineers used new Space-Age compactron circuitry to assure perfect performance at this remarkably low price.

Like all Scott kits the new Model LT-111 comes with an exclusive full-color instruction book to make construction absolutely fool-proof. The high conductivity copper RF front end is pre-wired and aligned at the factory. All wires are pre-cut and stripped. Scott's amazing new Align-A-Scope lets you align each section of the tuner perfectly without special instruments.

Specifications: Usable Sensitivity 4.0 μv; Signal to Noise Ratio 55 db; Harmonic Distortion 0.8%; Drift 0.02%; Capture Ratio 6 db; Selectivity 32 db; I.M. Distortion 0.3% (CCIF); Separation (1 kc) over 30 db. Dimensions in accessory case: 15½w x 5¼h x 13¼d.

Available early in April.

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Like Scott's new tuner kit, the LK-30 utilizes a full color instruction book, Kit-Pak container, and all the Scott kit features the experts recommend so highly. Its performance will astound you!

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Electronics World

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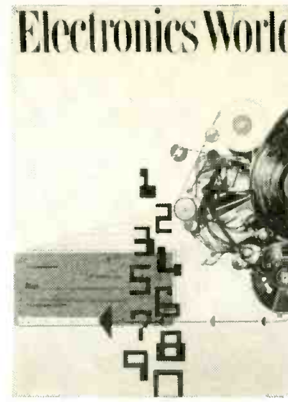

ELECTRONICS IN BANKING
Bankers have turned to the electronics industry for help in meeting the great paper challenge of 13 billion checks a year. Ken Gilmore explains the operation of Magnetic Ink Character Recognizers and their companion computers—which combine to turn in a tremendous job of bank accounting—quickly and accurately.

MUSIC-SPEECH DISCRIMINATOR
If commercials get you down, here is an interesting solid-state device that will reject all speech and pass all music. It takes just seven transistors and can be home-built for under $30.00. Ideal for those seeking continuous background music.

FORD TRANSISTOR IGNITION SYSTEM
J. Oldham of Ford Motor Company's Ignition Product Engineering Department, discusses the company's new "Perma-Tuned" system which promises increased point and plug life, easier starting, better high-speed performance, and improved fuel economy.

NEW CB CIRCUITS
Among the interesting new circuits being employed in class D Citizens Band units are Communications, Inc.'s "Speak-Easy," Poly-Comm's "Model 23," and Metrotek's "Monocall." Len Buckwalter discusses the special points of interest on each of these new circuits.

EXPANDING U.H.F. TV COVERAGE—ROLE OF TRANSLATORS
When v.h.f. goes u.h.f., certain characteristic limitations in transmission coverage will show up. Techniques for overcoming these drawbacks, including the use of translators, have been developed from recent experience. This article includes ways of "filling in" areas where signal is poor in an attempt to duplicate the service presently provided on v.h.f.

THE HALL EFFECT
Although the principle has been known for decades, it is just moving out of the laboratory. John R. Collins points out how it is being applied in a good number of measuring devices and other instruments, including gaussmeters, generators, ammeters, multipliers, and many others.

SOLID-STATE 3-CHANNEL COLOR ORGAN
A compact, well-designed display device that produces changes in color intensity and hue in step with musical signals. This transistorized unit can be connected to the output of any hi-fi amplifier and is capable of handling up to 1 kw. of light power.

All these and many more interesting and informative articles will be yours in the April issue of ELECTRONICS WORLD . . . on sale March 19th.

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...for the Record

By **W. A. STOCKLIN**
Editor

EIA Defines "High Fidelity"

ALTHOUGH not all of the facts have been made public as yet, we do know that the Electronic Industries Association has agreed on a definition of the term "high fidelity." Their recommendation will be presented shortly to the Federal Trade Commission in the hope that it will help them to determine what may or may not be advertised as a "high-fidelity" product.

There is obviously a need for a realistic definition, but we suspect that the EIA recommendation will be identical to their previously published proposal. If this is so, it will be one of the biggest fiascos of 1963. Imagine a definition that permits the term "high fidelity" to be applied to any product that (1) will produce 5 watts of music-power output and (2) has a frequency response within −3 db at 100 cps to −6 db at 8000 cps. No mention is made of many other important characteristics such as distortion, hum, power response, etc. Why? There are many table radio sets that could qualify as "high fidelity" under these standards.

The EIA even apologizes in that they point out that their standards are inadequate from an engineering and technical aspect and that only minimum standards were set. If they are not satisfied, why make such a recommendation? It is unfortunate that those manufacturers who produce minimum-standard equipment will be given the same recognition as those producing truly high-quality designs.

None of our readers will be misled but, unfortunately, the uninformed consumer will become even more confused about high fidelity than he already is.

Why not call the low quality units simply "radios and phonographs"? Then set realistic standards for high-quality designs. We might even set a number of different standards to denote various levels of performance.

We hope that the FTC gives considerable thought to the recommended definition before accepting it, since the standard, as proposed, will not help them solve their problems regarding high-fidelity equipment.

Is Pay-TV Here?

BERNARD P. GALLAGHER, in one of his recent "Gallagher Reports"—a newsletter published in New York for advertising, marketing, and media executives—has made some interesting comments which sort of lift one's eyebrows—"Pay-TV breakthrough is here—will be biggest industry in communications field within ten years—Hartford first on-the-air test of Pay-TV." Interesting comments, but we wonder how any person can be so positive. Certainly the Hartford test wasn't the first, in that Zenith had a similar test in the Chicago area back in the late 1940's. Conditions haven't changed much over these years, with the exception that the economic status of the individual home owner has been raised, and people are more inclined to spend money for entertainment today than they were twenty years ago.

To be completely realistic, we do believe that pay-TV will become a part of our everyday life in the years ahead. Our guess is that it will be at least twenty years before an appreciable number of homes are covered and we doubt that it could ever surpass free TV, let alone become an industry surpassing all other forms of communications.

Technically there are no real problems. In fact even in the earlier tests there were no technical difficulties. There are various coding system methods, but this is relatively unimportant. There also will be vigorous opposition, obviously, from companies presently in free television and, of course, the movie houses. These, however, are simply desperation delaying tactics.

As long as v.h.f. TV is the predominant form of transmission, pay-TV will be blocked. Congress, however, has helped by passing a law that all TV sets manufactured in 1964 and thereafter must include means for receiving u.h.f. TV stations in addition to those on v.h.f. It should then take five to eight years for present v.h.f.-only models to become obsolete. Only then would the new all-channel sets become predominant. We have no doubt that television will eventually lose all v.h.f. channels and will have to go all-u.h.f. but this will take at least ten years. Pay-TV should then make slow and gradual inroads from that time on.

The most difficult problem is the availability of first-rate program material that people will be willing to pay to watch. In all of 1962 Hollywood produced only 138 films. Add to this the possible availability of legitimate stage shows, major sports events, operas, and symphony programs. To sum up, it would seem that there is a serious lack of top performing attractions. If pay-TV hopes to use second-rate attractions, it will fail—the public will not pay for anything but the best.

If pay-TV is to succeed, Hollywood would, for example, have to make available their entire inventory of new films. This is not as remote a possibility as it may seem, but it will take time.

Yes, pay-TV will come, but it is not here today nor will it be the biggest industry in the communications field in ten years. ▲

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Nicholas E. Lambert, RFD #1, Ulysses, Pennsylvania	1st	12
Michael A. Rutkaus, Rt. 1, Box 664, Fairfax, Virginia	1st	12
John W. Rompinen, Rt. 3, Box 403, Weaverville, N.C.	1st	12
Wayne Glaser, Cayuga Creek Rd., Cowlesville, New York	1st	12
LeRoy R. Murray, 4320 N. 30th Dr., Phoenix, Arizona	1st	12
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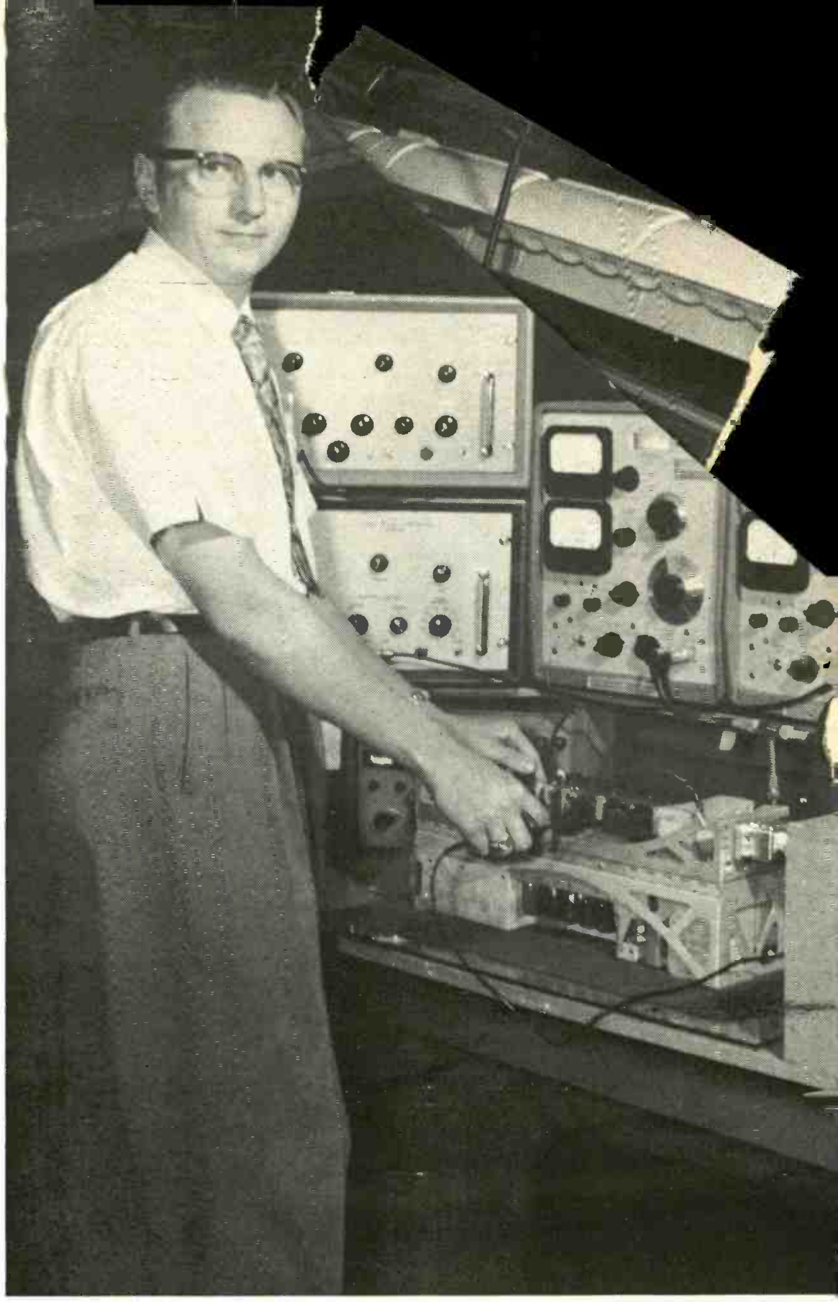

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LET'S LOOK AT THE FACTS. There's something wonderful about understanding how a circuit works or what a filter capacitor does. If you've ever fixed a TV set, built a radio or used a voltmeter, you've tasted the thrills of electronics.

This excitement may have led you to a job in electronics. But the glamour fades if you are stuck in the same job year after year. You'll be bored with routine and unhappy about prospects for future earnings. You'll discover, as have many men, that simply working in electronics does not assure a good future.

If electronics is the "field of opportunity," how is this possible? No question about it, electronics offers many opportunities, *but only to qualified men*. In any career field, it is how much you know that counts. This is particularly true in the fast moving field of electronics. The man without thorough technical education doesn't advance. Even men with intensive military technical training find their careers can be limited in civilian electronics.

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LETTERS FROM OUR READERS

TV SERVICE COVERAGE

To the Editors:

I've been a regular reader for the many years I've been fixing TV sets for a living—but you can cancel my subscription right now. I used to consider your magazine as useful as my v.t.v.m. or other tools of the trade. If you want to know why I don't anymore, take a look at some titles in your December issue, for example: "Lasers and Their Uses," "Electronic Weighing," "Radiation Fingerprinting," and so on. Come on now! How can one of those help me with the unstable sync on that tough dog now tying up my bench? You are blundering off into outer space, getting away from the real needs of your readers. All the issues in one year will not put one dime into my pocket.

J. McKenzie
Chicago, Ill.

To the Editors:

I want you to know how much I enjoyed the December article on "Lasers and Their Uses." I happen to be a TV service dealer, and I don't expect to be troubleshooting any lasers in the near future, but I like to be kept up on what's happening elsewhere in electronics.

Robert Wilkinson
San Francisco, Calif.

Take your pick.—Editors.

TRANSISTORIZED IGNITION SYSTEM

To the Editors:

There have been several inquiries addressed to me from people who are interested in building my transistorized ignition system (August and December, 1962 issues) in any or all of its versions for commercial exploitation purposes.

The company for which I work has applied for a patent covering the circuit and all its modifications.

Anyone who is interested in the commercial exploitation of the circuit should address their inquiries to: Patent Department, *Litton Industries,* Components Group, 336 North Foothill Road, Beverly Hills, California.

Boghos N. Saatjian
Triad Transformer Corp.
Los Angeles, Calif.

NON-DIRECTIONAL STEREO

To the Editors:

Mr. Hirsch's article on "Non-Directional Stereo Effects" in the October issue performs a good service in directing attention to the fact that there is value to stereo reproduction, even through loudspeakers, entirely aside from the well-known directional, or "ping-pong ball," effect.

The basis for Mr. Hirsch's thesis as to the independence of the two ears is presumably the experience of observers listening with one ear stopped up. Such listening must, of course, be done with loudspeakers rather than earphones to be of value. Beyond this, the validity of findings reported by persons having two good ears with one stopped up is open to question. The stopping up of one ear is a disturbing experience and would tend to interfere with subjective phenomena. Ideally tests should be performed with persons completely deaf on one side, who concededly could not give valid before-and-after testimony but could be examined as to what they experience in the case of stereo. Such experiments would, it is believed, show that while the loss of one ear greatly interferes with the perception of sound sources and with directional effects of stereo, the non-directional effects are not entirely eliminated. I, personally, am now converting to stereo after having had one ear disconnected surgically, for different reasons of course.

Winfield T. Durbin
Chicago, Ill.

ELECTRONIC DRAFTING MACHINE

To the Editors:

An interested group of draftsmen in this northern Michigan town would like further information concerning the electronic drafting machine described on page 49 of your October issue. In particular, does the man who makes the punched card need a drawing or graphic description of some kind before he can make the punched card? Can this machine design or does the operator have to know what he wants it to reproduce? Basically the question is—can this machine replace engineer and draftsman?

R. Barker
Packaging Corp. of America
Filer City, Mich.

The machine cannot actually do design work and it must be programmed by someone who tells it what to do. As with all automation techniques, some of the more routine types of job classifications will be eliminated, but because of all the additional work that must be done in

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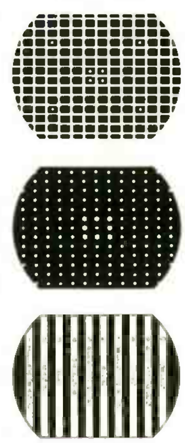

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many of our industries, people in what's being automated may simply change their job functions and raise their levels (and salaries) rather than lose their jobs.

This has been the experience of some of our larger banks that have installed elaborate computers to do most of the clerical work. The number of bank employees in these institutions has not declined at all. As a matter of fact, it has increased somewhat, although the level in job functions of some of the workers has changed.—Editors.

* * *

ELECTROLYTIC CAPACITORS

To the Editors:

What happens to the capacitance of electrolytic capacitors when a.c. or very low voltage d.c. is applied? I have in mind the use of electrolytics in speaker crossover networks and in d.c. circuits where the voltage applied is much lower than the rated voltage value.

Also along these lines, measurements of capacitance are frequently made in simple RC bridge circuits to which 60 cps a.c. is applied. Will the capacitance of electrolytics measured this way be the same as their capacitance in a d.c. circuit with the proper forming voltage applied to the capacitor?

JAY HUNTER
New Rochelle, N.Y.

According to several capacitor manufacturers we contacted on these questions, it appears that once the electrolytic is properly formed by the manufacturer, it can be used on low-voltage audio or a.c. as well as on a low value of d.c. that is far below the rated working voltage. After a period of time, however, the oxide dielectric film is reduced so that capacity is increased possibly by as much as 25% in a few months. This means that there will be a downward shift in crossover frequency if the electrolytics are used in speaker crossover networks and possibly increased leakage in low d.c. circuits.

When measuring electrolytics on a common RC bridge in which 60 or 120 cps a.c. is applied, the measurements should be quite accurate if the electrolytic is still properly formed. Therefore, it would be a good idea to check the capacitor for leakage first as this is done by the application of a d.c. voltage. This voltage insures that the dielectric is formed and that the leakage is brought down to its normal value. Once this is done, the capacitance can be measured with the a.c. from the bridge and the capacitance value thus measured will be as accurate as the bridge is able to read.—Editors.

* * *

MULTIPLEX SIGNAL GENERATOR

To the Editors:

The circuit diagram for the FM multiplex signal generator that is shown on page 36 of your January, 1963 certainly looks very interesting. Evidently, a lot of care and thought went into the design and construction of the unit. However, I don't think that the meter circuit will operate unless a ground connection is added at the bottom ends of resistors R67 and R70.

JOSEPH GARDENA
San Diego, Calif.

Thanks to Reader Gardena and others for pointing out the missing ground. In addition, the compactron tube V4 should be a 6K11 rather than a 6D11 designated on the parts list and schematic diagram.

Finally, in order to have balanced outputs from phase splitter V3B, both plate-load and cathode-load resistors must be equal in value. Hence both R26 and R30 should be 4700-ohm, 1-watt resistors.

For readers who are having difficulty in obtaining single 19-kilocycle crystals from the sources indicated in the article, we suggest that these readers contact the Audio Workshop, Inc., 732 Broadway, New York 3, N.Y. *This company is planning to make these crystals available at a price of about $18.25.—Editors.* ▲

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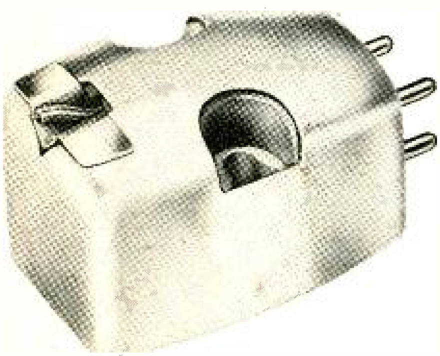
Audio Dynamics ADC-1 "Mark II" Phono Cartridge
Fisher KM-60 FM-Multiplex Tuner

Audio Dynamics ADC-1 "Mark II" Phono Cartridge

For copy of manufacturer's brochure, circle No. 58 *on coupon (page* 21).



THE *Audio Dynamics Corp.* ADC-1 was one of the first ultra-high-compliance stereo phono cartridges, designed to operate at tracking forces under one gram. The original ADC-1 had a minimum compliance of 10 x 10^{-6} cm./dyne. Later this was increased to 20 x 10^{-6} cm./dyne. Now, with a further increase to 30 x 10^{-6} cm./dyne, the cartridge has received the "Mark II" designation.

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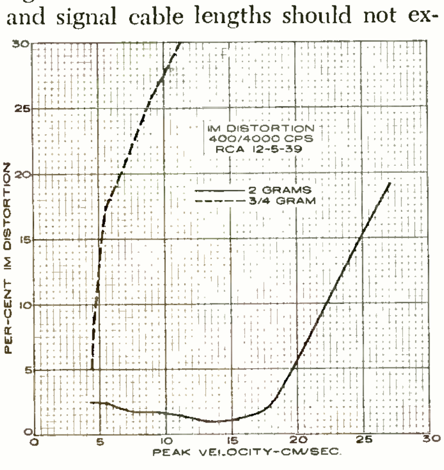
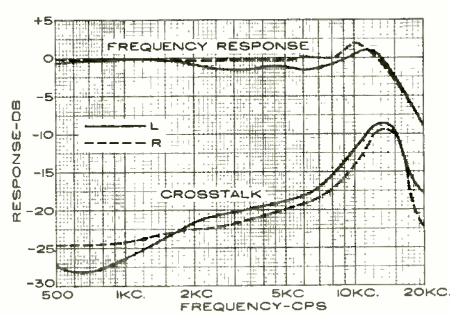


Before making measurements on the cartridge, we checked its ability to track high recorded velocities. It tracked the 32-cps band of the *Cook* 60 record at 1.5 grams, and the 1000 cps, 30 cm./sec. bands of the *Fairchild* 101 record at 2 grams. Both records contain recorded velocities far greater than those usually encountered in musical recordings, most of which can be comfortably tracked at 0.75 gram. This force was used for our frequency-response measurements.

The *CBS Labs* STR-100 test record was used for frequency-response and channel-separation measurements. The response was ±2 db up to 14 kc., falling



above that frequency. Our connecting cables were at or a bit beyond the maximum recommended length, and it is possible that shorter cables would slightly extend the high-frequency response. The channel separation was better than 20 db up to about 5 kc., reducing to 13 db at 10 kc., and exceeding 7 db all the way up to 20 kc.

ADC uses the *RCA* 12-5-71 (78 rpm) record as the basis for their specifications, so we checked the cartridge at several points with this record. The readings were similar to those obtained with the 33-rpm *CBS Labs* record.

The square-wave response, with the 1-kc. square waves of the STR-110 record, showed one cycle of ringing, at 30% of peak amplitude, which was quickly damped. The cartridge output was 7 mv. per channel at 5 cm./sec. lateral velocity. The two channel outputs were almost exactly equal at middle frequencies. The sensitivity to induced hum, although relatively high, was about 5 db lower than earlier ADC-1 cartridges we have tested. Since this cartridge is not likely to be used with inferior turntables having strong hum fields, this should present no problem. We have used the cartridge with several different turntables without experiencing any hum.

Finally, we measured the intermodulation distortion of the cartridge as a function of peak recorded velocity, using the *RCA* 12-5-39 record. At 0.75 gram the IM was quite large, but at 2 grams it did not exceed the residual distortion of the record and test equipment up to about 18 cm./sec. velocity.

The listening characteristics of the cartridge are best described as clean, musical, slightly bright, and with excellent definition. Surface noise is very low and there is a slight sparkle which is noticeable by comparison to some other fine cartridges. Needle talk is very low. We have found that these cartridges will track very nicely at 0.75 gram in good arms, and forces larger than 1.5 grams should never be required.

The price of the ADC-1 "Mark II" is $49.50. ▲

Fisher KM-60 FM-Multiplex Tuner

For copy of manufacturer's brochure, circle No. 59 *on coupon (page* 21).

THE KM-60 is an FM multiplex tuner, one of the "Stratakit" family of high-fidelity component kits by *Fisher*. These kits feature simple construction procedures, divided into a number of distinct stages ("strata"). In the case of the KM-60, there are 16 stages, each having all its parts (including pre-cut wire) in a plastic packet. The spiral-bound construction manual displays the steps for only one stage at a time, together with a life-size (or larger) pictorial layout of that part of the assembly.

The manual is written in a conversational style, which makes for enjoyable reading, and explains the significance of each stage in the final operation of the tuner. The critical circuits,

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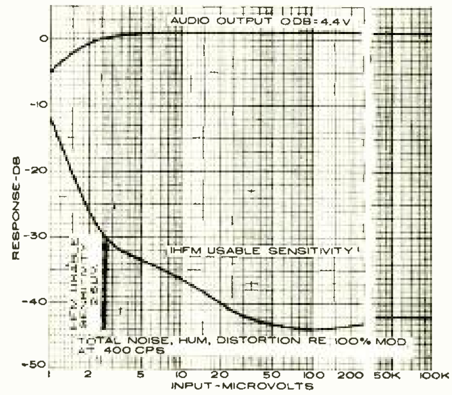
such as the front end and multiplex demodulator, are pre-wired and aligned. The i.f. transformers are roughly aligned; final adjustment is done with a received signal, using the unit's tuning meter. This process is further simplified by a switch on the chassis which connects the meter to the limiter grid for i.f. alignment (and normal operation) or to the detector output for detector alignment.

Physically, the tuner looks much like *Fisher* factory-wired tuners, with a rigid, brushed brass finished panel. On the panel are switches for controlling power, mono/stereo reception, and a stereo noise filter, as well as the tuning knob. On the rear of the chassis are two pairs of output jacks, for driving a tape recorder as well as the main amplifier, and individual channel level controls.

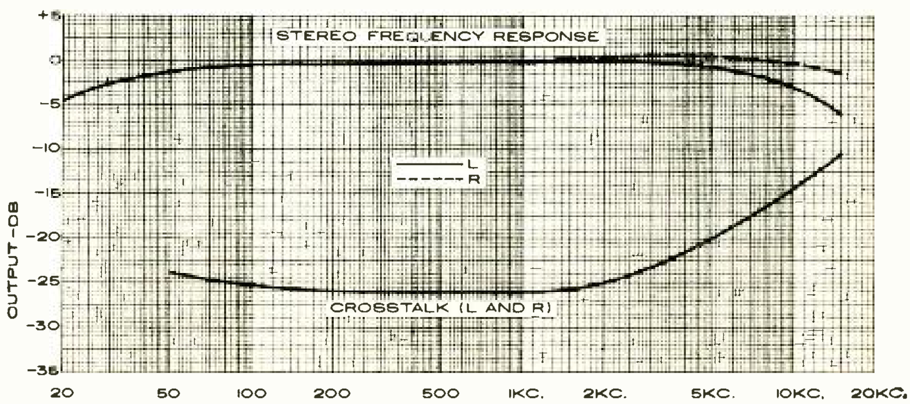
The unit has a 6DJ8 cascode r.f. amplifier, a 6AQ8 mixer/oscillator, two 6AU6 i.f. amplifiers, and two more 6AU6 i.f. stages which also act as limiters. Two germanium diodes are used in the wideband ratio detector. The multiplex chassis uses switching circuits similar to those in the company's multiplex adapters. A 12AT7 amplifies the composite signal which (after filtering to remove SCA modulation) goes to two four-diode switches. The 19-kc. pilot carrier synchronizes a 12AX7 push-pull oscillator at 38 kc., which alternately gates on the two switches. Their outputs are left- and right-channel signals, which are de-emphasized and filtered to remove any 38-kc. component before going to the 12AX7 dual output amplifier. This amplifier uses negative feedback to reduce its output impedance and distortion. The 19-kc. pilot carrier is rectified, and the resulting d.c. used to close the beam on an EM84A eye tube ("Stereo Beam"), signalling the fact that the station is transmitting in stereo.

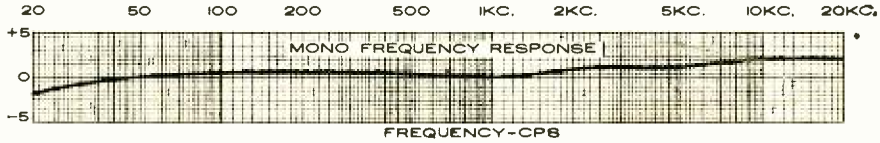


The unit we tested took 9½ hours to construct, plus alignment. This is a simple procedure with the built-in facility, and apparently is adequate to obtain full performance from the tuner. We were unable to improve on it by instrument alignment.

Following is a comparison of our measured performance (listed first) and

(*Continued on page* 89)





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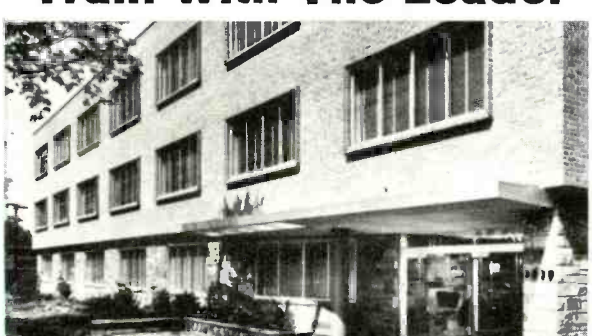

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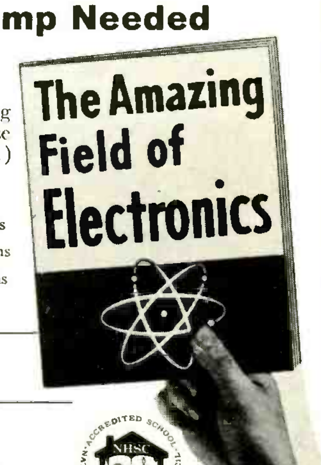

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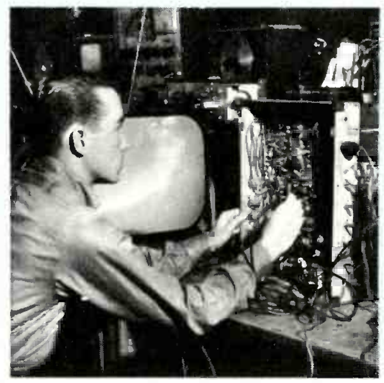

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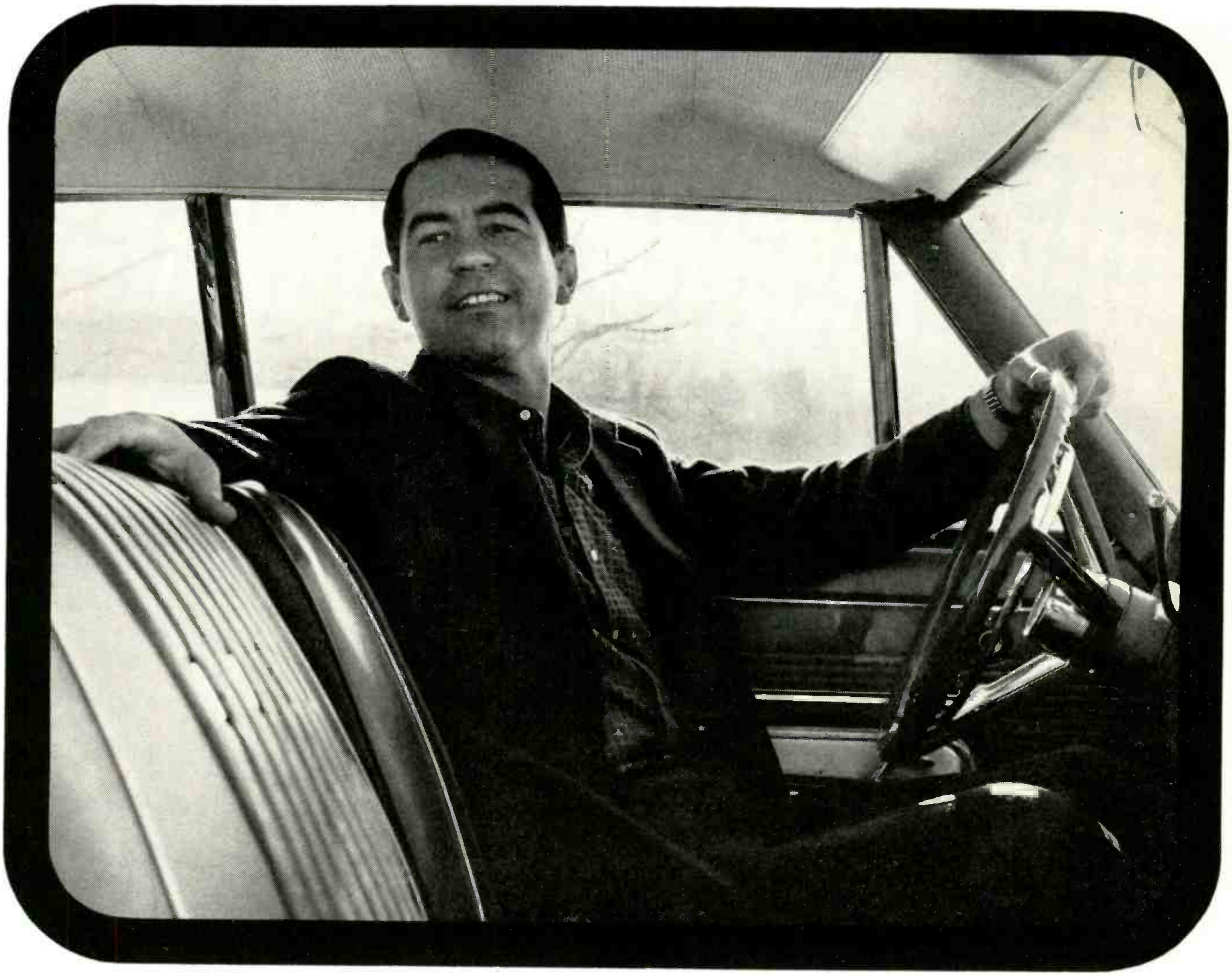

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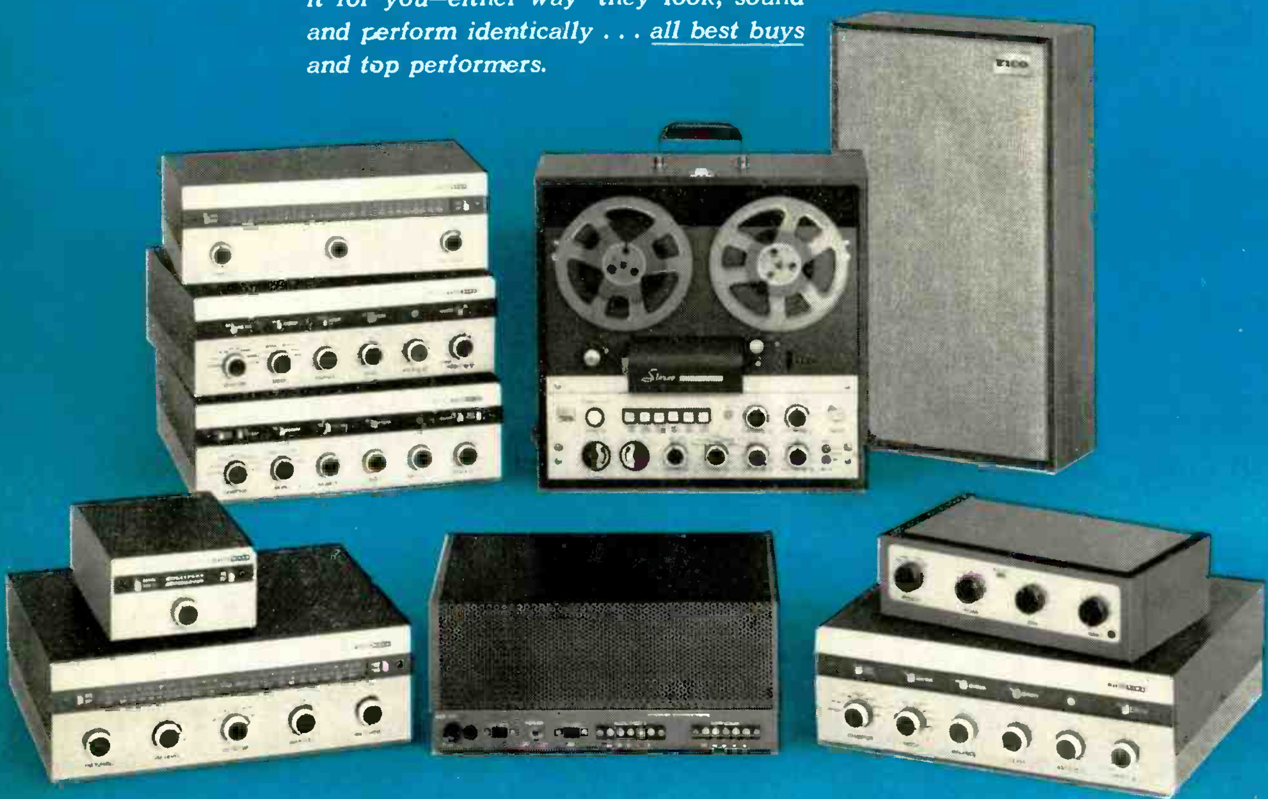

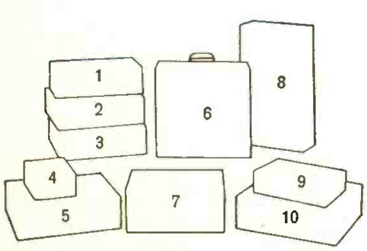

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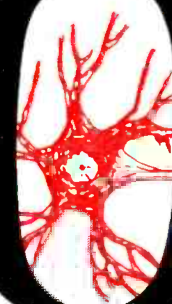
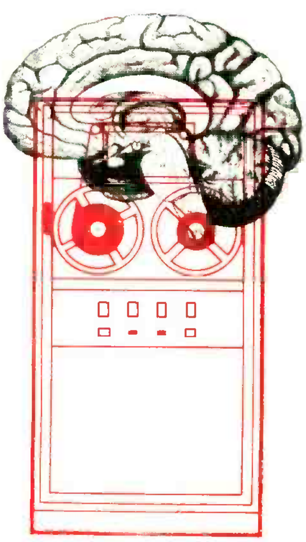
BIONIC COMPUTERS



Will future computers be able to learn, reason, and think for themselves? By studying the human brain and nervous system and by imitating their operation, we are beginning to make some headway to that goal.

By KEN GILMORE



IN a laboratory at Wright-Patterson Air Force Base near Dayton, Ohio, scientists are spending their time these days watching a mouse. The mouse—an electronic one—is learning to run a maze.

The mouse is of tremendous interest to the Air Force because its "brain"—the computer which directs its activities—is a completely new kind of device. This different thinking machine may be the forerunner of a whole new generation of advanced computers. And although opinion among experts in the field is by no means unanimous, some workers foresee the day when these unique machines may outdistance today's most advanced computers as easily as present computers overshadow the abacus.

Guiding the mouse through the maze is a *bionic* computer—a machine whose circuitry is based not on conventional computer elements, such as flip-flops and ferrite memory cores, but on principles which bionic scientists have learned from studying living brains and the way they work.

The Model: the Brain Cell

The basic element of the bionic computer is the artificial neuron—an electronic imitation of a nerve cell. Scientists have long known that living brains are composed of neurons: cells which are similar in some ways to computer elements.

The biological neuron (shown in simplified form in Fig. 1) is a threshold device. It has many inputs—usually a few hundred but sometimes as many as several thousand—called dendrites (D), and one output, an axion (A). The processing of electrical signals takes place in the central cell body (B). Most of the dendrites are excitory, that is, signals coming in over them tend to cause the cell to "fire." But some are inhibitory: signals appearing on these dendrites tend to keep the cell from firing. A neuron's status—firing or non-firing—at any particular moment is determined by the combination of signals appearing on the dendrites. If enough excitory signals appear, the cell threshold is exceeded and the neuron fires. Of course, if inhibitory impulses are present, it takes more excitory signals to exceed the threshold.

The biological neuron is essentially a digital device. Its output is "all-or-none." When its threshold is exceeded, it generates a constant-amplitude .5-millisecond pulse (Fig. 2). The normal resting potential is around −70 millivolts, and the peak potential is about +50 millivolts; hence, the pulse itself has a peak amplitude of about 120 millivolts. After firing, the neuron recovers for a millisecond or so—then if the signal is still present, or else if another input signal comes along, it fires again.

Neural Networks

The complexity of the human brain is almost incomprehensible. It contains on the order of ten billion neurons, each with hundreds or thousands of dendrites. The neurons are connected in semi-random patterns, with each one receiving signals from and sending signals to hundreds or thousands of others. Signals from eyes, ears, and scores of other sensors all over the body are fed into this complex network, where they set billions of patterns of currents swirling through trillions of interconnections.

Somehow, this fantastic data-handling system, which dwarfs to insignificance our most advanced electronic computers, generates all human and animal actions and reactions. Also produced in ways only dimly understood are qualities we have come to know as intelligence, learning ability, and emotion.

The electrical neural activity also accounts for memory, although there is some doubt as to how. Some physiologists and bionicists feel that a certain pathway set up for processing a certain signal tends to "wire" the neurons so that they are more likely to conduct a similar signal along the same pathway the next time. If you solve a problem, for example, the neural currents tend to "bias" the neurons involved in a certain pattern. The next time you face the same problem, the biased neurons would tend to conduct currents along the same pathways, or to put it another way, to "remember" the previous solution and repeat it. Continued exposure tends to reinforce the "biasing" or "wiring" and thus makes the memory firmer.

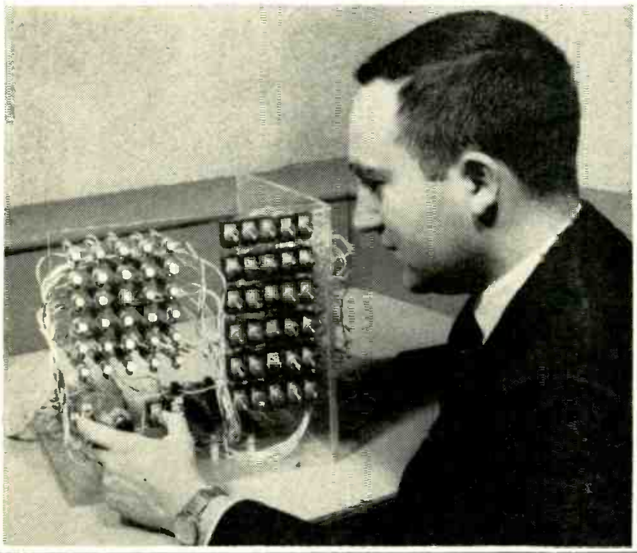
Imitating the Neuron

Although our understanding of the operation of complex biological neuron nets is extremely limited, the operation of single neurons is fairly well understood. Consequently, scientists have been able to construct artificial neurons—electronic circuits that duplicate closely the electrical activity of the biological neuron.

At least twenty companies are working on such a project, and have come up with many different kinds of circuits. Fig. 3 shows one such neuron designed at *Bell Laboratories*. It has six inputs—five excitory and one inhibitory. Its operational characteristics closely approximate those of the biological neuron, except that its input and output signals are on the order of one volt, rather than in the millivolt range as is the case with the biological model.

The *Aeronutronic Division* of *Ford Motor Company* has built an artificial neuron called "MIND" (Magnetic Integrator Neuron Duplicator), which is simpler but does not imitate the behavior of the neuron as closely as the *Bell* model. *General Electric*, *Melpar*, and many other companies

A



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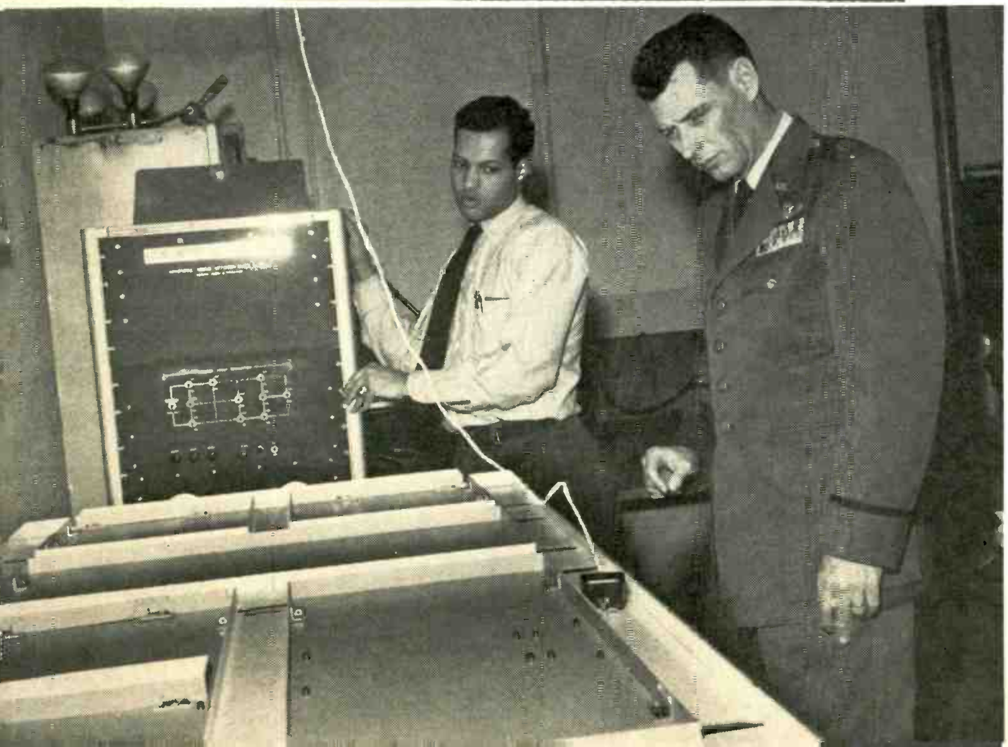


(A) Model of pattern-recognition system, based on array of neuron-like elements. Toggle switches for input sources and lights that display whether the sources are energized are in the two rectangular arrays on the front of the model. Neuron-like translation modules are also employed in similar array on right side of the unit.

(B) Network of electronic neurons is assembled by L. D. Harmon of Bell Telephone Laboratories, who initiated project of simulating the functions of nerve cells with simple transistorized circuit. Array shown imitates some functions of the eye nerves.

(C) The Air Force's "bionic mouse" learns to run maze in much the same way as does its live counterpart. Scientists hope that some day vastly more complex bionic brains may rival the human brain in its ability to think, to reason, and to learn.

have also built artificial neurons of one type or another.

The *Melpar* model—called "Artron" by its inventors—is the neuron used in the Air Force's maze-running mouse. The mouse's "brain" contains just 10 "Artrons"—as compared with 10-billion neurons in a human brain—but these give it enough learning ability to master the maze.

When the mouse begins its learning task, it has an almost limitless combination of choices as to which legs of the maze it will follow. At first, its course is completely trial and error. But each time the mouse makes a turn which works out properly, the cells are biased to operate that way again—in other words, they "remember" the proper turns.

The author saw the mouse put through its paces in Dayton recently. First, all circuits were returned to electrical neutrality—the mouse's memory was wiped clean. The first trip, it made scores of wrong turns and took about 45 minutes to find its way through the maze. The next trip out the time was cut in half. On the eighth trip, it ran through from beginning to end in 35 seconds flat, without a single error.

Self-organizing Systems

Scientists working with bionic computers are hopeful that these strange thinking machines may help break the programming bottleneck. Each step a present-day computer is to take must be outlined in detail before the machine can function. It frequently takes months of human time to program a computer to solve a problem which it can complete in a few minutes.

Man, animals—and now bionic computers, such as the one which guides the mouse—on the other hand, fall into a category labeled "self-organizing data-processing systems." One man can tell another to make out a payroll, and no further instructions are necessary. Man, in other words, is self-programming. He operates on general instructions, filling in details for himself. But a computer has to be instructed on each minute step: read certain names and amounts from the memory, compute certain figures, etc.

Bionic computers are, to some extent, already self-programming. The mouse doesn't have to be programmed to run the maze—it figures out the process for itself. Furthermore, if the maze is changed, it sets to work and learns the new maze—again without being told.

A new mouse—one with 40 neurons—is now being built and should be capable of even more complex behavior. In one experiment, Air Force scientists plan to put red and green lights on either side of the passageway. A green light will shine where a right turn should be made; red will indicate a left. The mouse, equipped with red and green sensors, won't be instructed—programmed, in computer language—to pay attention to the lights. But, like a live mouse, it will see them. If predictions hold, the mouse without being told will figure out for itself that red means left and green right. Then, when placed in a new maze equipped with lights, it should run it properly the first time.

Bright Bionic Future

A bionic brain might eventually begin to perform feats now completely out of the question for non-living systems, indeed, might display true intelligence. Pattern recognition, for example, is a field now in its infancy. A few machines have been built which can read several handwritten numbers or letters if they're written clearly enough. But human beings recognize with ease patterns of astonishing complexity. A child who can't add 2 + 2, for example, can recognize hundreds of different people at a glance, by differentiating between the subtle changes in the patterns of their faces.

Elementary self-organizing pattern recognizing systems called "Perceptrons" have already been built at Cornell and other places. So far, they work, but do well to recognize simple letters. But what scientists learn from these early machines may help them build more versatile devices in the future.

A highly sophisticated pattern recognizer would certainly be a useful device. In a satellite, it could look at clouds, spot important patterns and notify the ground station, ignore everything else. A spy-in-the-sky could look out for missile launchings, also for troop movements, armament buildups, or other tell-tale signs. It could look at microphotographs of blood samples and tissue sections and make diagnostic decisions. (MIT already has a working model of one such device which can recognize a certain type of cancer cell by looking at it through a microscope.)

Bionic brains, of course, wouldn't have abilities such as these the moment they rolled off the assembly line. Unlike ordinary computers which are ready to work as soon as the last soldered connection cools, bionic computers would have to learn their jobs. One Air Force scientist estimates that a newly completed brain might sit on the shelf for a year or more, soaking up information poured into it 24 hours a day. Its "education" received in this way would be comparable in some respects to the education of a human being.

Learning ability isn't the only benefit we may get from designing bionic computers to imitate living brains. Another is reliability. You were born with some 10 billion neurons—

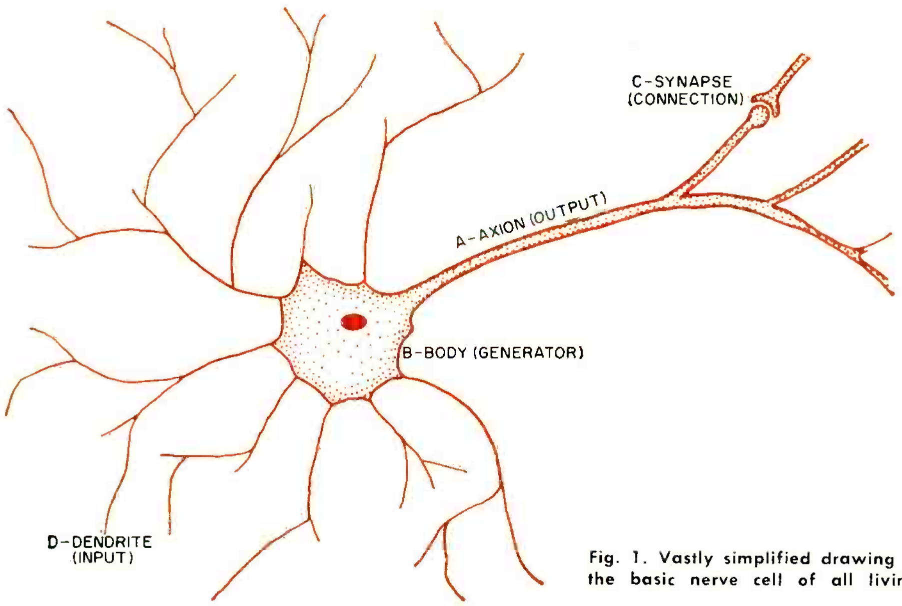


Fig. 1. Vastly simplified drawing of a neuron, the basic nerve cell of all living creatures.

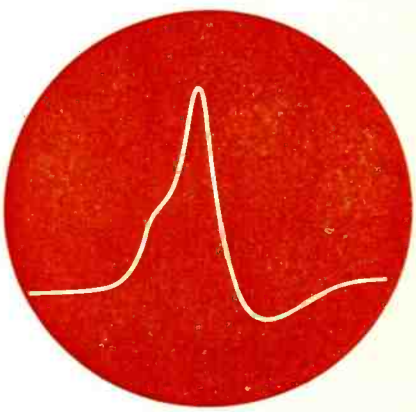
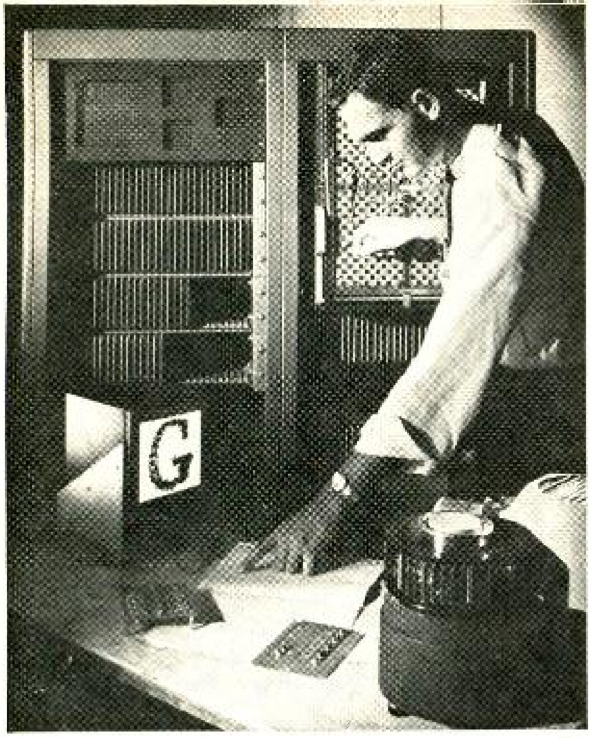
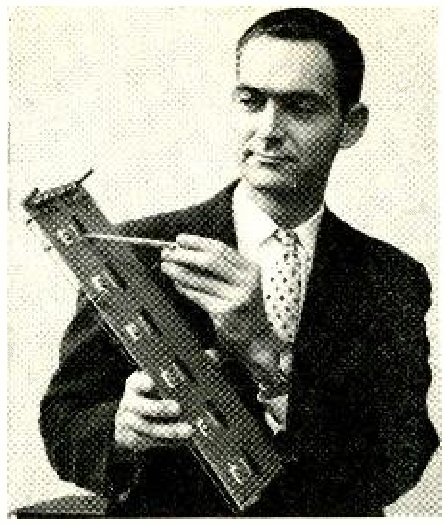


Fig. 2. The output pulse generated by a biological neuron may vary in amplitude from one neuron to another, but the output of any given cell tends to remain constant regardless of the signals applied to its input.

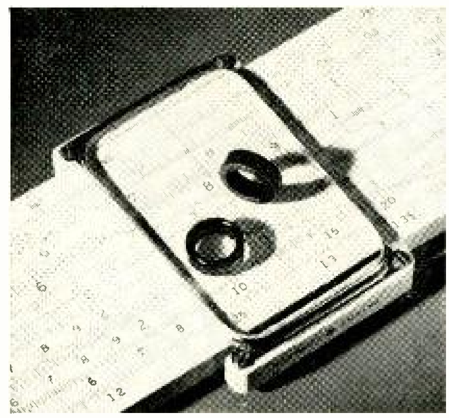


Bionic pattern-recognition machine learning to recognize "G."



Artificial "nerve network" used to test behavior of Aeronutronic neurons. Transistor circuits are used in conjunction with devices to help them carry out decision-making functions.

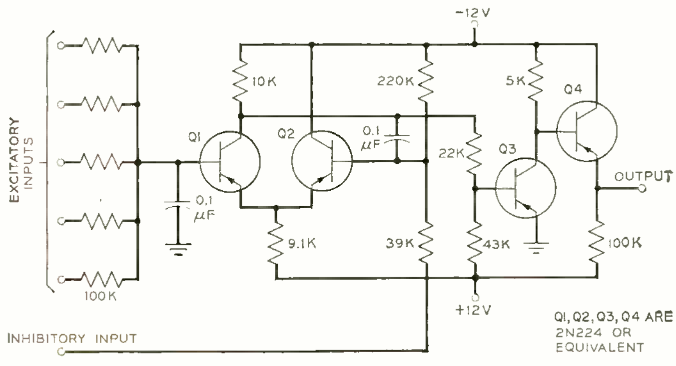
This small artificial neuron was developed by Ford Motor Co.'s Aeronutronic Div. as part of its self-organizing machine research work. The MIND (Magnetic Integrator Neuron Duplicator) device duplicates in some ways the functions of live nerve cells. While it cannot imitate a living neuron as closely as can the circuit shown in Fig. 3, it is able to remember and learn from experience when taught by human or mechanical teacher.



all you will ever have. When a neuron dies, it is not replaced. And about 1000 die every hour of your life. You'll lose 500 million during a normal lifetime, yet you will still operate effectively. As a matter of fact, there is apparently no adverse effect on the system due to the death of individual neurons, within certain limits.

Bionic scientists call this the principle of reliable operation with unreliable parts. Because of the vast number of neurons and their system of random interconnections, when one dies others around it take over its tasks. Designers expect that bionic computers will similarly continue to work reliably even if part is damaged or destroyed. In a satellite, where repair is impossible, bionic devices would continue to operate as part after part failed. Life expectancy of such devices—even without service—might be measured in terms of decades, rather than weeks or months as it is now usually the case with presently available equipment.

Fig. 3. Schematic diagram of electronic nerve cell. When the sum of the excitory inputs exceeds a preset level, the circuit "fires" and generates a pulse similar to the one produced by a biological neuron. If a signal appears at the inhibitory input, the firing threshold is raised. Under these conditions, the electronic neuron requires larger excitory signal to fire.



Human Beings—Living Computers

The idea which eventually resulted in bionic computers came from the brilliant mathematician, Norbert Weiner, in the late 1940's. His classic book "Cybernetics," published in 1948, pointed out for the first time that man could be considered not only as an animal with certain behavioral patterns, but as a fantastically complex information processor—a flesh and blood digital computer. But far too little was understood about the human mechanism to hope to apply its principles to electronic circuitry at that time. Richard Caton had discovered in 1875 that the brain was essentially an electrical device, but that didn't help much either. Trying to explore the brain's operation by reading electroencephalograms is like figuring out how an *IBM* 7090 works by measuring voltages on the outside of the cabinet.

The breakthrough in the study of the brain's operation came in 1949 when Ling and Gerard invented the intracellular electrode, a glass capillary tube with a conducting salt inside. Its over-all outside diameter was on the order of a few tenths of a micron (more than 10,000 such probes laid side by side wouldn't cover an inch). With the microprobe, it became possible for the first time to measure electrical currents in individual neurons.

In the early 1950's, the need for computer systems orders of magnitude better than those then in existence became obvious. So scientists, while continuing to improve conventional computers as rapidly as possible, also began to look around for new approaches to data processing. They found one clue in the oldest data handling system in existence: the brain. Scientists around the country set to work to wrest useful secrets locked in the brain cells of animals and men.

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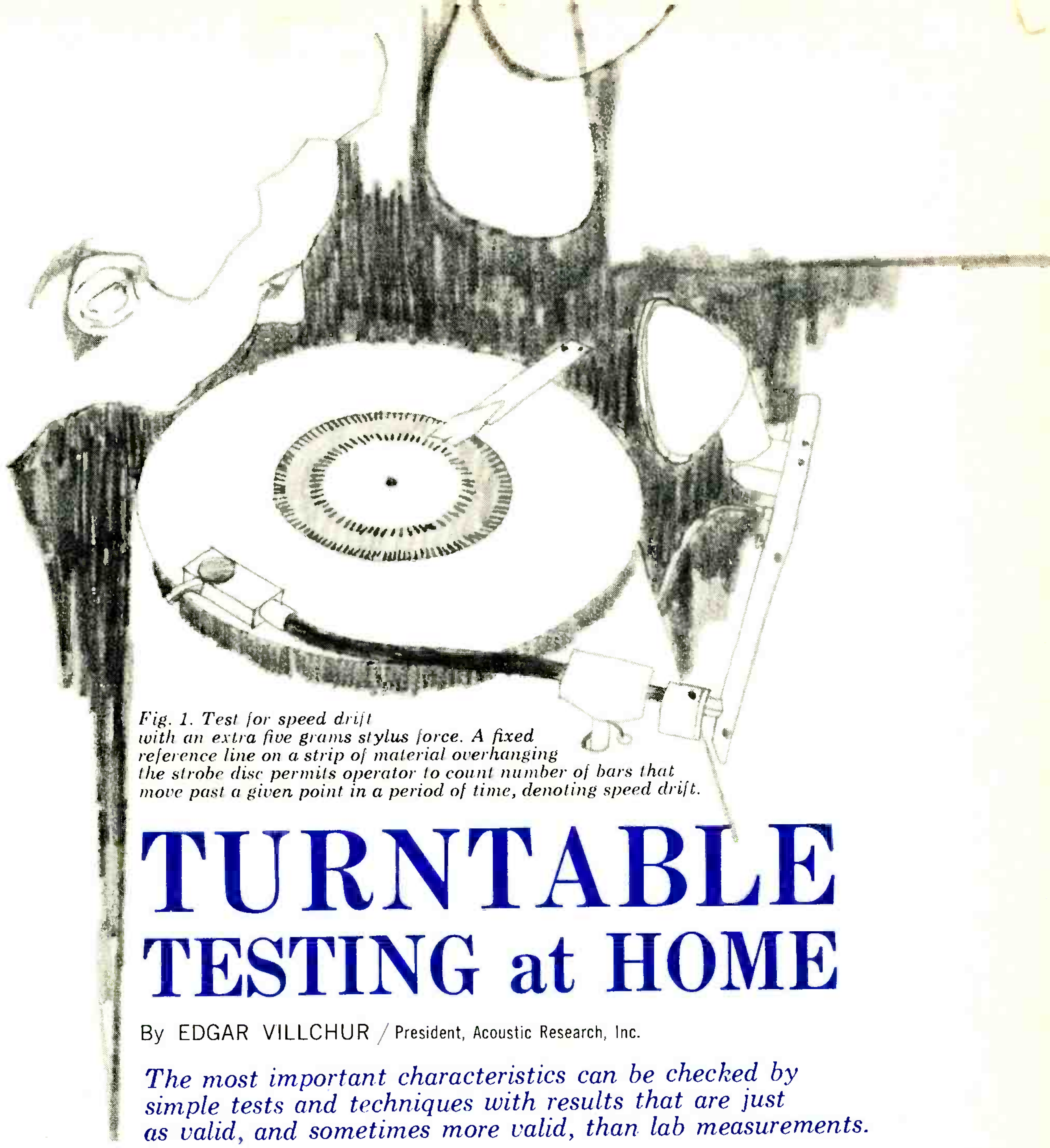


Fig. 1. Test for speed drift with an extra five grams stylus force. A fixed reference line on a strip of material overhanging the strobe disc permits operator to count number of bars that move past a given point in a period of time, denoting speed drift.

TURNTABLE TESTING at HOME

By EDGAR VILLCHUR / President, Acoustic Research, Inc.

The most important characteristics can be checked by simple tests and techniques with results that are just as valid, and sometimes more valid, than lab measurements.

A PREVIOUS article by this writer ("Loudspeaker Testing and Measurement," October 1961 issue of ELECTRONICS WORLD) stressed the professional requirements of equipment and techniques suitable for testing speakers. It was pointed out, for example, that attempts at making rough frequency-response measurements at home generally produce results that are meaningless or even misleading.

Two years of work in developing and testing the *AR* turntable have led me to the conclusion that there is very nearly a reverse situation with regard to testing turntables and arms. Only one commercial test instrument has yielded measurements of flutter[1] and rumble that correlate well with listening results—a behemoth made by *Dataservice Corp.* that weighs its measurements according to perceptibility. Flutter and rumble measurements with standard unweighted instruments have proven to be *less* valid in predicting performance than controlled, comparison listening tests, using methods and test records to be described here. Other turntable characteristics, such as speed accuracy and drift, can be measured at home as reliably as they can in the laboratory.

This article will describe methods of testing record players for the following characteristics: (1) speed accuracy, (2) speed drift (with time, line voltage, or change of mechanical load), (3) rumble, (4) flutter/wow, (5) vertical warp wow, (6) susceptibility to acoustic feedback and to floor shocks, (7) arm inertia and pivot friction, and (8) tracking error. Some of these tests, and particularly the one relating to flutter, take on meaning only in comparing two or more turntables. Others have validity by themselves, and the results can be compared to established Standards.

Speed Accuracy

Stroboscope cards are very common, but their proper use, and desirable standards of speed accuracy, are not as well known. It is not enough to glance at an illuminated stroboscope card and determine whether the bars or dots appear to be stationary or in motion. If the turntable is so far off speed that a *casual* glance reveals the card lines to be in motion, the speed is beyond acceptable professional limits of accuracy.

[1]The American Standards Association defines "flutter" as any deviation in the frequency of reproduced sound; "wow" is described as a colloquial term commonly applied to flutter at relatively slow rates.

NAB Standards for the speed accuracy of turntables used in broadcast work is ±0.3%, which is to say a drift of strobe lines on a standard card of 21 per minute maximum. Once this high standard is achieved there is no need to improve accuracy further.

The drift of strobe lines must be counted while holding a pencil or other marker near them, viewing the card under an a.c. light, preferably fluorescent. A watch with a second hand and an assistant are needed. The count should be made while the pickup is playing at normal stylus force at the outer grooves of the record, and it should be repeated at the inner grooves.

Speed Drift

Turntables may change speed after starting because the electrical resistance of the motor windings tends to increase with heat. This speed change does not take place at all in synchronous units, and modern induction motors can be designed to resist such drift. A strobe card check on starting, and again after a quarter of an hour of running, will show any speed change.

A more important source of speed drift is variation in line voltage. Many turntables with synchronous motors remain on speed in the face of tremendous line-voltage drops, sometimes to a value as low as 20 volts. A reasonable requirement for non-synchronous turntables is that their speed remain within the NAB ±0.3% accuracy when the line voltage is reduced from 117 v. to 100 v. or increased to 130 v. The test consists of varying input voltage to the turntable over these limits with a variable autotransformer (the arm playing in the outside grooves) and seeing whether the lines on the strobe card drift more than 21 per min. in either direction. If they do, and the user is in an area with large line-voltage variations, a voltage regulator between the turntable and wall outlet will solve the problem. Where such line-voltage variations are expected, however, selection of a synchronous-motor turntable to begin with is generally more economical.

The greatest weakness of turntables with regard to speed drift is susceptibility to changes of mechanical load associated with operating conditions. This type of speed variation takes place in both synchronous and non-synchronous units, because it results from slip in the drive system as well as in the motor. A simple method of varying the load on a turntable in a controlled manner is to add weight to the pickup—a U.S. penny for three grams, a nickel for five grams.

The difference in mechanical load imposed on the turntable between record drag on the outside grooves and drag on the inside grooves is typically equivalent to about two grams added weight on the pickup. A heavily recorded passage may increase the mechanical load by an amount equal to an extra gram or two. Dust cleaners that bear on the rotating record may increase the load by as much as an added six grams.

Turntable speed is first measured and recorded with the pickup playing a record's outside grooves at normal stylus force. This test should be repeated at least once to establish an accurate base for comparison. A nickel is then placed on the pickup (after it is put back to the outside grooves) and the speed of the turntable is accurately clocked once again.

There are no commercial home turntables that will not slow down enough on this test so that the change is readily measurable. Just how much increase of mechanical load should be tolerated before the 0.3% slow-down occurs has not been established as an industry standard. The writer believes that a turntable should be able to tolerate an extra five grams load on the pickup without slowing more than 0.3% or 21 lines/min. on the strobe disc.

This may not seem too difficult a trial, but probably one-third of current commercial units, both "heavy" and "light," would not pass the test. Some turntables appear to have high torque when the platter is stopped by hand, but this test is no index of *useful* torque, that is, the torque which keeps the platter from slowing down more than 0.3% in the face of increased mechanical load. A turntable may drop 0.7% in speed with only a few extra grams on the pickup, yet continue to revolve, at an unusably slow speed, under very great mechanical loads. The ability of the turntable to resist stopping by hand does reflect total torque, but not necessarily that part of the torque applicable to playing records.

Fig. 1 shows the speed-drift test made at a production line test station, with a nickel placed on the pickup.

Rumble

The NAB Rumble Standard for turntables used in broadcast work is explicit: the maximum instantaneous level of rumble is to be at least 35 db below a test signal of 1.4 cm./sec. at 100 cps. The ballistic characteristics of the meter must be the same as a vu meter, and the amplifier used in the test must have standard playback equalization.

This Standard is a very exacting one, particularly if it is applied to both vertical and lateral rumble, and many current turntables do not meet it. However, rumble measurement methods can be changed to "improve" the readings. The use of a meter movement more highly damped than a vu meter, and the employment of a playback preamplifier without bass equalization (a procedure in use by one testing organization) serves to reduce measured rumble level as much as 25 db.

Even with strict adherence to the NAB measuring technique, however, the NAB rumble reading is not an adequate index of turntable excellence with respect to rumble. The NAB Standard itself specifically points out that its described testing technique yields a measured *electrical* level, not the aural annoyance value of the rumble.

Rumble may be predominantly subsonic in frequency, or it may have strong components in the 30-cps, 60-cps, and 120-cps region. Hearing sensitivity at the higher rumble frequencies is much greater, and the difference between hearing sensitivity to subsonic rumble and that to rumble in the 30- or 60-cps region is often much more significant than the difference between two turntables in absolute rumble level.[2] Thus we may have two record players with the same unweighted rumble level, one very quiet in performance and the other exhibiting objectionable rumble.

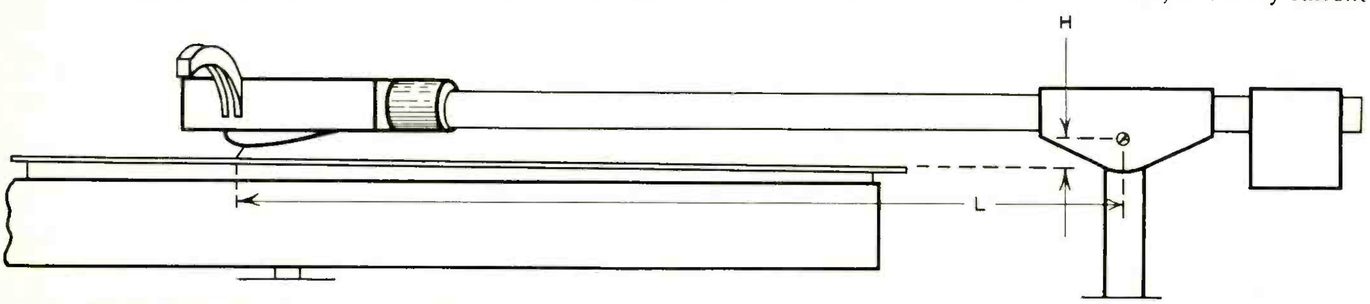


Fig. 2. The amount of warp wow is determined by arm length L and the height H of the pivot above the surface of the record.

[2]Although subsonic rumble can load the amplifier the level would have to be very high to be significant, and this consideration is not ordinarily involved in modern turntables.

It was discovered early in the *AR* development project that our very accurate rumble-measurement equipment, built exactly to NAB specifications, did not provide as valid information in assigning relative ratings to two or more turntables as a simple listening test. We now use, in addition to the NAB specified equipment, the *Dataservice* meter referred to earlier for production testing, which gives frequency-weighted readings that correlate very well with listening results. When the production-line tester takes rumble readings, he also listens to the rumble (in stereo) at a set sound level, as an added check.

A further advantage of listening tests is that lateral and vertical rumble are introduced in the same manner as they are under stereo operating conditions. Vertical rumble is normally the more significant component in stereo playback.

The suggested rumble listening test consists of setting up two or more turntable-arm assemblies and playing an unmodulated groove on each with the same cartridge, in stereo. (Some available rumble and flutter test records appear in Table 1.) The preamplifier should be set for normal stereo operation, the treble controls should be all the way down, and the volume and bass controls should be set high enough so that the rumble is readily audible but not so high that acoustic feedback is introduced. The controls, of course, must not be changed when one turntable is disconnected from the preamplifier and the next one plugged in.

The loudspeakers used must have reasonable response in the octave below 60 cps. The listener (or listening jury) should walk around the room to avoid dead spots at particular bass frequencies, but should make sure the comparisons between turntables are made from the same room position.

It is the writer's experience that differences in rumble between one turntable and another on the above test are usually obvious, and sometimes easier to establish than differences in unsteady vu meter readings. The higher the volume at which the test can be conducted the more readily the differences can be spotted, but an insufficiently compliant mounting of a record player introduces acoustic feedback when the volume control is advanced too far, masking the rumble component being examined.

One absolute rather than relative listening test that has validity can be made. This consists of determining the maximum position of the bass and volume controls that will be used for a particular installation, and listening to the quiet groove record with the controls in that position. The rumble should be almost or entirely absent at all listening positions in the room.

Flutter

As in the case of rumble, raw measurements of flutter (by which is meant the per-cent signal frequency deviation caused by instantaneous variations of turntable speed) are not sufficient to predict turntable performance on music. This is because the perceptibility of flutter varies by a factor of more than 3 to 1 with the flutter *rate*.

Speed variations at the rate of 3 per second are most noticeable in reproduced music. Flutter at ½ cycle per second—corresponding to one cycle per revolution at 33⅓ rpm—is less than half as noticeable, and flutter at much higher frequencies is only ⅓ to ¼ as noticeable. These relationships have been studied and validated, and are recognized by the ASA-IRE Standard "American Standard Method for Determining Flutter Content of Sound Recorders and Reproducers." This Standard proposes the use of a "flutter index" that is weighted according to perceptibility as determined by flutter rate.

Two turntables with the same per-cent flutter would exhibit sharply contrasting performance in the steadiness of musical tones if one turntable had flutter whose predominant rate was 3 cps, while the other had flutter rates at ½ and 15 cps. A listening test on the standard flutter test band—a steady 3000-cps pure tone—would provide a better index of the relative quality of these two turntables than would measurements that have been made with an unweighted flutter meter.

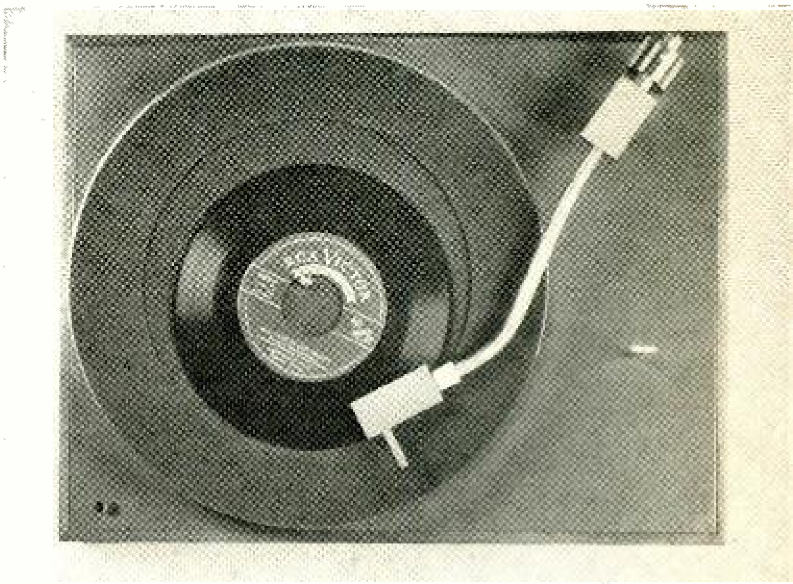


Fig. 3. Test for determining arm inertia and pivot friction.

No turntable or even professional tape machine will reproduce the 3000-cps steady tone so well in a normally reverberant room that some flutter variations are not apparent. The relative amount and rate of variation in different units, however, is not too difficult to perceive, and flutter listening tests can be used to establish relative ratings of different turntables. The listener rates each turntable on how steady the test tone sounds. Such a test cannot be used on a single turntable without reference to another, except after long experience.

The listener will probably be surprised, on first hearing a 3000-cps test tone played, at how much audible flutter is produced by even a high-quality turntable. This does not mean that turntables are not good enough, but that the test conditions for flutter measurement have been purposely chosen to exaggerate the effect. A small amount of detectable flutter in the standard 3000-cps test tone means undetectable flutter on music.

In listening to the flutter test record the volume should be set moderately high, and kept the same for all turntables. Treble controls should be at normal. It is a good idea to turn bass controls all the way down, to isolate any effects of rumble. Make sure that the turntable has come up to speed, and listen to each unit for at least 15 seconds. You may move around the room to find the position in which flutter is most noticeable, but this is less important than it is in the case of rumble testing.

Results of the above flutter tests can be checked against results with a piano record that has sustained tones. Flutter gives them a wavering, unsteady quality.

Vertical Warp Wow

Vertical warp wow is a term used to describe flutter caused by vertical motion of the tonearm due to record warp. When the needle follows warp in a record it not only swings vertically but must also move back and forth horizontally in the groove, since different points on its arc do not lie above the same point on the record. This creates a relative velocity between the needle and the record groove which is either added to or subtracted from the needle-groove velocity associated with rotation of the turntable. Groove speed variation, or flutter, is therefore introduced. It sounds exactly like any other flutter.

The amount of warp wow is precisely determined by two elements—the length of the arm (needle to vertical pivot[3]) and the height of this pivot above the record surface. The longer the arm, and the lower the pivot above the record,

Fig. 4. Measuring tracking error with triangle and protractor.

Manufacturer	Record	Price
Components Corp. Denville, New Jersey	1106 (flutter) 1108 (rumble)	\$1.00 ppd.; \$.89 at dealers \$1.00 ppd.; \$.89 at dealers
Dataservice Corp. 106 Calvert Street Harrison, New York	(flutter and rumble)	\$6.50 postpaid
Varo, Inc. (formerly D&R) 402 Guiterrez Street Santa Barbara, California	37-1002 (flutter and rumble)	\$3.95 plus \$.20 postage

Table 1. Test records that can be used to check flutter, rumble.

the less will be the amount of vertical warp wow (see Fig. 2).

The test for warp wow consists of a repetition of the flutter listening test, but with an ⅛" wedge placed under the record rim at one point. Listen for wavering of pitch at a one-per-revolution rate.

Acoustic Feedback

If you have tested a group of turntable-arm assemblies for rumble as described above, you have probably already encountered acoustic feedback. Acoustic feedback between speakers and record player sets an upper limit to the level at which the rumble test can be conducted; a low-frequency howl builds up, even on a quiet groove, when the volume and/or bass controls are turned up too high. Less obvious symptoms of acoustic feedback, occurring at lower volume levels and noticeable on music, are a tendency to boominess that does not seem to be caused by any one of the reproducing components, and an apparent increase of rumble.

The relative degree of freedom from acoustic feedback of different record players can be determined by noting how far the volume and bass controls can be advanced while the quiet grooves are being played, or with the pickup simply resting on a record with the motor off, before feedback sets in. The feedback should be egged on a bit by tapping the table surface on which the record player rests, or stamping lightly on the floor. A practical non-comparative test for an individual unit consists of turning the volume and bass controls to the maximum position at which they will be used in that particular installation, and then observing whether tapping or stamping sets up a train of low-frequency oscillations with the needle on the record. If oscillations are set up, improved shock-mounting is called for.

Insensitivity to mechanical shock is related to the same design elements that provide freedom from acoustic feedback. With proper shock-mounting of the turntable, heavy jumping or dancing nearby should not interfere with record performance.

Arm Inertia and Pivot Friction

On a perfectly flat, perfectly centered record the only motion of the arm is the slow sweep towards the center. Arm inertia and pivot friction do not need to be especially low to accommodate this motion.

Unfortunately even the best records are both slightly warped and slightly off center. The arm must oscillate both vertically and horizontally to keep the needle in the groove, and if the needle is to keep in proper groove contact, inertia and friction must be at a minimum.

Arm inertia is a function of the total effective mass of the arm referred to the needle tip, and must not be confused with stylus force. The counterweight, as a matter of fact, adds to rather than subtracts from the total inertia, at the same time that it counterbalances the effect of gravity. The desirability of keeping arm mass as low as possible is the reason that cartridge shells are often made of plastic or, if of metal, have cut-away sides.

A simple but effective test for arm inertia and horizontal bearing friction, first described by C. G. McProud, can be performed with a standard 45-rpm record. The record is placed eccentrically on the table, with the spindle against one edge of the large hole as in Fig. 3. The test is to see how much the stylus force can be reduced before the needle leaves the groove on its horizontal swings.

The lowest stylus force at which the arm will play the record without leaving the groove—ignoring the severe wow caused by the variation in groove speed—is an index of both arm inertia and horizontal pivot friction. It is easy to compare record players on this test (the same cartridge must be used in each case); establishing a standard which reflects the practical requirements of a high quality arm is not so easy. The writer feels that a very good arm should not be thrown from the groove in this test at the lowest force at which the arm is intended to work, with the record turning at 33⅓ rpm. Torturing the record player in this way is not an empty stunt, but a technique of simulating operating conditions in which high inertia and/or friction can give trouble. While the record eccentricity involved in the test is a gross exaggeration of any eccentricity ever actually encountered, the arm velocities induced may be equaled under operating conditions, for example by a very sharp warp.

Tracking Error

Tracking error is sometimes specified as the maximum number of degrees that the cartridge is off-tangent to the groove at any point on the record. This is not a very meaningful specification. Two record players which have the same maximum tracking error may differ in tracking-error *distortion* by more than two to one.

The proper way to specify tracking error is in terms of *tracking-error index*, whose dimensions are in degrees/inch radius. For example, a 9-in. arm with the correct offset angle, installed with the correct overhang, will have a tracking-error index of approximately 0.32°/in. This means that the maximum tracking error that will occur at any groove radius is 0.32 degree times that radius. At any given radius, of course, the error may be much less, and it will be zero at two points. Tracking error will usually be maximum at the outside groove —about 1.8°.

The reason that this type of index was established is that a given amount of tracking error, creating distortion of x per-cent at the outside record groove radius of 5.5 in., will create distortion of $2x$ per-cent at an inner groove radius of 2.75 in.

(*Continued on page 82*)

[5]The vertical pivot refers to the pivot controlling vertical motion of the arm. Its physical disposition is normally horizontal.

Types of antennas and their characteristics along with installation and maintenance information on this important link without which radio communications would be impossible.

Editor's Note: The term "Business Radio," as used in this article, means the "Business Radio Service" as defined in the FCC Rules and Regulations, Part 11, Subpart L. We are specifically referring to the frequency bands 25-54 mc., 150-174 mc., and 450-470 mc. Since many business organizations use, instead, the Citizens Band (class D, 27 mc., and class A, 460-470 mc.) much that is said here is equally applicable to antenna systems using CB frequencies.

THE OLD adage that a chain is only as strong as its weakest link has probably been applied to every type of electronic system from high-fidelity to space telemetry. That the antenna is a vital link in the chain of radio communications is a foregone conclusion; without the antenna, the message would be "stuck" at the plate of the final power amplifier. The purpose of this article is not to justify the importance of any antenna, but to point out some of the ways in which the antenna can be used to increase the effectiveness and efficiency of communications.

Although we are primarily interested in antennas for Business Radio, the discussion is general enough to apply to most antenna systems. Since the majority of business radio communications is concerned with base-station-to-mobile and mobile-to-mobile service, we will concentrate on these systems.

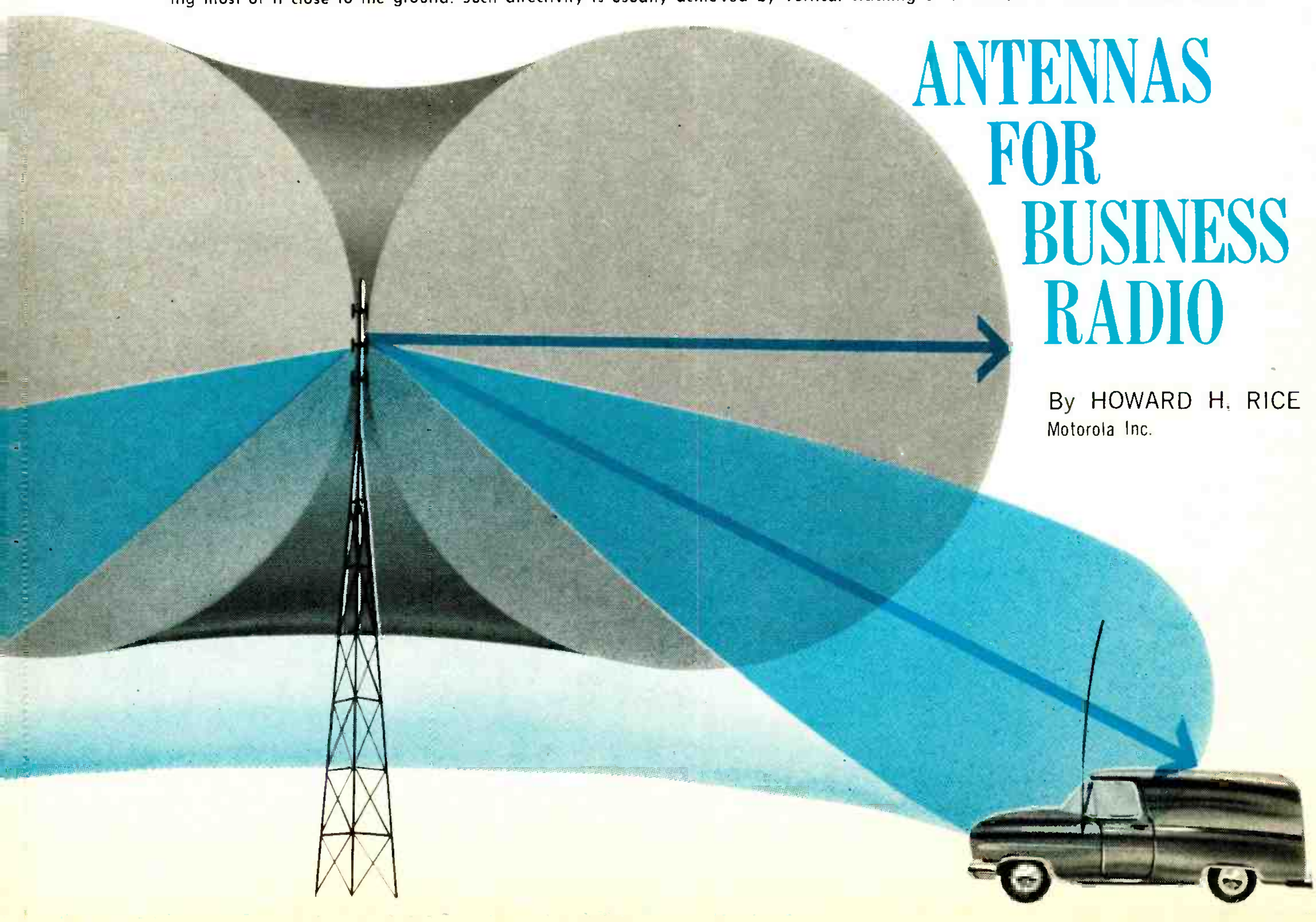
Antenna Types

The basic element in virtually all communications antennas is the vertical quarter-wave "whip" radiator. At 30 mc., a quarter-wave whip is approximately 8 feet long; at 150 mc., 18 inches; and at 450 mc., 6 inches. It becomes apparent that antenna arrays using multiple elements are more easily constructed at the higher frequencies since the size and mechanical strength limitations are more easily overcome.

The simplest antenna is merely a vertical length of wire, one-quarter wavelength long, connected to the inner conductor of the coaxial transmission line. The outer conductor of the line is grounded. A typical example is the automobile rooftop antenna. For that matter, most mobile antennas are quarter-wave whips. The basic radiation or reception pattern resembles a doughnut with the whip projecting through the hole in the doughnut. This type of antenna transmits or receives maximum energy horizontally; there is relatively little vertical response. However, to achieve this pattern, the antenna must be working against a good ground plane. In mobile installations, the ground plane is provided by the metal body of the car. For tower-mounted base-station antennas, some means must be employed to achieve an artificial ground plane and isolate the antenna from the effects of the metal tower and transmission line. The tower or line will be in the same direction as the polarization of the radiated or received energy and may act as a parasitic antenna element.

One method of isolating the antenna from the line and tower is by the use of ground-plane rods. At the base of the quarter-wave radiating element, four quarter-wave rods project at an angle slightly below horizontal. The particular angle is selected to maintain a proper impedance match.

Fig. 1. From the basic "doughnut" pattern of the simplest omnidirectional vertical antenna is derived the more useful pattern shown. This pattern results in improved coverage all around the antenna by concentrating the radiated energy vertically and keeping most of it close to the ground. Such directivity is usually achieved by vertical stacking of a number of omnidirectional elements.



ANTENNAS FOR BUSINESS RADIO

By HOWARD H. RICE
Motorola Inc.

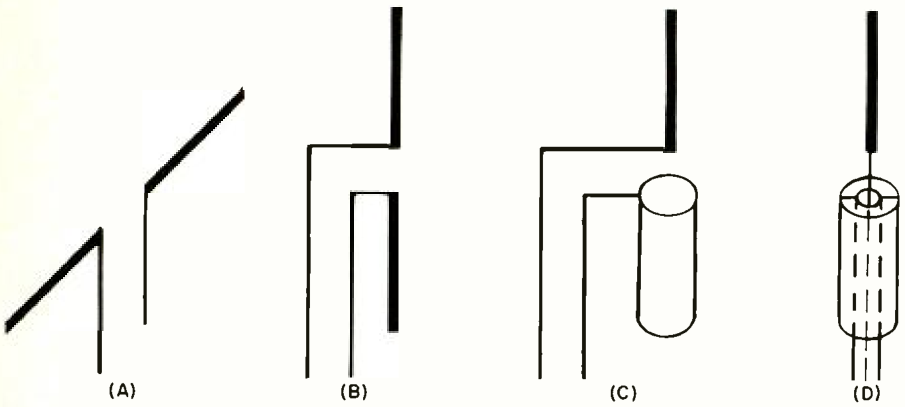
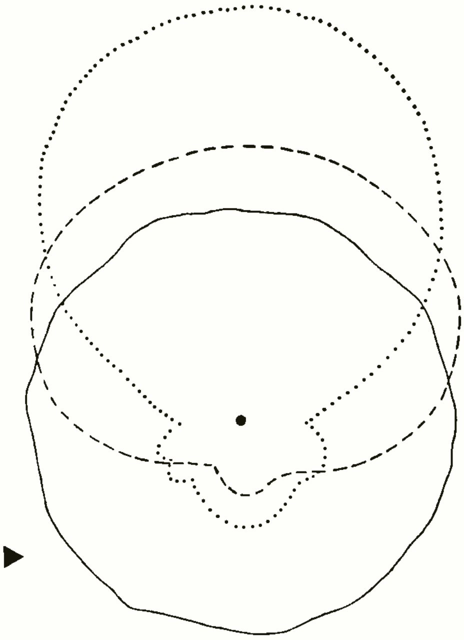


Fig. 2. Evolution of the coaxial dipole antenna from conventional dipole antenna.

Fig. 3. Basic radiation patterns. ▶

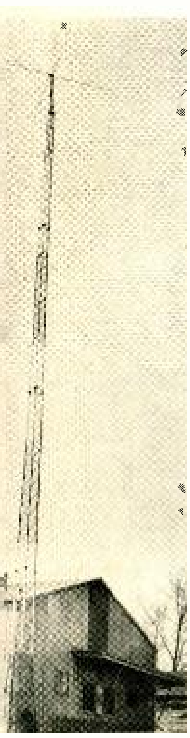


Additional isolation is sometimes provided by four other horizontal rods that are mounted somewhat lower on the mast.

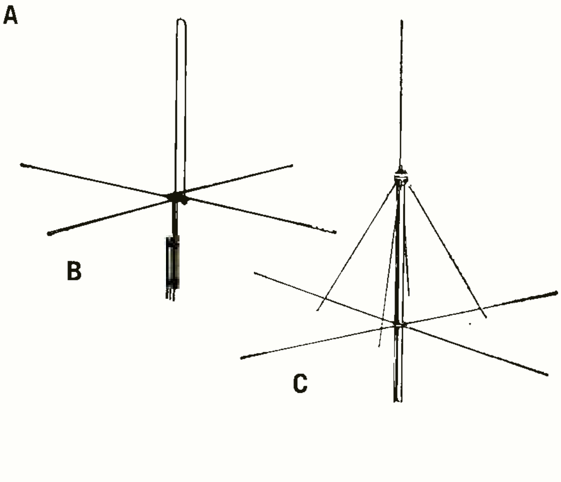
The quarter-wave "hairpin" folded dipole type of antenna is another variation of the ground-plane approach. The folded dipole is the radiator, one end of which is grounded. The grounded radiator provides a direct ground for static electrical charges which could add to receiver noise level, and it also provides a degree of lightning protection without the use of arresters or gaps. The use of a folded element also provides an increase in antenna impedance, which makes for improved transmission-line matching especially when parasitic elements are used.

From the horizontal dipole antenna, commonly used with TV receivers, the coaxial dipole antenna is easily evolved. The radiator is rotated to a vertical position, the lower element is enlarged into a tube, and the feedline is run through the tube to the junction of the two elements. (See Fig. 2.) The result is similar to the use of a ground plane.

Other types of antennas, or a number of the more common types stacked together, are used to produce different radiation patterns, thus covering the desired geographical area with the most efficient radio signal. The basic pattern, as we have seen, is omnidirectional, ideally providing virtually equal coverage 360° around the antenna. Many basic horizontal directional patterns are radiated by antennas incorporating pattern-shaping design characteristics. A cardioid or heart-shaped pattern results in extended coverage over 180° by reshaping the omnidirectional pattern. A unidirectional pattern results when the antenna elements concentrate the signal more strongly in one general direction. (See Fig. 3.) Many other lobe structures, in both horizontal and vertical planes, are obtainable with properly designed antennas or arrays.



A



B

C

(A) The antenna tower is most common and most practical way to raise the antenna above buildings and other obstructions. (B) Quarter-wave "hairpin" folded dipole is driven element in this ground-plane antenna. One end of the dipole is grounded to form a discharge path for static. (C) This ground-plane antenna uses extra set of ground rods to provide a better artificial ground plane and isolate the antenna. The upper ground-plane rods are tilted downward for better impedance match to the transmission line and lower angle of radiation.

Directional Patterns

An omnidirectional pattern fits the majority of applications. Here the antenna is generally in the center of the user's operating area (Fig. 4). Coverage is required in every direction to maintain contact with mobile units during their normal travels. However, a user's operating area and communications requirements should be carefully analyzed to avoid placing too much reliance on an omnidirectional antenna when another pattern might do a more effective job. As an example, a cardioid pattern is more suitable for situations where maximum coverage is required in one general semicircular direction. Antennas located on lake or ocean shores fall into this category. A cardioid antenna directs the radiated energy over land instead of wasting half the output power over the water (Fig. 5).

Another example of a situation in which a cardioid pattern might be used to good advantage involves an organization whose antenna site is just outside of town. Radio coverage is desired within the town itself, with little call for coverage on the other side of the antenna. A cardioid antenna would shape the pattern to provide more complete in-town coverage, while rejecting signals from outside the system's coverage area and thereby reduce interference to other radio systems on the antenna's non-radiating side. This is particularly beneficial in areas crowded with two-way radio users. A cardioid antenna is not always necessary to obtain this desired pattern; cardioid radiation can also be obtained by side-mounting an omnidirectional antenna the proper distance from a supporting tower. In this case the tower structure acts as a parasitic element and re-radiates the energy to form the necessary concentration.

More concentrated pattern-shaping is accomplished by a unidirectional or yagi-design antenna. This type pattern would fit the coverage requirements of a user interested in blanketing a specific site with a radio signal. Coverage of a city from a distant mountain site or right-of-way users, such as railroads and pipelines, are examples of systems which might obtain more efficient coverage with an antenna that uses unidirectional radiation and reception.

For bidirectional coverage, an omnidirectional antenna properly side-mounted and spaced on a tower will provide extra gain in the desired directions. The tower, in this case, is parasitically excited and serves as an antenna element to produce a bidirectional radiation pattern. However, more positive pattern control is obtained with an antenna specifically designed for bidirectional radiation.

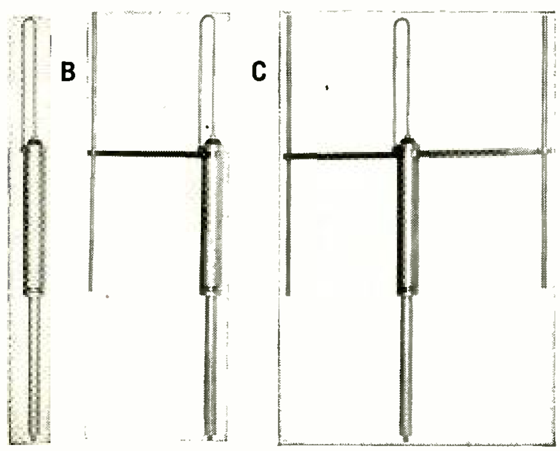
The user who wants to extend the fringes of his omnidirectional pattern—to talk a bit farther and to take in new operating areas—can take advantage of omnidirectional high-gain antennas in the v.h.f. and u.h.f. bands. For a low-band user, a higher antenna location or increased base-station power may have to fill the bill. In most cases, the large size required for a low-band, high-gain antenna precludes its use. An antenna producing 3-db omnidirectional gain in the 25-54-mc. band, for example, would have to be at least 30 feet long at 40 mc. Gain antennas are more practical in the higher frequency bands.

The high-gain omnidirectional antenna, just like the other special-pattern antennas, shapes and concentrates the radiation signal coverage. Instead of shaping on the horizontal plane, however, the high-gain omnidirectional antenna works vertically. The "doughnut" pattern is flattened and, as a result, its over-all coverage is increased. The fringe performance is thereby extended. (See Fig. 1.)

Antenna Gain

The choice of high-gain antennas must be weighed against what similar range-boosting effects might be gained from

A B C



(A) Omnidirectional coaxial folded dipole antenna. The coax skirt replaces the ground-plane rods cutting wind resistance.
(B) Parasitic reflector element on this coaxial folded dipole produces cardioid pattern providing additional directivity.
(C) Yagi coaxial folded dipole, using one director and one reflector, concentrates the radiated energy unidirectionally.

increasing base-station power or placing a regular antenna at a higher location. A "rule of thumb" suggests that a 3-db gain for the antenna is equivalent to a 100% increase in base-station power; a 6-db gain is equivalent to a 100% increase in antenna height. This power increase, relative to a resonant half-wave dipole, is called effective radiated power. Another point to keep in mind is that an increase in base-station power does not affect an antenna's receiving capability, whereas an increase in antenna height and/or the use of a high-gain antenna insures better reception from the fringe areas of a system, as well as increased talking range for the base station.

Gain is an indication of an antenna's ability to increase its effective radiated power in the desired direction or directions. However, to have any meaning, gain must be relative to some standard. The practical standard against which gain is measured is the center-fed half-wave dipole antenna. This antenna has its maximum energy radiated in a plane perpendicular to the antenna. Sometimes the gain reference is an isotropic radiator: a theoretical point in space which is emitting radiation. Its pattern is shaped like a sphere, with the antenna spotted in the center. Equal energy is radiated in all directions. Generally, this pattern is used only as the basic gain standard for parabolic and other microwave antennas. Lack of directivity causes the isotropic radiator to have about 2.15-db less gain than a half-wave dipole. Consequently, a two-way radio antenna which uses a theoretical isotropic radiator as a reference can have an apparent 2.15-db gain and yet exhibit no gain relative to a center-fed half-wave

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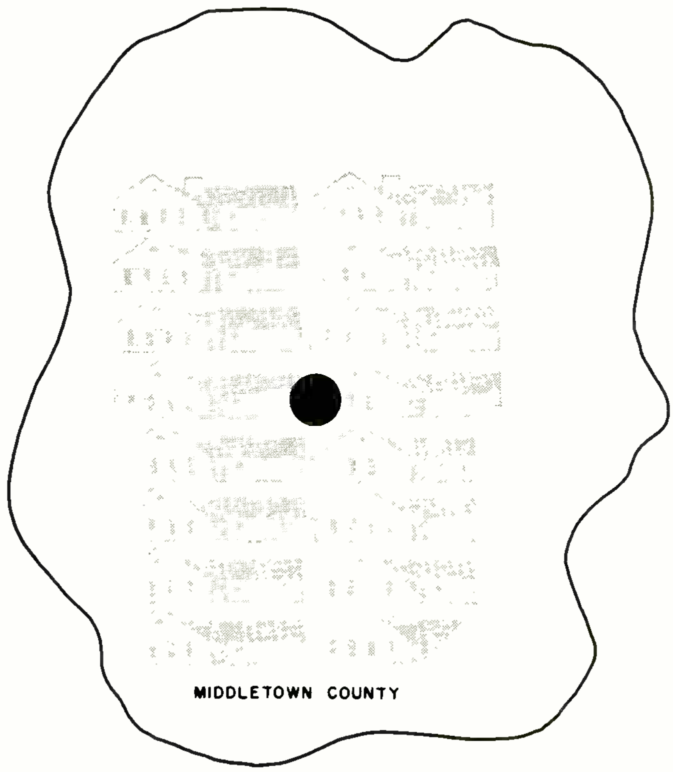
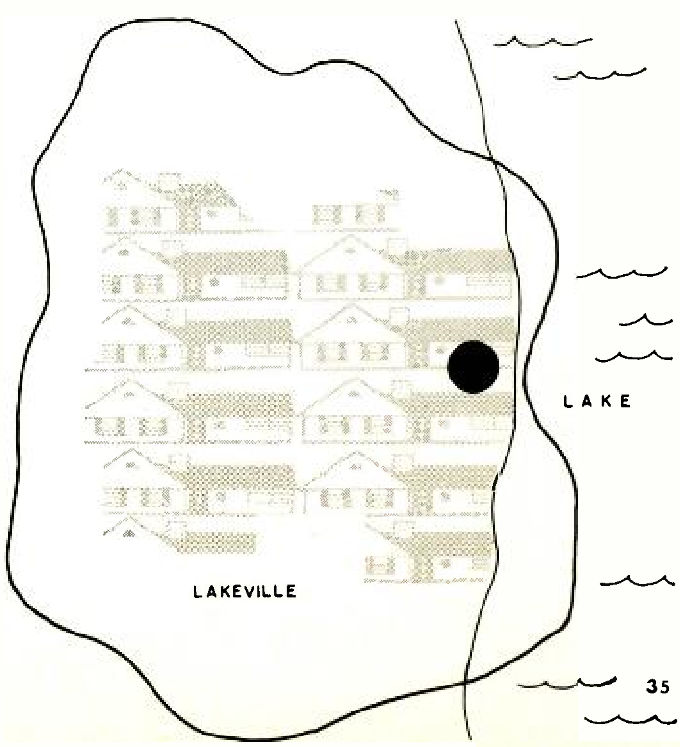


Fig. 4. An omnidirectional antenna is best suited to a radio system whose base station is located in the approximate center of the area in which it is desired to have communications.

Fig. 5. An antenna that is horizontally directional is used to concentrate the energy to achieve more efficient coverage.



SCEPTRON

A SOUND-OPERATED FIBER-OPTIC "BRAIN CELL"

A new optical pattern recognizer that "understands" spoken commands. It may find future use in dial-less phones, key-less cash registers, and typewriters that take dictation.

By LEO S. BALANDIS / Sperry Gyroscope Co., Div. Sperry Rand Corp.

CAN machines think? This question has been asked many times since the advent of high-speed digital computers. A recent invention by Robert D. Hawkins of *Sperry Gyroscope Company* comes close to being a "brain cell"—and is able to think, in the Webster dictionary sense of "to have or form . . . a mental picture." In fact, this device—the Sceptron—literally has a photographic memory and makes decisions by comparing incoming signals with the information that is contained in its memory.

Author Balandis triggers a Sceptron that has been "taught" to react when he says the word "five." Every time this word is spoken the numeral is lighted on the display illustrated.

So far, this could be the description of a typical electronic computer, and its operation is conceivably within the capability of computers if space and cost are thrown out the window. The resemblance stops there. This device uses mechanical motion, light, tiny glass or quartz fibers, a photocell, and electricity. Its operating principles, as you might expect, are completely different from devices used in ordinary computers. Before we examine details of its operation, let's consider what Sceptron can do, and what needs it fulfills.

A Pattern Recognizer

Sceptron stands for Spectral Comparative Pattern Recognizer—which indicates that it can identify signals by their spectra or frequency content. The term "pattern recognizer" has been chosen because it is a current technical idiom applied to machines which can identify sounds, images, or other patterns. Sceptron can be exposed to any signal in the audio-frequency range, and it will memorize it. Then it will recognize it when it is repeated. Although this would seem to restrict the device to recognizing sounds, it actually can be applied to any information which can be translated into an audio rate. For instance, a picture might be scanned by a revolving slit and photocell such that a complex audio signal is generated. If this signal represents the significant features of the picture, then Sceptron will memorize and recognize it just as it does for a signal that is audio to begin with. Similarly, signals normally outside the audio band can be speeded up or slowed down by means of a tape recorder. Human heart beats, for instance, could be memorized and any irregularities in a patient's pattern would be immediately detected.

Within the audio range applications are numerous. Spoken words are an immediate example. Sceptron has been successfully demonstrated with human speech. When exposed to a word spoken by one person, the device has correctly identified the word out of continuous speech.

Sceptron's memory feats stem from its ability to make hundreds of measurements on a complex signal. To recognize spoken words, for instance, it has been suggested that about 3000 measurements per second are required. A single short word, such as one of the first ten numbers, lasts for less than a half second. Therefore, a device which can make on the order of 1500 measurements can memorize the essential characteristics of a single word.

Although these measurements could be of many types, Sceptron is designed to make frequency measurements. This is where its unusual nature reveals itself: it is capable of packing 300,000 narrow bandpass filters in a volume of only a cubic inch. Obviously, this device is capable of handling a tremendous amount of information. Let's consider how it does it.

Basic Components

The basic components for a single Sceptron are shown in an exploded view on the cover. The fiber-optic array is the unique element. It is an open bundle of tiny quartz fibers, all held at one end. All fibers are approximately the same diameter, but their free lengths vary. Thus, each is a tiny cantilever beam, and will vibrate in its own fashion whenever it is mechanically excited at its natural frequency. There is sufficient space around each fiber so that it can vibrate in any direction without striking other fibers. The size of the fiber arrays with which we are working is ¼ cubic inch and it contains 700 fibers. We have also worked with tiny 1/300 cubic inch arrays containing even more fibers.

The fiber array requires a source of mechanical excitation. The driver provides this by converting electrical signals into proportional mechanical motion. The driver could be a piezoelectric device, as shown on the cover, or it could be electromagnetic like an ordinary loudspeaker. Signals to be processed are fed into the driver which, in turn, shakes the fiber array mounted on it.

Some means of detecting the pattern of fiber motion is required; this is provided by shining light through the fibers onto a photocell. If we also place a photographic plate between the fibers and the photocell, we can take a negative picture of the light pattern during passage of the signal. Each fiber that vibrates for that signal will leave a black line on the negative picture. (Note that as the fiber moves it carries its own tiny light beam with it.) Those that do not move will leave a small spot corresponding to its stationary or static position. Everywhere else, the plate will be transparent. When developed, this plate is the memory of Sceptron, and it will be mounted with the array in its housing.

How it Works

Now let's consider how signal recognition is achieved. The mask is made by exposing it to the pattern of fiber motion during the time that the signal is on. (See Fig. 1.) It is developed and placed back in its original position. In the absence of any signal, the photocell will be in the dark, since each fiber light spot will be blocked by a black spot on the mask. When a signal is received, the fibers will again vibrate in some pattern characteristic of that signal. If it is the same signal, all the light will still be blocked by the mask; if different, some light will get through because the mask pattern will not be matched. Thus, the photocell can tell us whether or not the signal is the same by virtue of the amount of light it sees.

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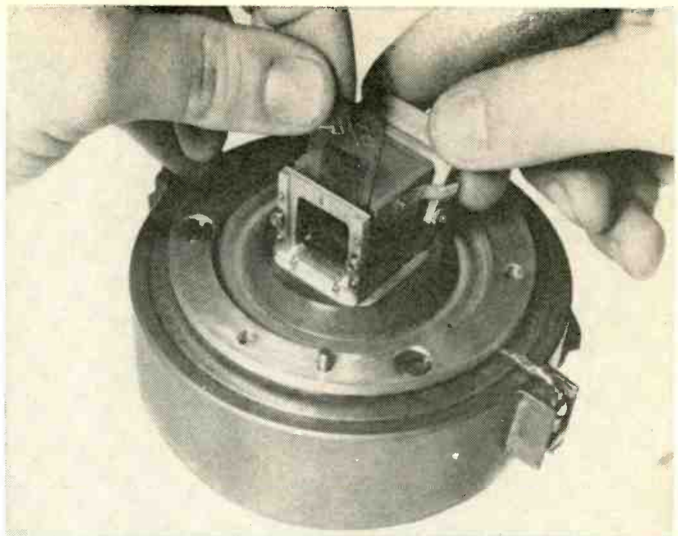


The tiny masks by which the unit is programmed to recognize words are easily interchangeable, thereby changing its vocabulary. A small lever-controlled platen permits the change and allows proper positioning to be made. The Sceptron is shown here mounted on the diaphragm of an ordinary magnetic loudspeaker which is used to excite array of optical fibers.

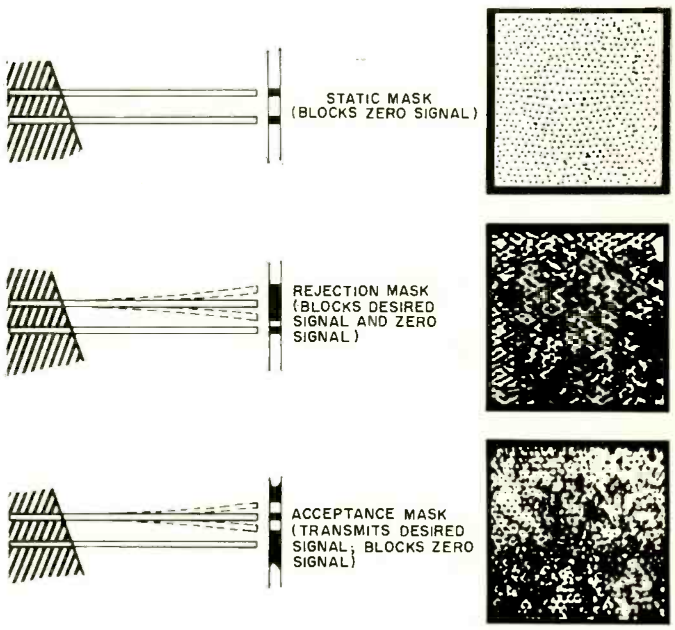
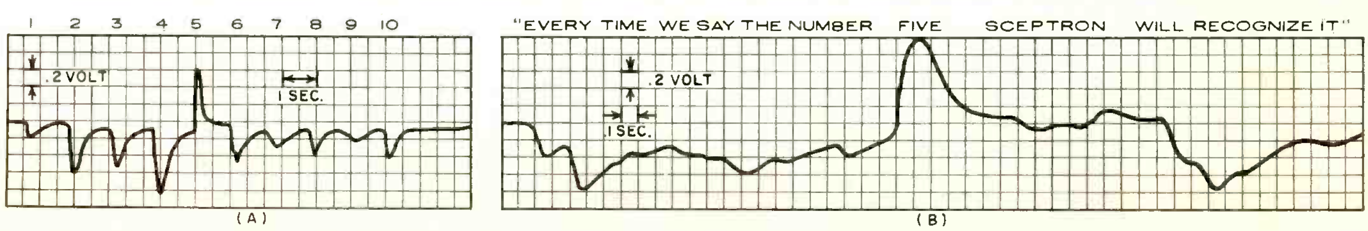
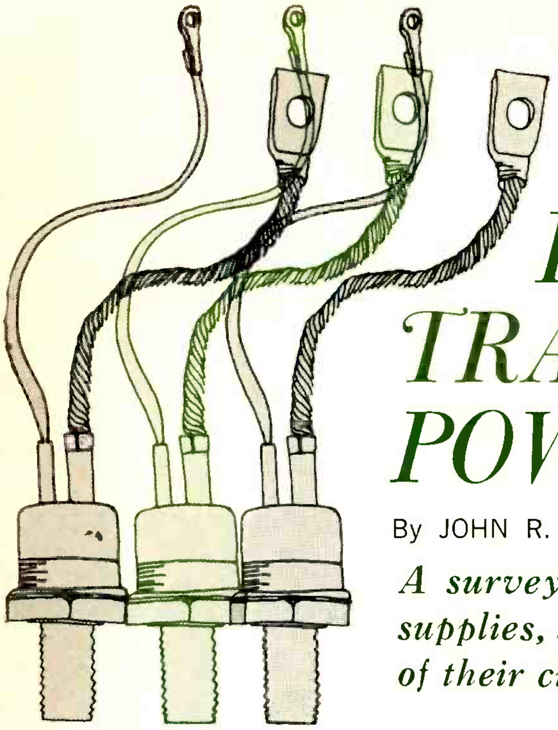


Fig. 1. These masks are prepared by exposing the photo emulsion to light from the fibers during their response to the programmed signal. The bottom two masks are Sceptron's "eye views" of the word "five," the rejection mask having been developed negative and the acceptance mask is a positive.

Fig. 2. Recorded output from the device programmed to recognize the spoken word "five." Waveform at (A) is produced when the series of numbers from "one" to "ten" are spoken. Waveform at (B) is produced when the sentence that is shown is spoken into a microphone. Notice that different time scales are employed for both conditions that are illustrated below.





REGULATED TRANSISTORIZED POWER SUPPLIES

By JOHN R. COLLINS

A survey of several different types of power supplies, special applications, and a discussion of their circuit designs and operation.

ONE OF the most useful instruments in a research and development laboratory or on the test bench is a regulated power supply, capable of providing a stable voltage which does not change with fluctuations in either line voltage or the load current. Now that transistors able to handle sizable amounts of power are available, transistorized power supplies are finding increasing use. Compared to vacuum-tube designs, transistorized supplies are generally smaller and lighter—important factors for mobile equipment or on a crowded bench—their efficiency is higher, and they do not require warm-up time.

One of the many different types of transistorized power supplies now available is shown in Fig. 1. Made by *Harrison Laboratories, Inc.*, it is designed to provide any desired output between 0 and 60 volts. Load-current variations from 0 to 7.5 amperes and fluctuations in the line voltage between 105 and 125 volts will cause changes in the output of less than 0.02 per-cent or 10 mv., whichever is greater.

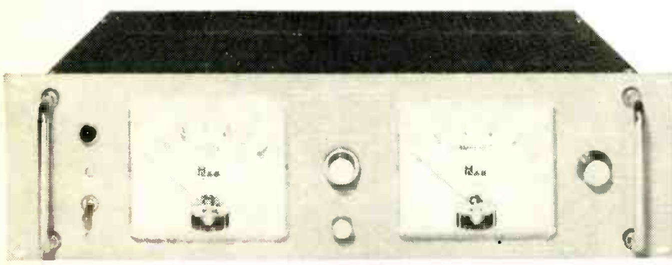


Fig. 1. Rack-mounted transistorized power supply that is designed to maintain either a constant-voltage or a constant-current output. The voltage range is 0-60 and the current range is 0-7.5 amperes.

A special feature of this instrument is that it can be operated either as a constant-voltage or a constant-current supply. This is accomplished by means of a special current-limiting circuit which may be adjusted to any desired value. In operation, the supply will function as a constant-voltage regulator until the load current reaches the selected level, after which the current will remain constant despite further lowering of the load resistance. The instrument can be deliberately operated as a constant-current supply simply by setting the current limit control to the desired value of output current, and the output-voltage control to a value greater than the highest *IR* drop which will occur across the load.

Current-limiting circuits protect instruments of this kind even if the output is directly short-circuited. This feature also safeguards delicate test circuits, which may be connected to the power supply, against accidental overloads.

Automatic test systems often require several different voltages to be applied in rapid sequence, and this requirement is sometimes fulfilled by using a different power supply for each voltage needed. However, the "Programmable Regatran" power supply (Fig. 2) made by *Electronic Measurements Co.* is specially designed for the rapid and remote selection of output voltages.

The unit is designed so that the output voltage at the "−" and "+" terminals is determined by the resistance connected between the "+" and "Rem" (remote) terminals. This is in contrast to most regulated power supplies, in which the output voltage is selected by the setting of a potentiometer on the front panel. In the "Programmable Regatran" supply, the output follows a fixed ohms-per-volt ratio called the programming constant which is usually 1000 ohms-per-volt. Thus a 47,000-ohm control resistor would develop a 47 volt d.c. output.

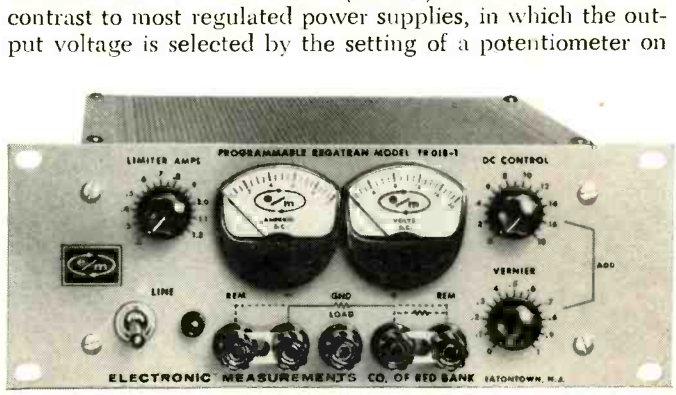


Fig. 2. Programmable power supply designed to provide a rapid series of output voltages through remote switching of control resistors.

An elaborate test setup for automatic operation is shown in Fig. 5. Four separate voltage regulator units permit four simultaneous voltages to be applied to the test circuit and, with seven resistors for each unit, a total of 28 test voltages is available.

Control resistors of selected values to provide the needed voltages are arranged sequentially, and a stepping switch connects them into the circuit. Since an open circuit would cause an uncontrolled voltage rise which might damage the test circuit, precautions are taken to prevent opens. In particular, make-before-break switches are used to retain contact one resistor until contact with the next resistor is established. A shielded coaxial cable is generally used to connect the control resistors to the power supply. This precaution prevents the injection of noise and ripple from external sources into the test circuit.

A portable transistorized power supply, made by *Sorensen* is shown in Fig. 3. It will provide any selected voltage between 0 and 40 volts at up to 5 amperes. It is recommended by the manufacturer for powering critical transistor circuits or for supplying a stable voltage for computers and communications circuits. While the model shown has a handle for carrying, companion units are designed for rack mounting.

A different kind of power supply, also made by *Sorensen*, is shown in Fig. 4. Compact units of this kind contain a transformer and rectifier, and a completely transistorized voltage regulation system with a zener-diode reference, transistor amplifier, and a current-passing transistor. They are available for voltage outputs from 3 to 48 volts and for current up to 5 amperes. However, individual units are adjustable over only a relatively small range, and this adjustment is made with a screwdriver.

These miniature units are intended for use as highly stable supplies for transistor circuits, for regulated bias supplies for vacuum tubes, and as power sources for critical laboratory or production-line test equipment. An interesting application is the furnishing of d.c. for the filaments of vacuum tubes in low-level amplifiers where a.c. hum pickup is possible.

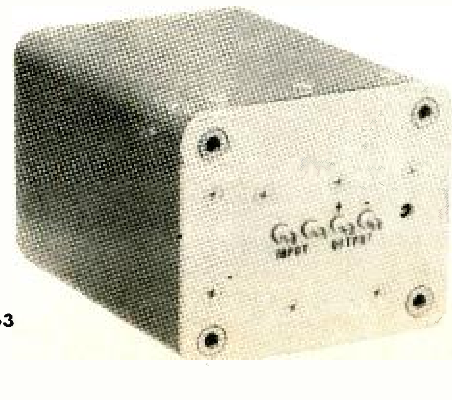
Elementary Circuit

The components of a transistorized power supply regulator circuit are shown in block-diagram form in Fig. 6A. After rectification, the unregulated d.c. voltage is applied to the regulator input terminals. The output voltage is sampled and this sample is compared to an internal reference voltage. If they are not the same, the difference is amplified and used to operate a control element which adjusts the output current in such a way as to maintain the output voltage at a preselected level.

It is apparent from Fig. 6A that a transistorized power

Fig. 3. Portable power supply with output of 0-40 v. at 0-5 amps.

Fig. 4. Miniature d.c. power supply for fixed-output applications.



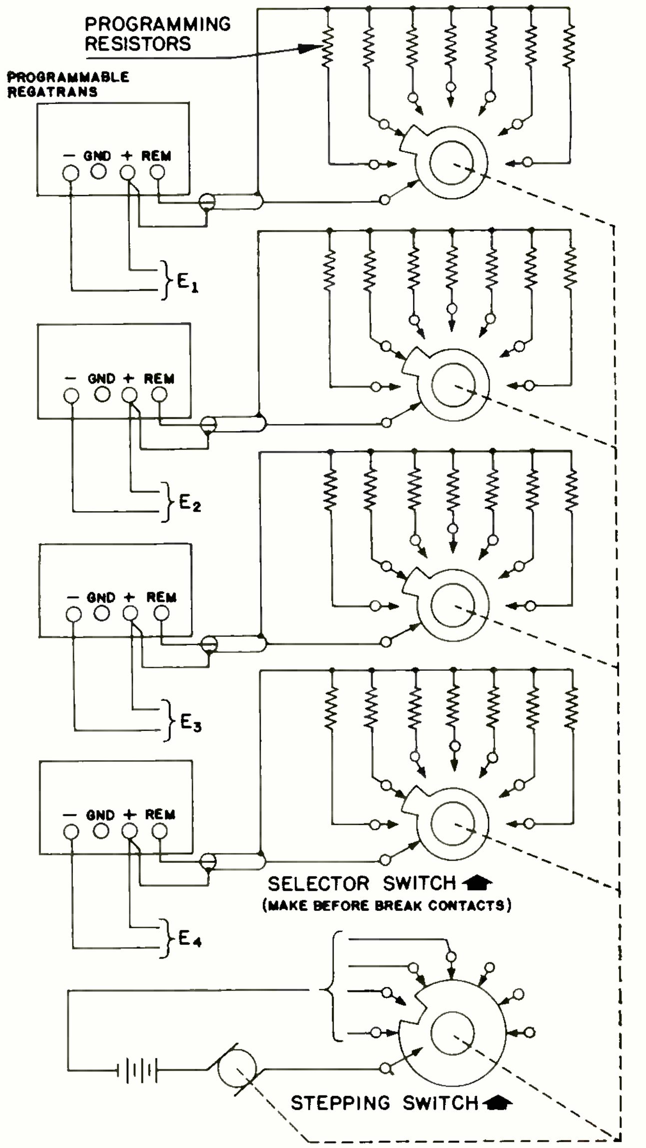


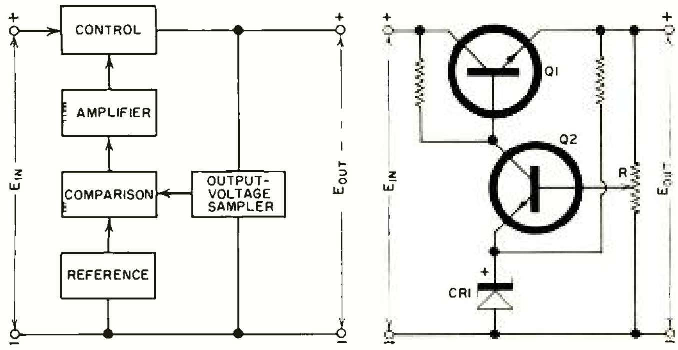
Fig. 5. Stepping switch and programming resistors for supply, Fig. 2.

supply is a form of servomechanism, since the output is sampled and an error signal is derived which is used to correct the input. Such corrections are made instantaneously, and the output remains substantially constant at all times.

A simple voltage-regulator circuit is shown in Fig. 6B. The control element, sometimes called the passing transistor, is *n-p-n* transistor *Q*1. It is connected in series with the line so that the full load current passes through it. In this configuration it acts as a valve and its conduction is varied to regulate the voltage at the output of the power supply. When the voltage (*i.e.*, the *IR* drop) across the load resistance starts to increase, *Q*1 reduces the amount of current flow to bring the output voltage back to the original level. Conversely, when the output voltage starts to decrease, *Q*1 permits more current flow until the condition is corrected.

The opening and closing of the valve are controlled by the collector current of another *n-p-n* transistor, *Q*2, which serves both as the comparison element and the amplifier. An examination of the diagram will show that changes in *Q*2's collector current and the current through *Q*1 are out of phase. As a result, an increase in *Q*2's collector current will cause a reduction in *Q*1's collector current and hence a reduction in the load current. Stated another way, an increase in the base-emitter voltage of *Q*2 (which will increase its collector current) will cause the output of the supply to decrease.

The reference voltage is supplied by a silicon diode, *CR*1, connected in the reverse direction, as shown. Often called



(A) (B)

Fig. 6. (A) Elements of d.c. supply, (B) simple voltage regulator.

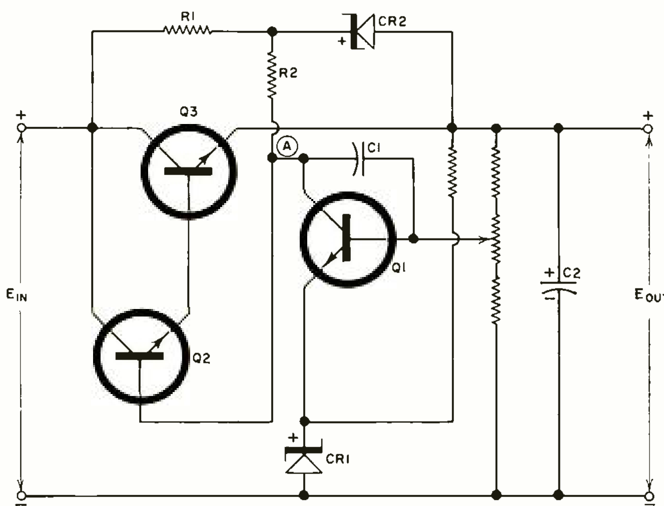


Fig. 7. Series voltage regulator with single-stage, common-emitter comparison element. R1,R2,CR2 provide constant current for Q2,Q3.

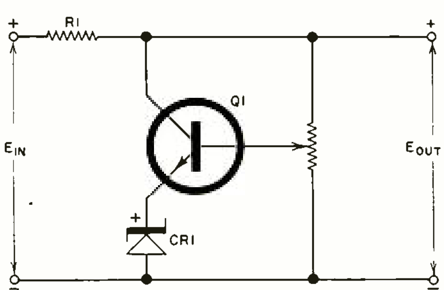


Fig. 8. Circuit of an elementary shunt-type voltage regulator.

zener diodes, silicon-breakdown diodes have characteristics similar to voltage-regulator tubes. When they are subjected to a reverse potential, a very small current will flow and voltage will build up across their terminals until the breakdown point is reached. At this point, current passes freely through the diode in the reverse direction and prevents any further build up of voltage. The effect is to stabilize the voltage at the breakdown level and to prevent any further increase. Since the zener diode is connected between the negative terminal of the power supply and the emitter of Q2, the emitter is held at a constant potential with respect to the negative terminal. The entire output voltage is dropped across a potentiometer, *R*, and a sample voltage is selected by adjusting the wiper contact of the potentiometer.

The setting of the potentiometer determines the fraction of the output voltage to be compared to the reference voltage. Any difference between the selected fraction of the output voltage and the reference voltage becomes an error signal which is amplified by Q2 and used to regulate the current through Q1. It is evident that the magnitude of the output voltage can be determined, within the operating limits of the transistors, by the setting of the potentiometer, since the action of the circuit is such as to adjust the output voltage so that the selected fraction will equal the reference voltage. Once the output level has been selected, any fluctuation which causes a change in the output voltage will also cause a proportional change in the selected fraction which is compared to the reference voltage. A correction is made automatically as described above.

Practical Circuit

A more elaborate voltage regulator diagram, provided by *Texas Instruments Inc.*, is shown in Fig. 7. An important feature is the pre-regulator, made up of resistors *R*1, *R*2, and *CR*2. The function of the pre-regulator is to provide a constant current to the collector of d.c. amplifier Q1 and the base of control transistor, Q2. If point *A* is returned through a resistor directly to the positive terminal of the unregulated supply, as in Fig. 6B, ripple current caused by the unregulated voltage variations will be injected into the base of Q2. This ripple will be amplified by Q2 and Q3 and will appear in the output. *CR*2 and associated resistors help eliminate this difficulty. *CR*2 maintains a constant voltage across *R*2 and a constant current to Q2 and Q3. In addition to improving input regulation, the pre-regulator contributes to output stability.

As in the previous example, Q1 serves both as the comparison element and the d.c. amplifier. *C*1 is the phase-shift capacitor. It provides a margin against high-frequency instability by modifying the gain-phase characteristics of the d.c. amplifier. A capacitor connected this way has the same effect as a capacitor from the base of the control element to the negative side of the power supply. It does, however, allow a much smaller capacitor to be used.

It is obviously necessary that the collector current of Q1 be great enough to serve as the base drive of the control element. This requirement may be substantial, since the base-drive current must be adequate to maintain the required output current over a considerable range. Because the current supplied to the base of the control element is usually small, it is often convenient to use a combination of two transistors, as shown. This method of connection reduces the current requirements of both transistors and permits the use of transistors of lower power ratings for the control element. *C*2, a large capacitor (about 100 μf.) is connected across the output terminals to improve ripple suppression and reduce transients from the load.

Shunt-Voltage Regulators

The power supplies discussed above are called series voltage regulators, since the control element is in series with the load. Where only small fluctuations in the load are expected, it is often convenient to use a shunt voltage regulator of the type shown in Fig. 8.

In shunt-type power supplies, a resistor (*R*1) is placed in series with the load and the control transistor is connected across the load. As in the previous example, the emitter of the control transistor is held at a constant potential with respect to the negative terminal by a zener diode. The potentiometer is set so that the transistor base is slightly positive with respect to the emitter. If the output voltage increases, the base of the control transistor will become more positive with respect to the emitter, and this will cause an increase in the collector current. Since the collector current flows through the series resistor, the voltage drop across it will increase. In this way, the output voltage is corrected to its former value.

Because of the voltage drop across the series resistor, the shunt regulator is not as efficient as the series type. It is simpler to construct, however. For this reason, the configuration is often used where it is desired to control a relatively constant load. ▲

KOBE ("TEN") Transistor Substitution Directory

KOBE NO.	TYPE AND SERVICE	AMERICAN	
		NUMBER	MFGR.
2SA30, 2SA254	P—con.	2N412, 2N1058 2N136, 2N137	SYL SYL G-E
2SA31, 2SA255	P—i.f. amp.	2N409 2N410	SYL RCA
2SA35	P—con.	2N140 2N219 2N417 2N135	RCA, SYL RCA RAY G-E
2SA36	P—i.f. amp.	2N107, 2N135, 2N136 2N139 2N218 2N413 2N413A 2N414 2N414A	G-E RCA, SYL RCA RAY, G-E RAY, GI RAY, G-E, GI RAY, GI, SYL
2SA40	P—m.s. sw.	2N123 2N269-4 2N394 2N396 2N404 2N425 2N518	G-E RCA G-E GE, SYL, GI, RAY, TI RCA, TI, MOT, SYL, G-E, RAY, GI RAY, MOT, GI, SYL G-E
2SA43	P—s-w r.f. amp.	CK13, CK14, CK17 2N128 2N247 2N274-6 2N344, 2N345 2N416, 2N417 2N1432	RAY SPR SYL MOT SPR RAY SYL
2SA64	P—h.s. sw.	2N240 2N317 2N397 2N582 2N584 2N1017	SPR GI G-E, RAY, TI, SYL RCA, GI RCA RAY
2SA105, 2SA270	P—con.	2N344, 2N345, 2N346	SPR
2SA108, 2SA109, 2SA256, 2SA266	P—r.f. amp.	2N370 2N128	RCA, SYL SPR
2SA110, 2SA257, 2SA267	P—con.	2N371-2N373 2N374 2N482-2N486 2N499 2N504 2N544	RCA RCA, SYL RAY SPR, GI SPR, GI RCA, SYL
2SA111, 2SA258, 2SA268	P—osc.	2N371 2N499	RCA SPR, GI
2SA112, 2SA259, 2SA269	P—mix.	2N372	RCA
2SA116	P—r.f. amp, vhf.	2N346 2N384 2N1177	SPR RCA, SYL RCA
2SA117	P—osc., vhf.	2N346 2N384 2N1178	SPR RCA, SYL RCA
2SA118	P—mix., vhf.	2N346 2N384 2N1179 2N1180	SPR RCA SYL RCA RCA
2SB32, 2SB261	P—a.f. amp., d.	2N34 2N105 2N107 2N238 2N240 2N322 2N367 2N405 2N406	RCA G-E TI SPR G-E, MOT TI SYL RCA, SYL SYL
2SB33, 2SB262	P—a.f. amp., d.	2N34 2N109 2N189, 2N190 2N265-2 2N324 2N409 2N1144 2N1145 2N1265	SYL RCA, SYL G-E G-E, BEN G-E RCA G-E G-E SYL
2SB34, 2SB38, 2SB263	P—a.f. amp., p.	2N185 2N186, 2N186A, 2N187A, 2N188A, 2N241A 2N270-5 2N291-14 2N319-2N321, 2N323 2N327A-2N329A 2N464 2N465 2N466 2N633	TI G-E RCA G-E, MOT RAY, HUG RAY, MOT, GI, SYL RAY, MOT RAY, MOT, GI, SYL RAY TI
2SB37	P—a.f. amp., p.	2N43, 2N44 2N109, 2N217 2N104 2N189-2N192 2N238 2N331 2N422 2N632 2N1097 2N1098 2N1144 2N1145	G-E RCA, SYL RCA G-E TI RCA, GI, MOT RAY, SYL RAY G-E G-E G-E G-E
2SB39	P—a.f. amp., l.n.	2N175 2N220	RCA, SYL RCA
2SB41, 2SB131	P—a.f. amp., p.	2N155 2N255 2N256 2N301 2N307, 2N307A 2N376	RAY BEN RCA, SYL SYL, BEN SYL, BEN RCA
2SB42, 2SB132	P—a.f. amp., p.	2N242, 2N296 2N251	SYL TI
2SB61	P—a.f. amp.	2N322, 2N323 2N324 2N422	G-E, MOT G-E RAY, SYL
2SB65	P—l.s. sw.	2N464-2N466 2N467 2N592, 2N593 2N602-2N604	RAY, MOT, GI, SYL RAY, GI GI GI, SYL
2SB120	P—a.f. amp., d.	2N591	RCA
2SB121	P—l.s. sw.	2N398	RCA, SYL, MOT, GI
2SB151	P—l.s. sw.	2N456 2N457 2N458, 2N511, 2N511A, 2N511B 2N1043, 2N1044	TI, RCA TI, RCA TI
2SB152	P—l.s. sw.	2N1021, 2N1022 2N1045, 2N1046	TI
2SB180	P—a.f. amp., m.	2N524, 2N527 2N525, 2N526 2N1038, 2N1042 2N1183, 2N1184	GE, MOT GE, MOT, SYL TI RCA
2SB181	P—a.f. amp., m.	2N1039-2N1041 2N1183, 2N1183B, 2N1184A, 2N1184B	TI RCA
2SD33	P—a.f. amp., p.	2N649	RCA
2SD37	P—a.f. amp., p.	2N647 2N1101, 2N1102	RCA SYL

P—"p-n-p"; N—"n-p-n"; con.—converter; i.f. amp.—i.f. amplifier; l.s., m.s., h.s.—low, med., high-speed switch; s-w r.f. amp.—shortwave amp. osc.—oscillator; mix.—mixer; vhf. very high frequency; d.—driver; p.—power; l.n.—low noise; m.—medium power. BEN—Bendix, G-E—General Electric, GI—General Instrument, HUG—Hughes, MOT—Motorola, RCA—Radio Corporation of America, RAY—Raytheon, SPR—Sprague, TI—Texas Instruments.

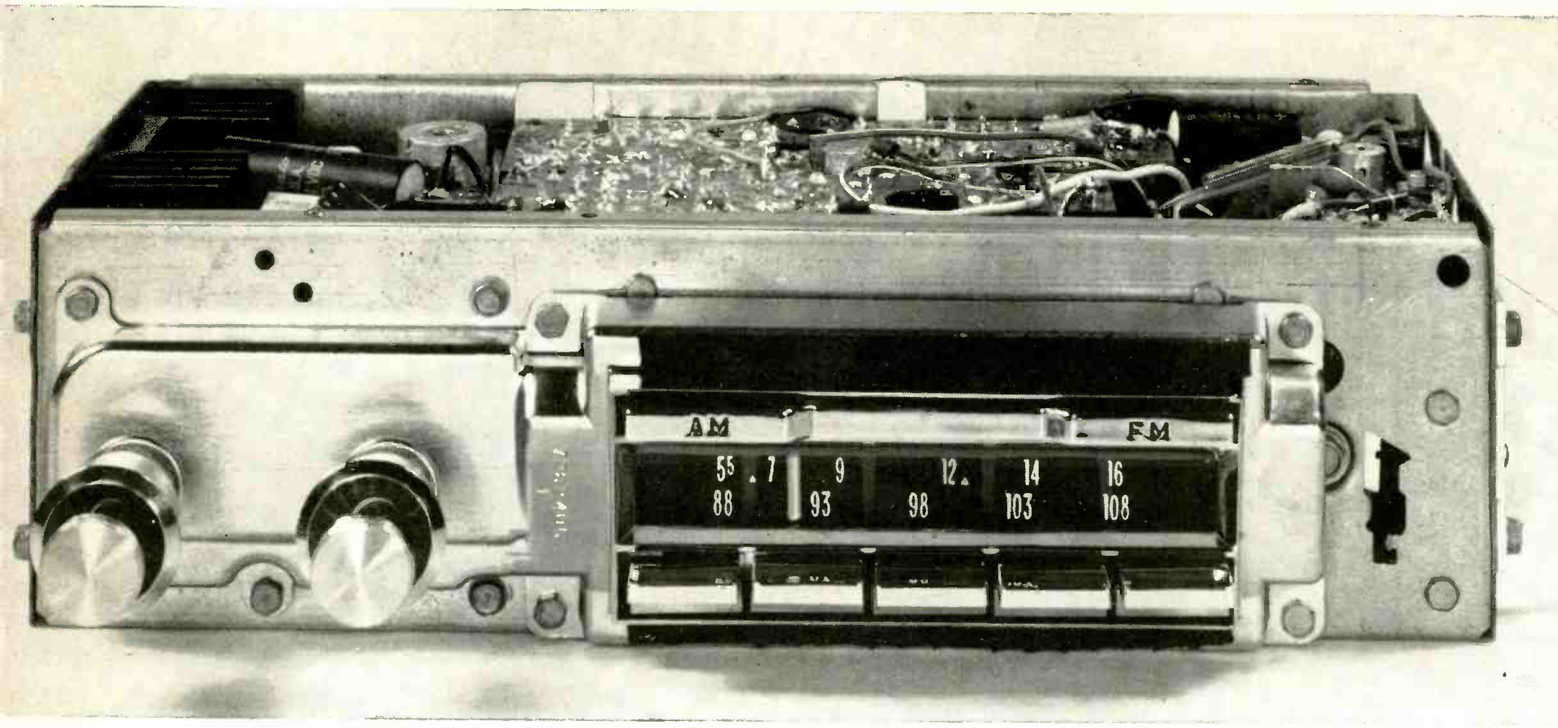


Fig. 1. A version of the basic, 2-band completely transistorized set that is used in Cadillac cars.

AN AM-FM CAR RADIO

Avoiding circuit duplication without impairing performance was the goal. This is how Delco Radio engineers handled the problem in a transistorized design.

By T. A. PREWITT / Delco Radio Div., General Motors Corp.

IN THE PAST several years, the listening audience for FM radio has grown enormously. Established stations have added more powerful transmitting equipment and better antennas to increase their coverage areas; the number of new stations has increased at a rapid rate.

Furthermore, a large percentage of today's many FM listeners live, work, shop, and consequently spend a number of hours every week driving within the metropolitan and suburban areas served by such stations. For these persons, practical reception of FM signals while they are in their vehicles has much attraction now.

Yet an FM-only receiver is not likely to satisfy the listener's needs. There will be occasions on which he may not be able to get the FM reception he wants—or simply prefers to listen to something available only on an AM broadcast. The ideal radio for him, then, must be designed to receive both services. Since he will be using only one at a time, completely separate circuitry for both bands is wasteful. Furthermore, there are obvious advantages in using transistorized circuitry, with respect both to reliability and the power-supply simplification made possible by direct use of a 12-volt d.c. electrical system.

In its 1963 car models, *General Motors* offers for the first time a line of custom-designed AM-FM receivers. Built by *Delco Radio*, these sets have all-transistor circuitry in which a number of interesting features appear.

A representative version is model 1283295, used in *Cadillac* vehicles, shown in Fig. 1. The FM tuning section is at the top right, the main circuit board in the center, and the common power-output stage to the left. Such bandswitching as is used is accomplished by depressing the appropriate end of the pivoted, horizontal bar just above the tuning dial.

To illustrate the circuit approach employed, a block diagram (Fig. 2) will serve as well as a complete schematic. But for the diode-using detectors, each stage or block conveniently represents one transistor—nine in all. The number of semiconductor diodes used is also nine. In addition to the separate detectors, these are employed in separate a.g.c. systems for the two bands, the a.f.c loop for FM, and voltage regulation for stabilizing the supply to the FM front-end stages.

Each band has its own tuned, r.f. stage. For FM, there are four i.f. stages, with the last two acting as limiters on stronger signals. The a.f.c. action is achieved with a voltage-variable diode capacitor, whereas the semiconductor stabilizing the supply is a zener regulator. The AM band has its independent oscillator. With these features, both high-quality performance on FM and high sensitivity on AM are obtained.

Combining Circuit Functions

Two fundamental approaches were available to the design engineers. The first was to start with a conventional AM receiver and add an FM tuning section, i.f. strip, and detector. A very simple switch could then apply the output of the desired detector to a common audio amplifier. Alternatively, the number of components used could be reduced substantially by making the r.f., converter, and i.f. stages of the AM channel function as FM i.f. amplifiers. Ordinarily this would involve the use of a complex bandswitch that would be a potential source of trouble.

After further study of the second approach, a method was developed to make these stages serve a dual purpose without the use of switch contacts through the use of automatic signal path switching. This general technique, which is based on the difference in frequency between signals in FM and AM service and the consequent involvement of different resonant circuits in each dual-purpose stage, is not a new one. As a rule, however, the result is some compromising of performance on each band. In the case of the all-transistor design, it was possible to minimize the effect of these compromises.

With reference to Fig. 2, it can be seen that the FM-AM switch involves only three circuits. Antenna signal is applied to either the FM or AM r.f. amplifier; supply voltage is applied to (or removed from) either the FM front-end transistors or the AM local oscillator; and output from the appropriate detector is chosen for audio amplification.

A simplified schematic of the two stages that serve as mixer and i.f. on AM or 2nd i.f. and 1st limiter on FM (Fig. 3), showing interstage coupling, illustrates how automatic signal switching is arranged.

The primaries of transformers *T10* (10.7-mc. FM i.f.) and *T6* (262-kc. AM i.f.) are in series in the collector circuit of transistor *Q5*. However the secondary of *T10* is connected in the emitter circuit of transistor *Q6*, while the secondary of *T6* is placed in the base circuit of *Q6*.

When the bandswitch, not shown, is in the AM position, operating power is applied to the AM oscillator, the car antenna is connected to the AM tuner, and 262-kc. i.f. signals appear in the common i.f. strip. Since the tapped portion of the *T10* primary consists of only a few turns, it offers little impedance to the 262-kc. signal, all of which, in effect, then appears across the *T6* primary.

On the AM band, it is desirable to obtain high i.f. gain. This is accomplished by operating *Q6* as a common-emitter stage. The secondary tap of *T10*, also a low-impedance path to 262-kc. signals, ties the emitter of *Q6* to ground through capacitor *C33*. The secondary of *T6*, which is connected in the base circuit of *Q6*, completes the common-emitter configuration.

I.f. amplifiers are operated in the common-base mode on FM to simplify switching and eliminate the need for neutralization. The change is accomplished as follows: The 330-$\mu\mu$f. capacitor across the primary tap of *T6* bypasses the 10.7-mc. signals; therefore the full signal voltage appears across the *T10* primary. Likewise, the .0022-μf. capacitor across the secondary tap of *T6* bypasses the base of *Q6* to ground through capacitor *C36*. The *T10* secondary injects the 10.7-mc. signal into the emitter of *Q6*, which thus operates as a common-base amplifier.

Coupling to *Q5* from the AM oscillator and r.f. stage, on the one hand, and from the FM tuning section, on the other hand, is somewhat different. Nevertheless, the same principle of separating and optimizing performance for each band is followed.

Since the same vertical whip is used as antenna for reception on either band, the problems of optimizing for either service occur here too. Since transmitted FM signals are horizontally polarized, there is some reduction in the strength of received signal. Most owners would prefer this sacrifice to having a conventional FM antenna on the car. On the other hand, the whip offers the advantage of being substantially omnidirectional. In practice, a change of only 2 or 3 db in signal is noted when the car turns a corner, which minimizes or eliminates audible changes. With the antenna adjusted to its recommended length (31 inches), its base impedance is approximately 50 ohms in the FM band. The tuner is designed to operate from this base impedance.

For optimum signal transfer to the AM tuner, the lead-in cable must be the usual low-capacitance type, which has a characteristically high impedance of 160 ohms when used as a v.h.f. transmission line. To avoid impedance mismatch and standing waves on FM, this line is cut to half a wavelength at the center of the FM band. It accordingly repeats the 50-ohm impedance of the whip antenna at the input of the FM tuner.

Reception Range

Through long experience, the driver-listener has formed an idea of what kind of performance he can expect from a well-designed AM car receiver. He will have questions, however, as to how much usable reception he can obtain on FM in a moving vehicle. Conventional statements, like the number of microvolts required for a given quieting level, in db, will have little practical meaning. Nor are claims of reception up to a given number of miles much better.

Transmitter power, terrain, and the presence or absence of prominent signal-reflecting objects all enter into a determination of satisfactory reception at the receiver. The chart in Fig. 4, therefore, probably gives the most realistic picture of what is possible. Assuming only a reasonably unobstructed location in level or gently rolling terrain, it shows the range of satisfactory reception at the radio installed in the car as a function of transmitter power.

Reception of out-of-town stations within a metropolitan area will be reduced by surrounding, tall buildings. The graph will hold, however, in the more usual case: reception from a metropolitan station as the vehicle moves toward or from it in outlying areas. A transmitter whose effective radiated power is 25 kw., for example, will provide good reception more than 20 miles away. A four-fold increase in e.r.p. will double the reception range. ▲

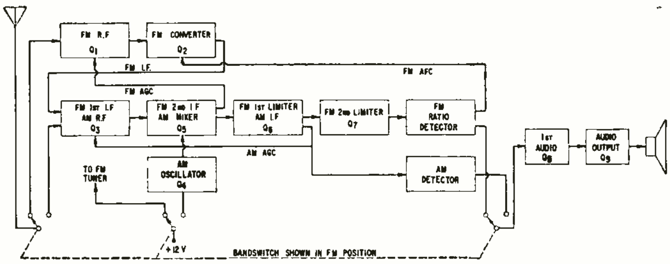


Fig. 2. With several dual-function stages, only three circuits need to be changed from AM to FM by the bandswitch.

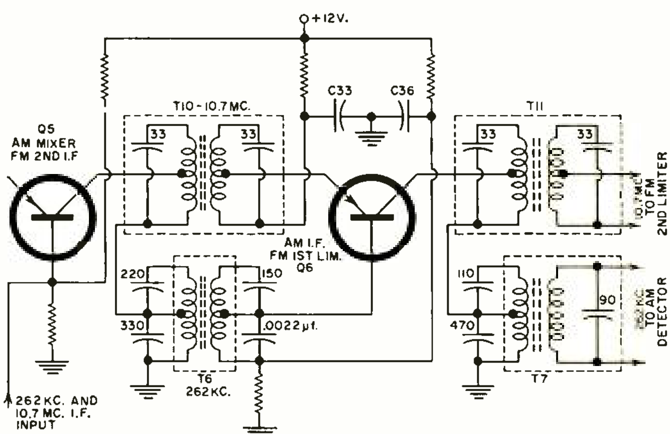
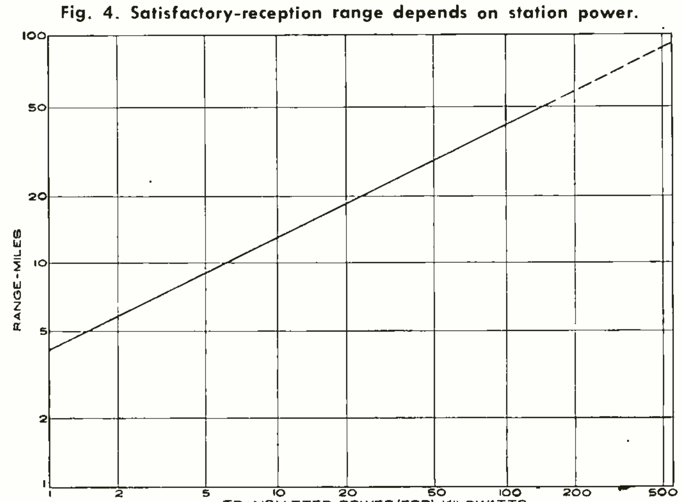


Fig. 3. Coupling between two dual-function stages shows automatic channeling of signals without mechanical switching.

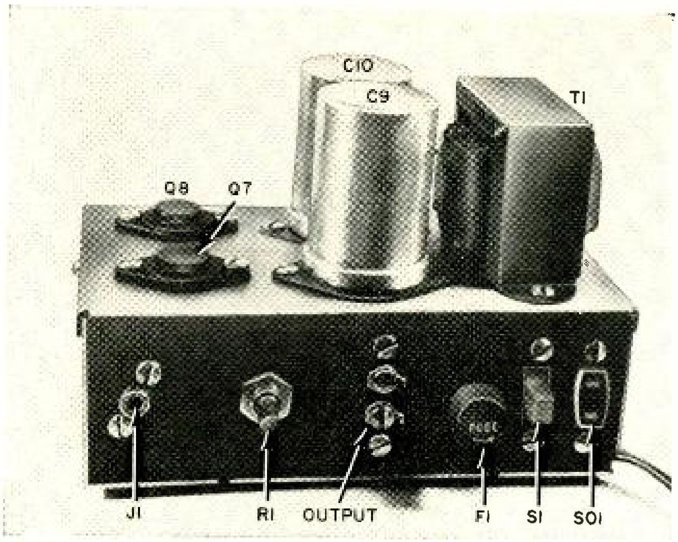
Fig. 4. Satisfactory-reception range depends on station power.



9-WATT TRANSISTORIZED HI-FI AMPLIFIER

By STANLEY E. BAMMEL

Construction of an output-transformerless amplifier employing inexpensive transistors —for use with efficient loudspeaker systems.



Front view of amplifier. The two output transistors are mounted atop the chassis but one is insulated from it.

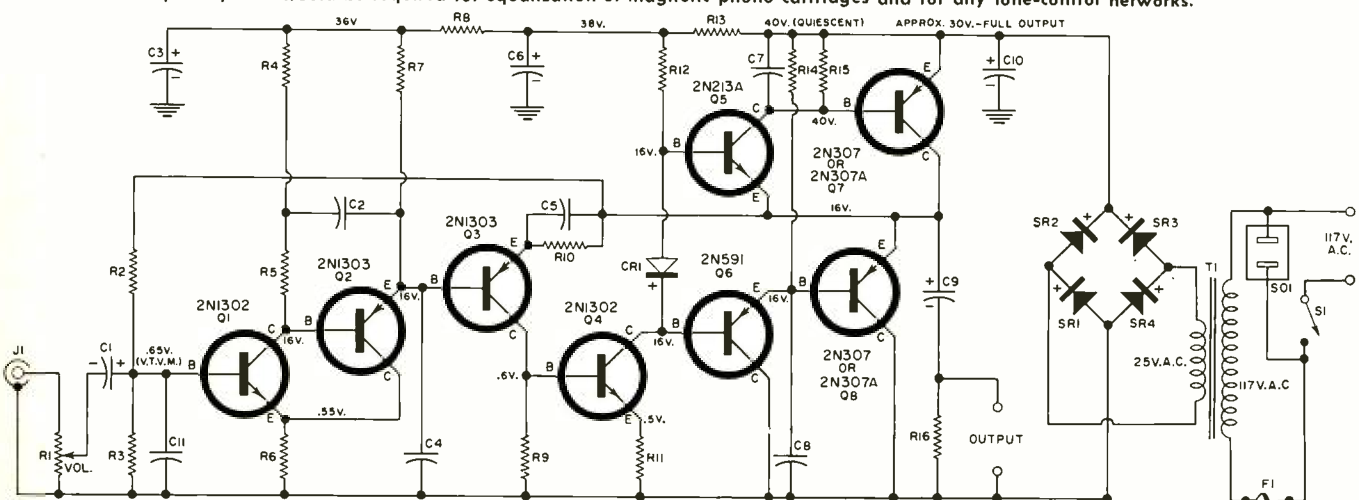
IT is well known that from the standpoint of size and power consumption, transistors offer tremendous advantages as compared to tubes. Unfortunately, transistors often suffer from the disadvantage of rather complex circuitry which tends towards high cost. However, the absence of an expensive output transformer and the availability of inexpensive, good-quality transistors has largely offset this disadvantage.

The absence of an output transformer also offers performance advantages. Its unusually large amount of phase shift at low and high frequencies limits the amount of negative feedback which can be used if an adequate stability margin is to be maintained. The amplifier to be described has about 40 db of feedback in each of its two main loops. There is plenty of stability as evidenced by the absence of overshoot in the square-wave response.

Signal input is to the base of Q1 (see Fig. 1). Q1 and Q2 are connected in a negative feedback loop so that together they act as a single, low-distortion, high-gain transistor. C2 provides positive feedback which increases the collector load impedance of Q1. This maintains high gain within the negative feedback loop. This high gain is essential in order to obtain maximum effectiveness of the negative feedback. Q1 receives the negative feedback *via* its emitter from the collector of Q2.

The output of Q1 and Q2 is direct-coupled to Q3 which is a grounded-emitter stage. Q3 is then direct-coupled to Q4, another grounded-emitter stage. However, the emitter of Q3 receives 100% negative voltage feedback from the output. This holds the voltage gain between Q3 and the output to unity. The feedback does not affect the current gain, however, which is very high.

Fig. 1. Complete schematic diagram and parts listing for the eight-transistor hi-fi audio amplifier. A separate preamplifier would be required for equalization of magnetic phono cartridges and for any tone-control networks.



R1—25,000 ohm audio taper pot
R2—1 megohm, ½ w. res. (see text)
R3—39,000 ohm, ½ w. res.
R4—100,000 ohm, ½ w. res.
R5—22,000 ohm, ½ w. res.
R6,R11—270 ohm, ½ w. res.
R7—10,000 ohm, ½ w. res.
R8, R10—1000 ohm, ½ w. res.
R9—2200 ohm, ½ w. res.
R12—10,000 ohm, ½ w. res.
R13,R16—470 ohm, ½ w. res.
R14—15,000 ohm, ½ w. res.
R15—220 ohm, ½ w. res.
C1—2 μf., 6 v. elec. capacitor
C2—.47 μf., 10 v. disc ceramic capacitor (Centralab UK10-474)
C3,C6—100 μf., 50 v. tubular elec. capacitor
C4—100 μμf. disc ceramic capacitor
C5—.002 μf. disc ceramic capacitor
C7,C8—.005 μf. disc ceramic capacitor
C9—1000 μf., 25 v. can elec. capacitor
C10—500 μf., 50 v. can elec. capacitor
C11—330 μμf. disc ceramic capacitor
CR1—1N91 germanium diode
SR1,SR2,SR3,SR4—1N1692 silicon rectifier
F1—¼-amp "Slo-Blo" fuse (see text)
J1—Phono jack
S1—S.p.s.t. slide switch
SO1—A.c. receptacle
T1—Fil. trans. 117 volts pri., 25 v. @ 1 amp sec.
Q1,Q4—2N1302 "n-p-n" transistor (Texas Instruments)
Q2,Q3—2N1303 "p-n-p" transistor (Texas Instruments)
Q5—2N213A "n-p-n" transistor (Sylvania)
Q6—2N591 "p-n-p" transistor (RCA)
Q7,Q8—2N307 or 2N307A "p-n-p" transistor (Sylvania)
1—2" x 3½" x 6" aluminum chassis

The output of $Q4$ is direct-coupled to $Q5$ and $Q6$. $Q6$ and $Q8$ are both grounded-collector stages or emitter followers. The voltage gain of an emitter follower is slightly less than unity, but its current gain is high. The effect of these two transistors can be considered that of a single, high-gain, high-power *p-n-p* emitter follower.

$Q5$ and $Q7$ are connected in the same type of feedback loop as $Q1$ and $Q2$ whereby two transistors act as a single transistor. In this case, the pair of transistors is connected as an emitter follower. Its characteristics are identical to those of the pair $Q6$ and $Q8$ except that $Q5$ and $Q7$ act as an *n-p-n* transistor. This gives push-pull operation by allowing $Q5$ and $Q7$ to operate on positive half cycles and $Q6$ and $Q8$ to operate on negative half cycles.

The voltage drop across $CR1$ biases $Q7$ and $Q8$ for a quiescent (no signal) current of approximately 1 ma. The

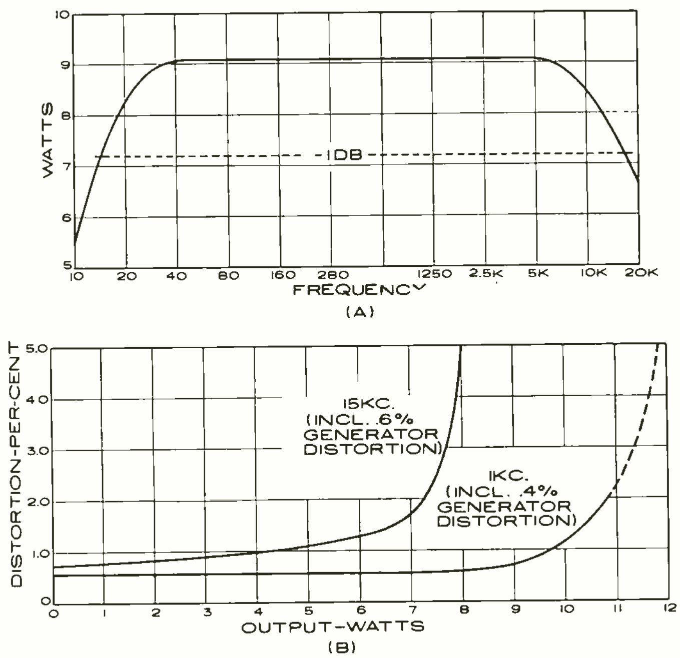


Fig. 2. (A) Maximum power output into 8-ohm load before clipping. (B) Total harmonic distortion vs. output (8-ohm load).

temperature characteristic of $CR1$ is in a direction to give temperature compensation to the output transistors.

As an over-all result, all voltage gain takes place in $Q1$ and $Q2$ and by far the greater part of the current gain takes place in the rest of the transistors. The use of localized negative feedback rather than over-all feedback gives better stability and overload characteristics, resulting in better transient response. The large amount of current gain, in conjunction with the negative feedback, gives a very low output impedance, yielding good speaker damping.

If you check the specifications of $Q1$ to $Q4$, you will find that their collector voltage ratings are 25 or 30 volts. Then you will notice that the power supply delivers 40 volts at quiescent conditions. This allows the collector voltage to swing considerably above its rating. However, the extensive use of *local* feedback gives much more voltage allowance. Over a considerable period of use and experiment, no trouble whatsoever has been encountered, except when using these transistors at higher power in the place of $Q5$ and $Q6$. Therefore, different transistors are used for the latter. These latter units are more expensive and have better voltage ratings but, due to inadequate frequency response, cannot be used as substitutes for $Q1$ to $Q4$.

Any substitutions for $Q7$ and $Q8$ should be undertaken carefully. The 2N307's called for have outstanding frequency and low-leakage characteristics compared to several other inexpensive power transistors tested. Unless a substitute compares very favorably with these transistors, difficulty will be experienced with both thermal and high-frequency stability.

A "Slo-Blo" ¼-amp fuse is used in the a.c. line. If this type is not used, the surge when the amplifier is turned on will blow an ordinary fuse. At steady high power output, for which the amplifier is not intended, the fuse may blow. However, it is considered adequate for all program material while giving maximum protection against accidental output shorting.

Construction

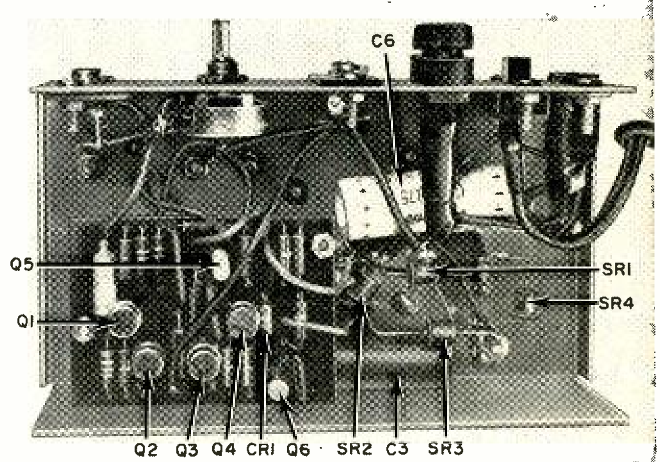
The amplifier is completely contained on a 2″ x 3½″ x 6″ aluminum chassis. $C10$ is mounted on the chassis with the metal mounting supplied with it since its can is grounded. $C9$, however, must be insulated with the insulating mounting plate supplied. As a matter of personal safety, use insulating tape on all exposed a.c. line connections.

$Q8$ is fastened directly to the chassis since its collector is grounded. $Q7$ must be insulated, however. Use an insulating washer which is specified for this purpose. Some manufacturers (*Sylvania* among them) supply such a mica washer with each of their power transistors. Mount the washer between $Q7$ and the chassis. In addition, the mounting holes must be larger than the screws in order to permit insulation between the screws and the chassis. Use insulating washers on the underside of the chassis as well.

In order to achieve necessary cooling, the power transistors are mounted on the chassis. Thermal conduction between the transistors and chassis can be enhanced by the use of silicone grease (*Dow Corning* DC4 or equivalent). Before mounting, apply this grease to both the under side of the transistors and the chassis. With $Q7$, apply the grease to the insulating washer as well. Tighten mounting screws well so that the transistors make firm contact with the chassis.

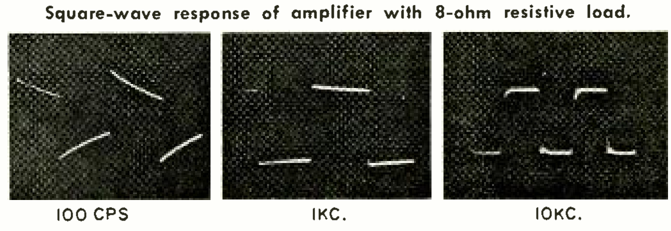
Connectors to the power transistors can be obtained from an old 7- or 9-pin miniature tube socket. It is not a good idea to attempt to solder directly to the transistors. Connection

(Continued on page 66)



Underside view. The author used a printed board for most components (lower left) but conventional wiring may be used.

Square-wave response of amplifier with 8-ohm resistive load.



Proposal to the FCC

A Citizens Radio Technician License

By R. L. CONHAIM, 19W7377

THE proposed new regulations for the Citizens Radio Service should go a long way toward cleaning up operations on this overcrowded and often misused band. True, as with any regulations, they have their pros and cons. But one place, in the author's opinion, where the FCC missed a bet is their failure to do something about better adherence to the technical standards set up for the class D Citizens Band.

First, let us hasten to say that nothing in the technical standards in sub-part C of Part 19 of the FCC Rules and Regulations is unfair or difficult to achieve. But, the fact that so many stations are off frequency, so many are overmodulating, so many are using too much power, is evidence that something is wrong. And, it is not only the transmitters used by the renegades on the band that are failing to meet technical requirements. One has only to make routine, off-the-air frequency checks of even the most law-abiding users, and he will find many cases of off-frequency operation.

When you compare the requirements of Part 19 with other services, such as industrial, business radio, public safety, and land transportation services, you will find little in Part 19 that differs radically from the regulations applying to these other services. The big difference arises from the fact that no one could possibly have forecast the tremendous popularity of the class D band, or that there would be 350,000 licenses issued in just a few years.

Licenses for Servicing

All of the services mentioned, including the Citizens Band, require a holder of a second-class commercial radiotelephone license, or better, to make any adjustments to a transmitter that would affect its operating frequency, modulation, or maximum output power. The purpose of this requirement is to assure the maintenance of technical standards. The technical standards for all bands have been set up to assure maximum utilization of available spectrum space, and the least possible interference to users within the same band or on other bands.

Equipment for all these other bands is sold and serviced by specialists in the field. The equipment, in practically all cases, is considerably more expensive than Citizens Band transceivers, a single mobile transmitter-receiver combination costing close to $500.00 or even more. Service for such equipment can obviously be expected to cost more. A routine survey indicates that maintenance contract service may cost from $5.00 to $8.00 per month, per mobile unit, and more for base stations. A frequency check of a single- or dual-channel transmitter usually costs in the neighborhood of $5.00. This kind of business is worthwhile for the professional service organizations involved, and the trouble of securing and maintaining a first- or second-class radiotelephone license is worth the effort.

But, the sad truth concerning Citizens Band is that entirely too few holders of first- or second-class commercial radiotelephone licenses are interested in selling, installing, or servicing CB equipment—and for a variety of reasons. Most of the professional service organizations which handle two-way radio are too busy selling and maintaining the higher priced and more profitable equipment used in other services. Others have expressed the opinion that some CB equipment is not built to high technical standards and requires too much time to align, adjust, or repair, and that CB-ers are unwilling to pay their regular rates. Many persons employed by radio stations, governmental agencies, or large users of commercial radio equipment are unavailable for CB repair because of the requirements of their regular jobs. Occasionally, you will find a qualified license holder who is willing to perform CB service on a part-time basis during his off hours. But there aren't enough of these people, nor enough hours to take care of the CB equipment which needs adjustment or maintenance.

In talking with other organizations, the author has frequently encountered the attitude that CB requires different test equipment, or entails the making of too many test harnesses because of the lack of standardization. For these reasons, the organization in question is unwilling to make the expenditures to secure the necessary equipment to service CB.

So here we are, with a crowded band of ardent users, forced by circumstances or disregard for regulations to dabble unlawfully with their own equipment, or to have it serviced by unqualified personnel. Is it any wonder that there is such great laxity at the present time in the maintenance of the proper technical standards?

CB—A Special Case

CB, by its own growth pattern, has made of itself a very special case, and will undoubtedly have to be treated as such. Is there any necessity for the requirement that most transmitter adjustments and repairs have to be made or supervised by the holder of a first- or second-class commercial radiotelephone license? Unquestionably, there is a need for competent repair services, and in order to establish high standards such repair personnel should be licensed. But certainly the knowledge required to repair CB equipment is nowhere nearly as extensive as that required in other services. The holder of a second-class commercial license must pass a written examination, on which he must demonstrate his knowledge of all manner of electronic theory and circuitry—much of which is not applicable to CB. It is no wonder, then, that few people have applied for such a license for the sole purpose of maintaining CB equipment.

It becomes quite obvious, when one analyzes the problem, that if CB technical standards are to be maintained, something must be done to find a more practical solution to the problem of adjusting and repairing transmitters. It is equally obvious that until some practical solution to this problem is found, technical standards on the class D Citizens Band cannot be maintained, and irresponsible dabbling with equipment is going to continue.

A Practical Solution

In looking for a solution, we have to be practical. We must find some source of technically adequate repair service which is readily available to the average CB-er and at the same time a source which will assure the maintenance of technical standards to the satisfaction of the FCC. Unquestionably, such sources will have to be li-

The acceptance of this proposal should go a long way in getting better repair service for CB equipment and cleaning up operation of gear not meeting technical requirements.

censed to prove their ability to maintain technical standards. But knowledge of CB equipment is not hard to acquire especially if the student is already familiar with electronic circuitry and theory. Fortunately, there is a very large pool of such "raw material" already available. We are speaking, of course, of the large number of TV-radio service technicians and technically qualified CB users, who with very little study, and proper equipment, could become the nucleus of an efficient, capable, and widespread service facility for all users of CB equipment.

The author therefore proposes to the Federal Communications Commission a special class of license which would authorize the holder to align, repair, and measure CB equipment to maintain it in accordance with the technical requirements of Part 19 of the Commission's Rules and Regulations. But, more than just requesting such consideration, let's spell out in detail how such a class of license would be set up, what its requirements would be, and how such license holders would function.

Some of the Details

The special class of license for which we ask consideration might be called Citizens Radio Technician Class License. Each applicant for such a license would be required to prove his knowledge of radio laws and treaties, as they pertain to Citizens Band operation. He would have to be able to pass a written examination divided into two parts. Part one would cover knowledge of Part 19 of the Commission's Rules and Regulations and any other part referenced in Part 19. Part two would cover technical knowledge, specifically limited to Citizens Band circuitry, especially to transmitters with 5 watts or less of input power. Included would be all modulation, oscillator, and r.f. power circuits, antenna coupling, transmission line, and antenna theory, specifically as applied to Citizens Radio Service. Because by far the greatest problems in the Citizens Radio Service exist in class D, the technical requirements would only cover class D and the license would be good only for working on class D equipment. If the Commission saw fit, additional tests could be given on classes A and B and those applicants passing this additional phase could be authorized to work on the higher frequency tranceivers. In the absence of such provisions, class A and B transmitters would have to be adjusted and repaired by holders of regular second-class commercial licenses.

Because a great many people might qualify for such a license, and to prevent an excessive work load for FCC examiners, the Citizens Radio Band Technical License examination could be taken by mail much like the present Amateur Technician Class License. In the case of a Citizens Band Technician License, however, the examination would be given by the holder of a first- or second-class commercial radiotelephone license.

The license would permit the holder to work on any class D equipment, but if he did so as a commercial service for which he charged a fee, he would have to demonstrate to the Commission, upon request, that he had equipment capable of reading frequency, harmonic radiation, modulation percentage, and power output within specified tolerances.

If such a license were made official, the Rules and Regulations within Part 19 should be altered at some later date so that the owner of class D equipment could only change tubes in the portions of the transceiver not common to both receiver and transmitter, or change fuses. The changing of any other part, the altering of circuits, or any alignment and repair, other than receiver i.f. alignment, would have to be done by the holder of a Citizens Band Technician Class License.

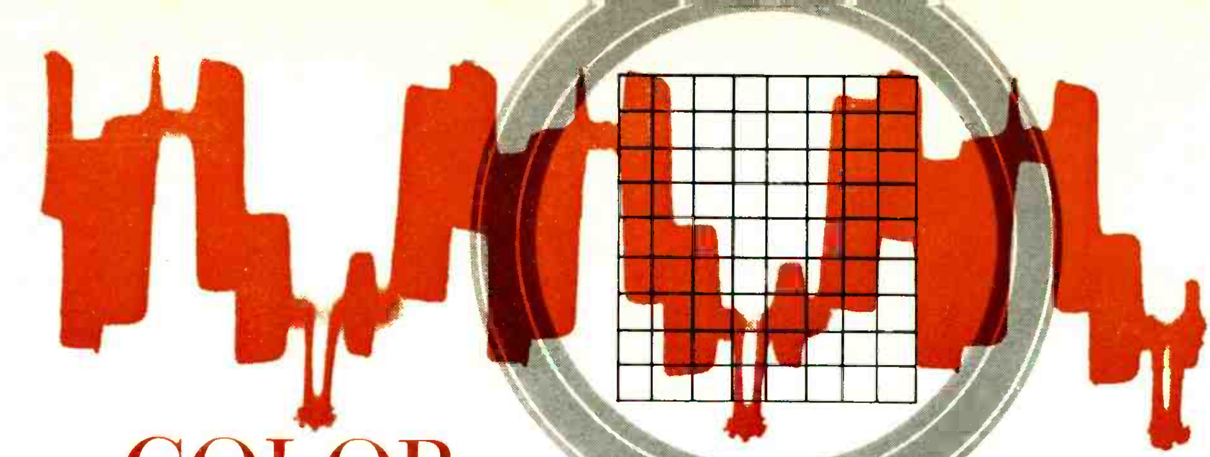
Equipment Certification

In addition, each Citizens Band transceiver would have to be certified, at least once every year, for frequency tolerance, acceptable harmonic radiation, power output, and modulation of less than 100% by the holder of a Citizens Band Technician Class License. Such certification and all repair work would be entered on official FCC forms or facsimiles thereof, one copy of which would be given to the owner of the transceiver and the other kept by the licensed service technician or repair organization, subject to inspection by the FCC.

It may seem that the author is suggesting even more stringent requirements for Part 19 than are now being imposed. This is true. It is based, however, on the fact that most CB equipment is made in transceiver form, in which some circuits are common to both receiver and transmitter. While in some cases present regulations allow the user to adjust or repair such common circuits, many of the problems with overmodulation and splattering arise from just such repairs and alterations. In an effort to get just a little more from his transmitter, the user often fools around with the modulation circuits, substituting hotter tubes or otherwise beefing up the circuit to the point where overmodulation takes place. Under present regulations he may be permitted to work on these circuits because they are basically audio circuits. However, if a readily available repair organization were in existence, such alterations should not be permitted by the user.

The author believes that such a special class of license could be easily obtained by the average TV-radio service technician, or by many knowledgeable CB-ers, after very little study. The additional equipment required by a TV-radio service shop would be relatively low in cost. TV-radio service technicians are already used to working on equipment of the average CB quality. In fact, in many cases, such men are better qualified to work on class D CB equipment than those who are used to working on equipment built to much higher technical standards.

If licensing such as is proposed in this article were to become effective, it would go a long way towards eliminating the technical problems that beset class D Citizens Radio Service and would eliminate much of the irresponsible alterations and adjustments of equipment which are now being made under the excuse that no qualified repair service is available. Further, it could be implemented without putting an undue workload on the FCC. It would place responsibility for adequate maintenance upon duly licensed persons, and it would further place responsibility on the CB owner for periodic check-ups of his equipment. ▲



COLOR-PATTERN GENERATORS

By WALTER J. CERVENY / Chief Engineer, The Hickok Electrical Instrument Co.

How NTSC-bar and rainbow-pattern generators operate, are used to align color circuits, and points to bear in mind before buying.

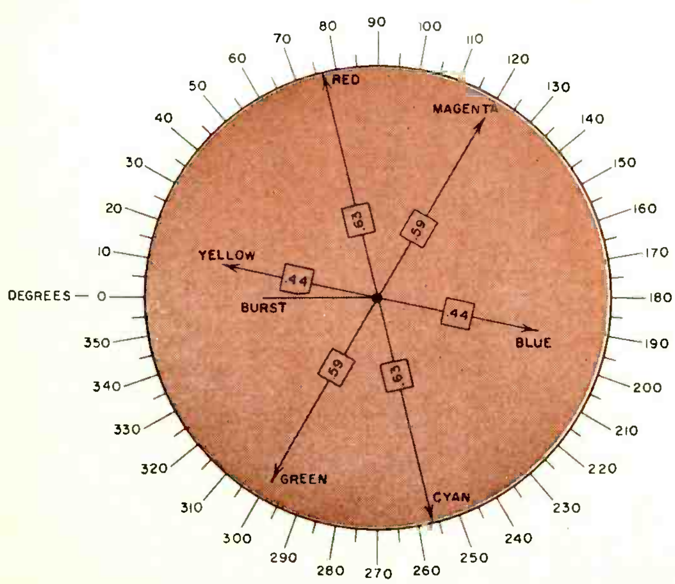
SALES of color-TV receivers are on the rise today for several good reasons: The sets are more reliable, they can be serviced easily in the home, and they do not require frequent readjustment—a far cry from the sets of a few years back. Programming time is increasing, and most of the leading manufacturers are now marketing receivers. This growth should convince the service technician that it is time to seriously "tool up" for color.

If you own a color set and feel confident about making your own adjustments, you may have heard and wondered about color-pattern generators—how they work, what they can and are used to do, and which type—NTSC-bar or rainbow—would be best for making the various adjustments that are required in a color set.

Basic equipment for black-and-white TV service includes a sweep and marker generator, a tube tester, a v.t.v.m., and an oscilloscope. Color TV service, in addition to this equipment, will require a wide-band scope and a color-pattern generator. In the case of the scope the choice is not difficult to make. The requirement is that it have a flat frequency response to at least 3.6 mc. and that it be able to sync well at the 3.58-mc. color subcarrier frequency. Years ago a scope of this caliber was considered a laboratory instrument, however today it is within the financial reach of almost everyone. The choice of the color-pattern generator is not as easy to make. Several types are available and unless you are aware of the advantages and limitations of each, the decision can be difficult.

There are only two basically different color-pattern generators—the NTSC-bar and the rainbow. Two different type rainbow generators are available—the continuous display and the gated rainbow. But before discussing them, let's talk about color TV transmission.

Fig. 1. Vector diagram of a 100% saturated NTSC color signal.



NTSC Standards

The NTSC (National Television Systems Committee), which was formed in the early 50's, set up standards for the compatible color TV system. These standards were later adopted by the FCC and are in effect today. Although the design of color TV receivers may change over the years, it will always be such that color sets will be able to operate with an NTSC signal.

A color picture is transmitted as a combination of brightness (Y) and color difference ($R-Y$ and $B-Y$) signals. The Y component is transmitted as an AM signal, while the color information (chroma) is a 3.58-mc. phase-modulated signal with a suppressed carrier. Both Y and chroma are transmitted on the same channel. In order to produce a color at a specific hue and saturation, the chroma signal fed to a color demodulator circuit in the TV set must have a specific amplitude and phase relationship with respect to the color burst signal. And, if the color is to have the correct brightness, there must always be a Y component in the signal.

NTSC Color-Bar Generators

Fig. 2A shows the output waveform of an NTSC color-bar generator, a composite signal representing fully saturated primary and complementary colors. To understand how this composite signal is formed, remember that it is made up of two parts—a brightness, or Y component (Fig. 2B), and a chrominance component (Fig. 2C). The chrominance component consists of a color burst and a series of six color bars and white; white is at zero level. The color bars and burst, whose phase and amplitude relationships are shown in Fig. 1, are produced by a common frequency of 3.58 mc. The burst is the reference and therefore at 0° phase; yellow lags burst by 13° with an amplitude of .44; red is next with a phase of 76° and amplitude of .63; magenta has a phase of 120° and an amplitude of .59; and so on.

It would exceed the scope of this article to describe in detail operation of an NTSC bar generator. However, we will cribe the operation of the *Hickok* Model 656XC generator, shown in block-diagram form in Fig. 3.

How the NTSC Generator Works

The color pattern must contain all the elements of an NTSC signal; that is, sync, chroma, and brightness information in correct phase. The color-bar phase differences are produced with precision delay lines; their amplitudes are determined by potentiometers. The brightness component of Fig. 2B is produced by Schmitt trigger circuits with appropriate time delays for each bar.

The heart of the generator is a timer which consists of five blocking oscillators (31.5 kc., 15,750 cps, 4500 cps, 900 cps, and 60 cps) that are electrically locked together and controlled by a 315-kc. crystal-controlled oscillator. The blocking-oscillator outputs, when combined, produce the composite.

The chroma component is generated by a 3.58-mc. crystal oscillator. The output of the 3.58-mc. oscillator is fed to a cathode-follower stage which drives a delay line that has three output taps—one for each primary color (red, blue, and green). The three output signals from the delay line, which are of different phase, are fed to three chroma gates. Another output of the 3.58-mc. cathode-follower is fed to a burst gate. All gates are driven by 15,750-cps pulses derived from another delay line and four multivibrators. The outputs of three of the multivibrators are fed through attenuators to form three Y, or brightness, signals in time sequence. All four signals, sync, chroma, Y, and burst are then added together in the composite adder-stage to produce the composite color-bar signal. This signal is fed to a cathode-follower stage for a low-impedance output. The complementary colors (yellow, magenta, cyan) and white are generated by overlapping the primary color bars. For example, when the green and red bars are added, you will get yellow. Magenta is produced by mixing blue and red, cyan by mixing blue and green. From the diagram of Fig. 1 you can determine that if vectors of the three primary or three complementary colors are added vectorially, the resultant will be zero, or white. The brightness component will equal unity since the sum of the individual brightness levels equals 1 (.3+.59+.11=1).

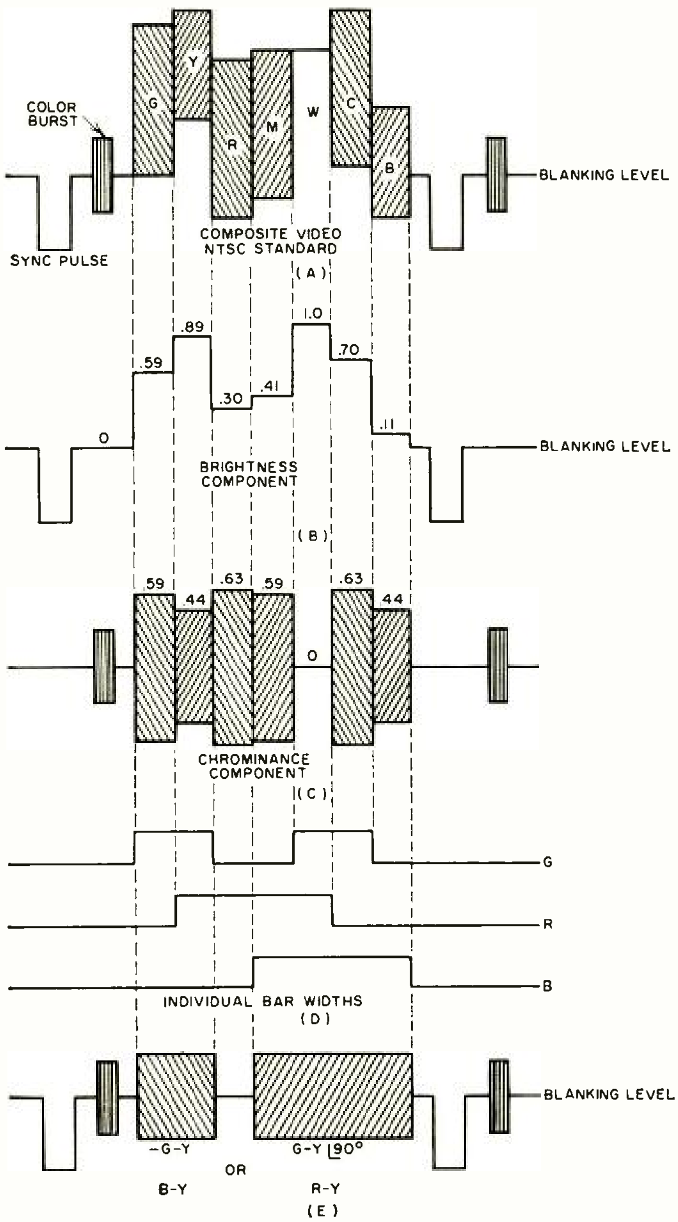


Fig. 2. Composite video signal (A) produced by an NTSC generator consists of two parts—brightness (B) and chrominance (C). Note that in C the amplitude of each bar represents the degree of color saturation. Over-all amplitude of all color bars with respect to the zero or blanking level is set by the brightness component (B).

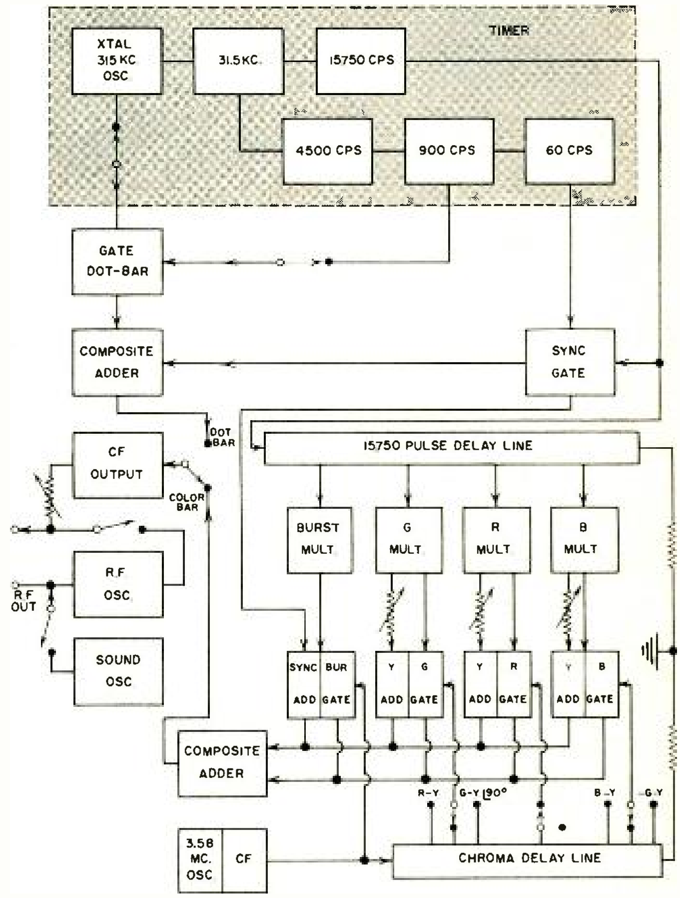


Fig. 3. Block diagram of Hickok 656XC NTSC color-bar generator.

To generate the $R-Y$, $B-Y$, $-G-Y$, and $G-Y$ at 90° alignment signals, as in Fig. 2E, rather than color bars, one primary color bar is switched off, the phase of the other bars is changed to "alignment signal phase," and the Y component is removed. The rest of the process is identical to that described for generating color bars.

To generate a dot pattern, the 60-cps and the 15,750-cps pulses are fed to a sync-gate circuit. Here the composite sync signal is formed. The 900-cps pulses and the 315-kc. pulses are fed to a gate-dot-bar circuit, where the dot information is formed. To complete the composite signal, the dot information is added to the composite sync signal in the composite adder stage. The output of the composite adder is fed to the cathode-follower output stage and the output attenuator.

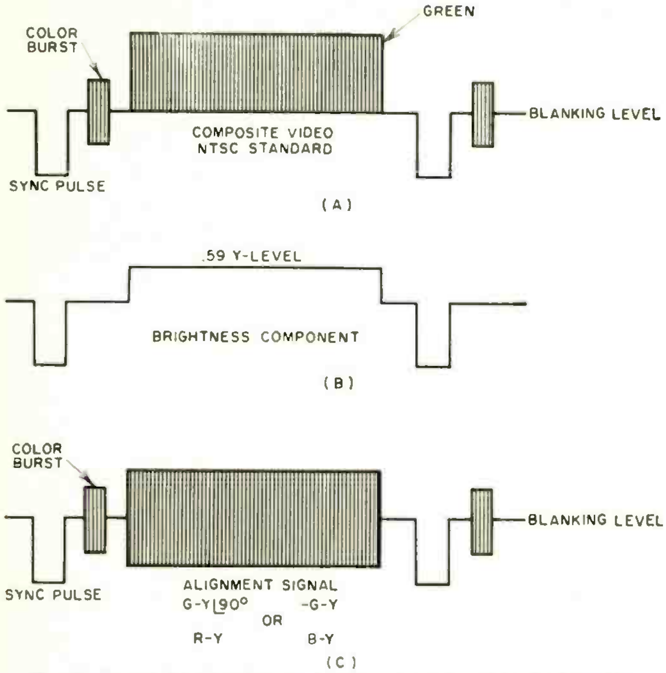


Fig. 4. Composite signal and component produced by Hickok 661.

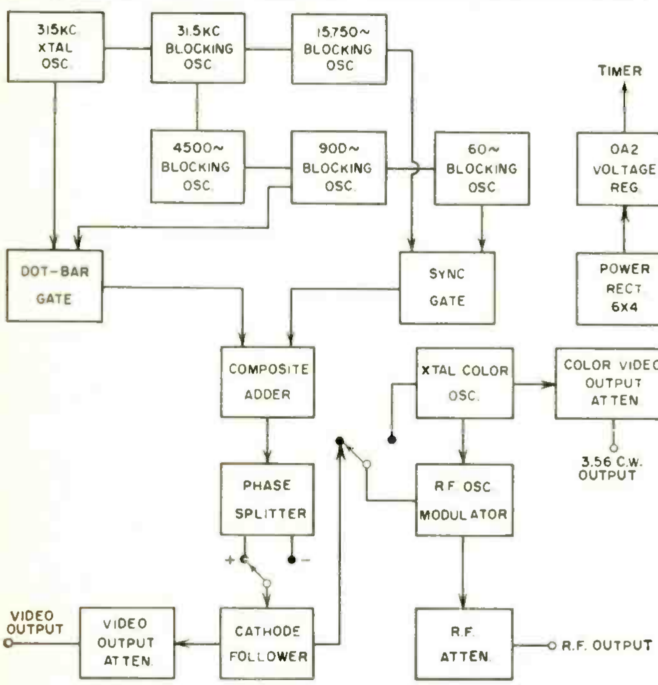


Fig. 5. Block diagram of Hickok 660 rainbow-pattern generator.

To produce a crosshatch pattern, the gate-dot-bar circuit is converted to an adder stage allowing the 900-cps (horizontal-bar frequency) and the 315-kc. (vertical-bar frequency) to be fed to the output directly. Horizontal bars alone are produced by switching off the 315-kc. signal in the crosshatch positions, and *vice versa* for vertical bars alone.

In addition to the composite video output stage there is an r.f. oscillator that can be modulated by the composite signal so that color bar, dot bar, or alignment signals can be fed directly to the antenna terminals of the color TV set through channels 2-6. A sound-frequency crystal is also provided to facilitate fine tuning of the receiver.

A less costly NTSC color generator (Model 661, Fig. 10) is also available. It differs from the generator just described in that it develops only one NTSC color (displayed on the entire CRT face) at a time. Each color is the correct brightness level, and in conformity with NTSC standards. Alignment signals of $R-Y$, $B-Y$, and $G-Y$ at 90° are also available; these signals are at black levels as shown in Fig. 4, lacking brightness (Y).

In addition to the color signals, this generator also produces dot and crosshatch patterns, and vertical and horizontal bars. The crosshatch pattern consists of 20 vertical and 15 horizontal bars, less those in the blanking region. This is an aspect ratio of 4 to 3, ideal for height, width, and linearity adjustments. You merely make adjustments for perfect squares in all areas of the CRT screen.

Alignment with an NTSC Generator

Color demodulator alignment with an NTSC generator is relatively simple. On sets that demodulate in quadrature, that is, the type with $R-Y$, $B-Y$ demodulators, a scope with a low-capacity probe is connected to the output of the $R-Y$ demodulator. A $B-Y$ signal is fed to the set. Then, with the hue control set to mid-position, the $R-Y$ phase is adjusted for a null or zero output of the $B-Y$ signal. The scope is then connected to the plate or output of the $B-Y$ demodulator and an $R-Y$ signal is fed into the set. The quadrature phase is adjusted for a null or zero output of the $R-Y$ signal. Normally this completes the demodulator alignment since most receivers use a fixed matrix for $G-Y$ and do not require adjustment. However, if a $G-Y$ adjustment is required, the scope is connected to the $G-Y$ output. A $G-Y$ signal at 90° is fed to the set and an adjustment is made for a null or zero output.

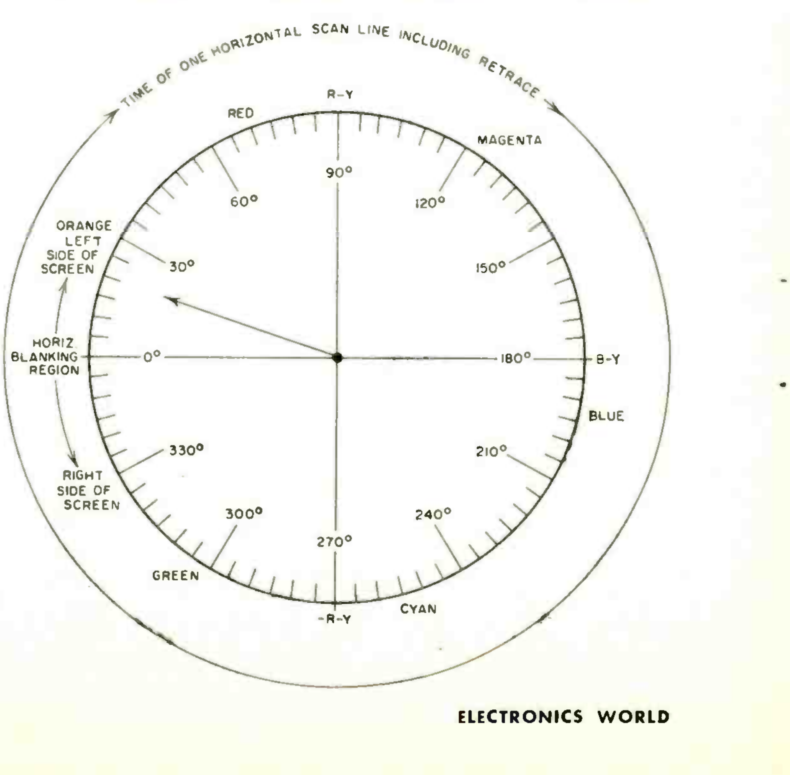
On color sets that demodulate out of quadrature, that is sets with the so-called X and Z demodulators, alignment is also simple. Instead of connecting the oscilloscope to the demodulators, it is connected to the $R-Y$, $B-Y$, and $G-Y$ outputs which are located at the grids of the CRT. The procedure then is identical to that for quadrature demodulators.

Rainbow Generators

Many service technicians might shy away from an NTSC color-bar generator because of the high cost, and especially when just starting to do color work. If they are willing to sacrifice some performance and versatility for a saving in price, then the rainbow generator should be their choice. Later, as color service business increases and more complicated work is considered, an NTSC generator could be purchased. The rainbow generator could be used for installation and service in the home while the NTSC generator is used for bench work where an accurate standard signal source is required.

(*Continued on page* 88)

Fig. 6. "Rotating vector" produces rainbow-generator color pattern.



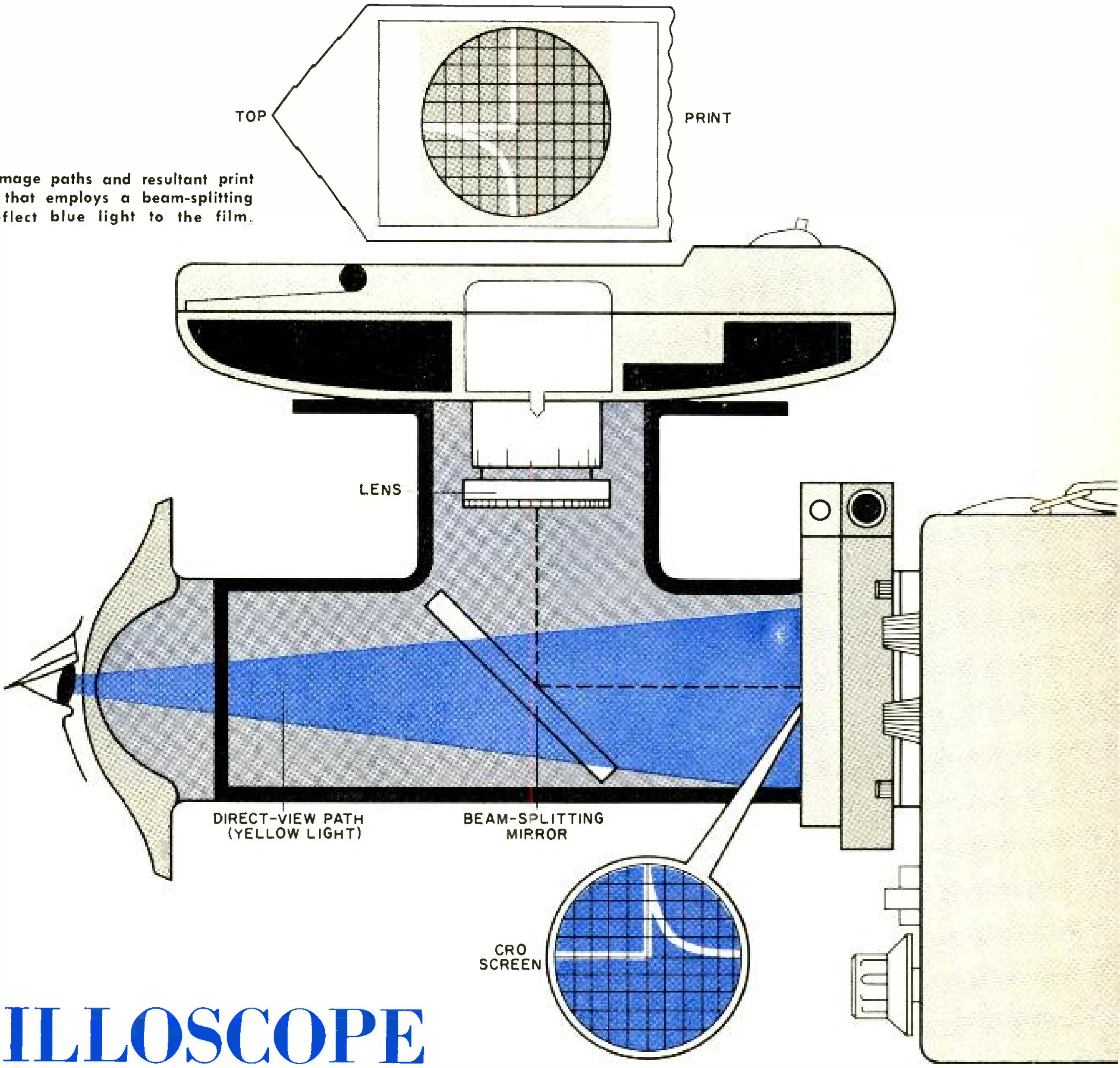


Fig. 1. The image paths and resultant print in a system that employs a beam-splitting mirror to reflect blue light to the film.

OSCILLOSCOPE PHOTOGRAPHY IN INDUSTRY

By RAY A. SHIVER / Instrumentation Laboratory, AirResearch Mfg. Co. of Arizona

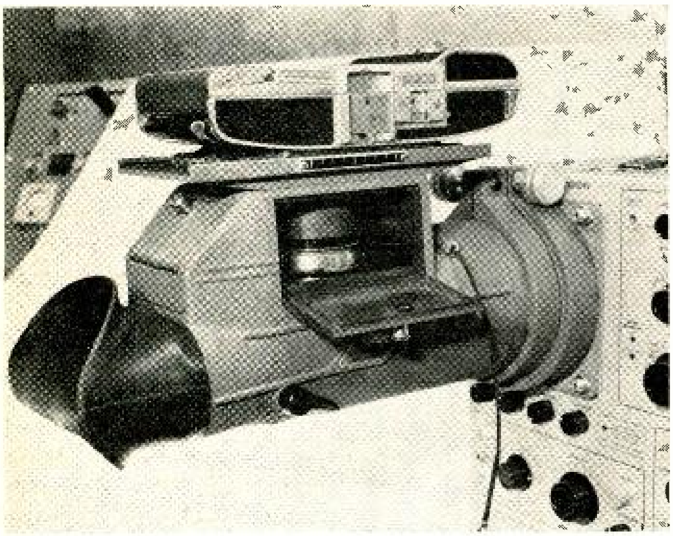
Description of cameras and techniques used to make a record of scope patterns —particularly those that are non-repetitive or too rapid for direct viewing.

THE VALUE of the modern laboratory oscilloscope as a measuring instrument is well known to most engineers and technicians. However, the instruments available to photograph cathode-ray oscilloscope traces and the techniques required to use them properly are probably not so well known. Some type of photographic record is very often desirable, or may be absolutely necessary in some cases, if the signal to be measured requires an extremely fast time base and is non-repetitive in character. Any type of signal that can be displayed on a CRO can also be photographed if the appropriate camera and film combination is used.

Oscilloscope Cameras

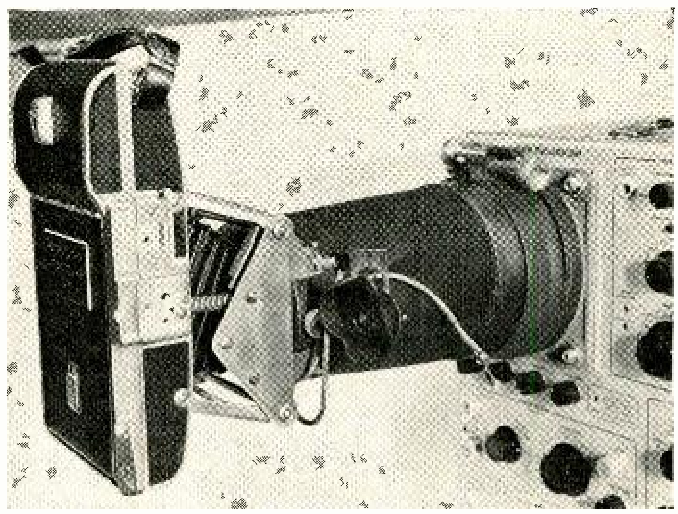
Conventional cameras can be used, of course, to photograph oscilloscope traces if a suitable lens and shutter combination is used and some sort of light-tight enclosure is provided. The disadvantage in this case is that the film must first be developed before the results are known. This can be a time-consuming process and, in addition, one cannot be absolutely certain of the results until the negative or print is available for inspection. For these reasons most commercial cameras available for photographing CRO traces employ a *Polaroid* Land® back. For certain applications, high-speed 35-millimeter strip cameras are also used.

Cameras employing *Polaroid* backs offer many advantages, the most important of which are: First, the finished print is available for almost immediate inspection (10 seconds for film types 47 and 410), which permits a shot to be retaken immediately if for some reason the first is not satisfactory. Second, finished prints can be made on paper (types 42, 47, and 410) or on positive transparencies (types 46 or 46-L). Positive transparencies can be projected in conventional slide projectors, or they can be blown up for enlarged prints. And finally, *Polaroid* films are available with a wide



The DuMont Model 302 camera-scope attachment discussed in text.

This Beattie-Coleman unit produces full-size photo prints.



The Fairchild Model F-286 does not produce a reversed print.

range of speeds from an ASA rating of 200 for type 42 up to a rating of 10,000 for type 410. This permits a wide range of data to be photographed from steady-state signals up to extremely fast transients.

Three oscilloscope cameras, employing *Polaroid* backs, that are representative of the types available for this work are shown in the photos. Note that in each case the camera back is mounted differently with respect to the screen of the cathode-ray tube. This is an important characteristic of each type of camera and determines the form the final print will take, as well as the construction of the viewing system used.

Fig. 1 illustrates the picture-image path and the viewing system for the *DuMont* Model 302 camera shown in the photograph. Note the dichroic or beam-splitting mirror that intersects the primary image path. This is actually a yellow filter which diverts most of the highly photographic blue light to the camera while permitting some of the less efficient yellow and green to pass through for viewing purposes. For this reason this type of camera works best with a CRT employing a blue-light phosphor, such as type P-11.

Use of the beam-splitting mirror permits direct or head-on viewing of the CRO screen, which can be a big advantage when adjusting the gain of the scope to precise calibrate signals. One disadvantage, however, is the image reversal caused by the mirror action of the beam splitter. This causes the final print to be a reversed image of the CRO trace. As long as one remembers the correct relationship of the final print to the original trace, there is no particular problem, although photographs taken on instruments with calibrated screens, such as spectrum analyzers, will show all calibration figures in reverse order. When using *Polaroid* type 46 or 46-L film, which produces positive transparencies, this situation can be corrected by simply viewing or projecting the transparency from the reverse side.

The Model 302 camera produces a final image that is considerably smaller than the CRO screen. This permits two full exposures to be made for each frame, as illustrated in Fig. 3. If it is not necessary to expose the graticule each time, several traces can be recorded on each frame, as shown in Fig. 4. Where practical, this method can produce a considerable saving in film. A movable back and slide track are provided on this model which permits advancing a frame a portion at a time for the desired spacing. A graduated scale indicates the position of the back with respect to the frame length.

A camera designed to produce a full-size reproduction of the CRO screen is the *Beattie-Coleman* Model 12445 shown in the photo. Note that the camera back is mounted in such a way as to allow the full 10-cm. scale of the graticule X axis (horizontal) to be photographed. Slightly over 8 cm. of the Y axis (vertical) will be covered using standard 3¼ x 4¼ *Polaroid* film. Paper prints produced in this manner have an advantage in that they are more easily read because of the larger trace size. Also, a centimeter rule can be applied directly to the print for measuring trace dimensions. Positive transparencies can be used to produce full-size contact prints.

As in the previous example, a beam-splitting yellow filter is used to divide the light from the scope trace into two parts, one for photography and the other for viewing purposes. An added feature of this particular model is the ability to rotate the camera back 90 degrees in the same plane, if desired. This permits moving the back along the Y axis for recording multiple trace exposures on the same frame. On a 1:1 reproduction ratio, the graticule can be pre-exposed before the camera back is moved in order to provide reference lines for multiple exposures.

An example of a CRO camera that does not produce a reversed photo print is shown in the photo above. Note that the camera back now occupies the position of the binocular viewer found in the beam-splitting type. This particular model is a *Fairchild* F-286 and it provides non-reversed prints with an image reduction ratio of 2:1. This permits two exposures of the CRO screen for each frame. The image path is shown in Fig. 2. Since the viewing port is offset from the straight-line path to the CRT face, some parallax is introduced due to the spacing between the tube face and the graticule. This may make precise calibration of the oscillo-

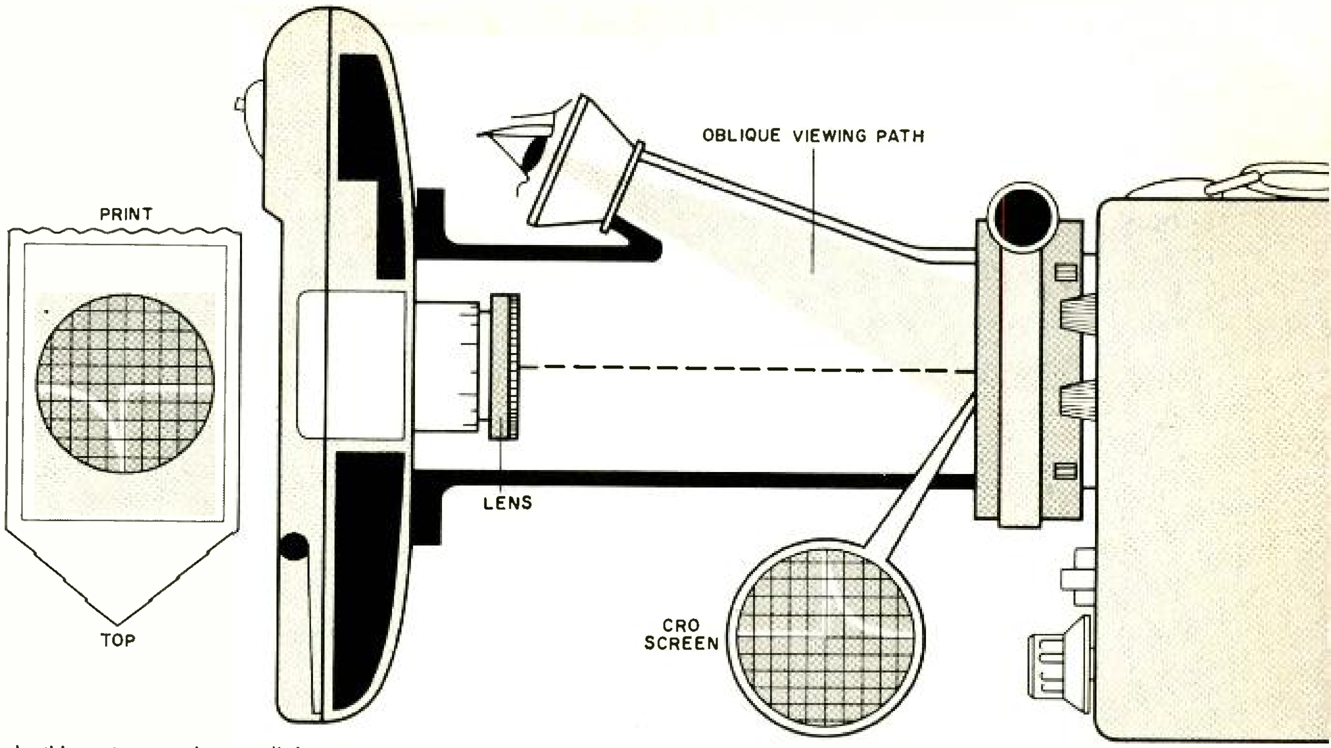


Fig. 2. In this system, no beam-splitting mirror is used so that the print is not reversed. Eye views scope screen obliquely.

scope difficult with the camera in place. However, for ordinary viewing purposes this offers little or no disadvantage. The camera back and lens assembly are mounted on a spring-loaded hinge arrangement that permits the camera to be positioned for two exposures per frame.

Lens and Shutter System

Most CRO cameras made by American manufacturers employ a 75-mm. $f/2.8$ or $f/1.9$ lens. This is generally coupled with a shutter having speeds up to 1/100 second as well as "time" and "bulb." The shutter is usually operated with a cable release external to the camera. Accessibility to the lens and shutter settings is provided for in several ways, depending on the make and model of the camera. The camera of the *DuMont* unit shown provides access through the small trap door visible in the photograph. Two thumb screws located on the bottom of the camera in the *Beattie* unit permit the back to be removed from the periscope for lens and shutter adjustment. A ring and detent assembly located on the front of the camera in the *Fairchild* unit allows the camera to be completely removed from the barrel if required.

It is not meant to suggest that the cameras described are the only models offered by a particular manufacturer. As a general rule, CRO camera manufacturers offer several different models with a choice as to camera orientation, lens and shutter accessibility, and other features.

Exposing the Film

Camera lens and shutter settings are dependent on the type of trace to be photographed, the type of film used, and the level of the CRO beam intensity. There are no hard and fast rules since often the same end result can be obtained with several different combinations of lens, shutter, and beam intensity settings. Generally the lower the beam intensity setting and the smaller the aperture size, the sharper the trace will be in the reproduction. When photographing steady-state data (where a stationary trace can be displayed), one of the faster shutter speeds can be used. This is illustrated by Figs. 5 and 6. The object in this example is to photograph five cycles of a 100-cps sine-wave signal.

Fig. 3. Both exposures made on single frame.

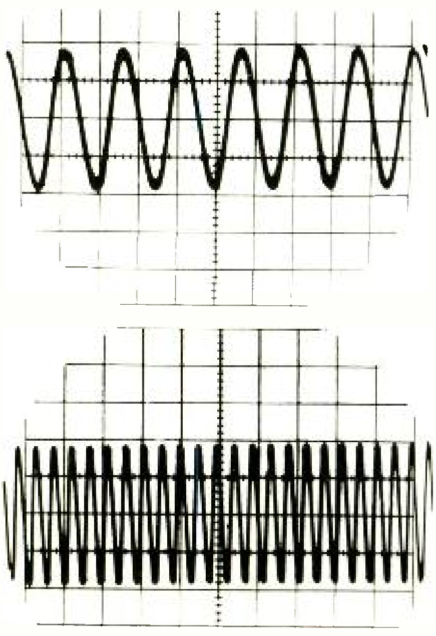


Fig. 4. Five exposures made on single frame.

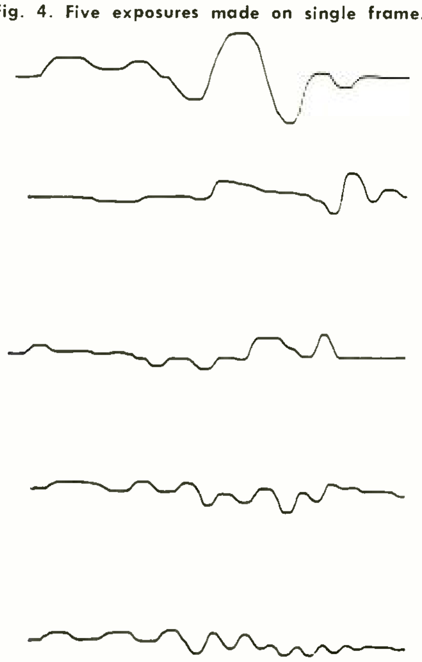


Fig. 5. Photo of 5 cycles of a 100-cps signal at a shutter speed of 1/25 sec. (40 msec.).

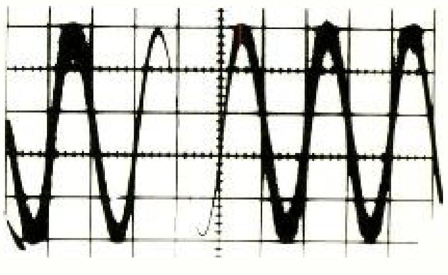
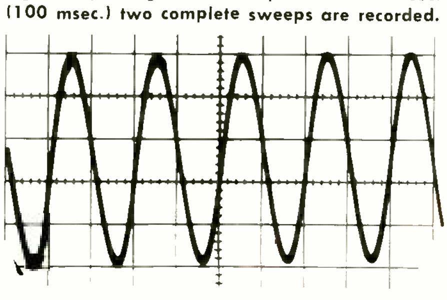
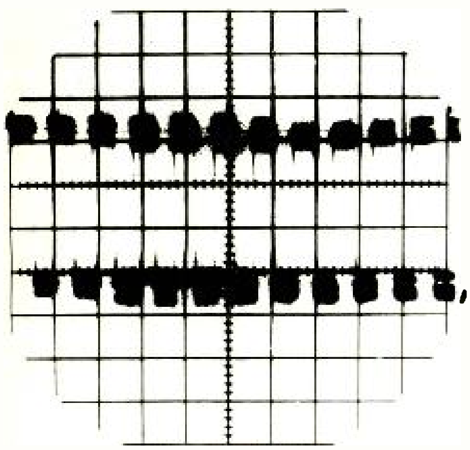


Fig. 6. By using a shutter speed of 1/10 sec. (100 msec.) two complete sweeps are recorded.





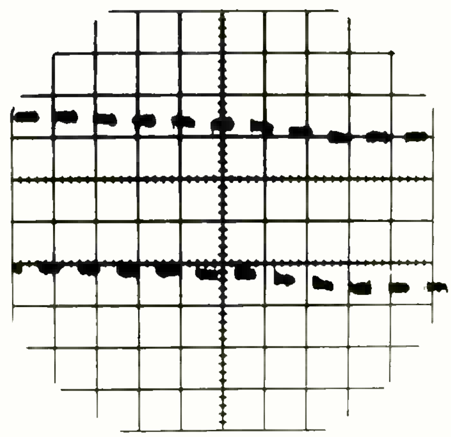
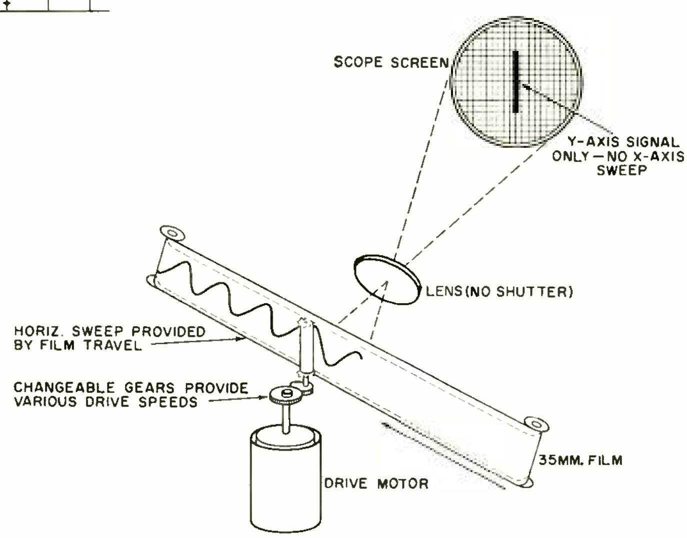


Fig. 7. (Far left). Square wave modulated by 60-cps sine wave produces these unsatisfactory results using a recurrent sweep.

Fig. 8. When a single triggered sweep is used and the camera shutter is set to "bulb," resultant photo is far more satisfactory.

Fig. 9. (Below). With 35-mm. film in a special camera, it is possible to photograph transient signals that occur at random.



Since the sweep system of most laboratory-type oscilloscopes is calibrated in unit time per centimeter it is convenient to first convert 100 cps to a function of unit time. Time (in seconds) = 1/freq. (cps) = 1/100 or .01 second (10 msec.). To display one complete cycle the CRO sweep would have to equal the time of the displayed signal, or in this case 1 msec./cm., which gives a total time of 10 msec. for a 10-cm. scale. Since we wish to display five complete cycles of the 100-cps signal, the CRO sweep time would have to be five times the length of one cycle of the frequency to be displayed, or 5 msec./cm. It is helpful to think of the shutter speeds in the same units of time as the oscilloscope sweep system, 1/100 sec. being 10 msec., 1/50 sec. as 20 msec., etc. It then becomes quite easy to determine how many complete sweep cycles will occur during the time the camera shutter is open for a particular setting of sweep and shutter time.

Fig. 5 shows the result of photographing 5 cycles of a 100-cps signal using a shutter speed of 40 msec. (1/25 sec.). Since we have determined it takes 50 msec. for one complete sweep cycle, we have only succeeded in photographing 4/5 of one sweep, or 4 cycles. A good rule-of-thumb is to choose a shutter speed that will give at least two complete sweeps of the CRO trace. In this example a shutter speed of 100 msec. (1/10 sec.) will capture two complete sweeps as shown in Fig. 6.

The preceding example was used to show the time relationships among a specific frequency, horizontal sweep time, and camera shutter speed. In actual practice, for displaying steady-state signals the sweep frequency is generally adjusted until the desired pattern is obtained on the CRO screen and the time base may be incidental. However, if a picture is desired, a quick glance at the sweep rate will allow one to calculate mentally a shutter speed that will permit photographing two or more sweeps.

Often a signal to be photographed may contain several frequency components which makes it difficult to produce a satisfactory picture at normal shutter speeds. This is illustrated by the example in Fig. 7. The picture shown is a square wave being modulated by a 60-cps sine wave. This caused the trace to jitter badly and produced the results shown. Much better definition can be secured by setting the shutter to "bulb" and manually holding it open while triggering only one sweep of the signal. Note the much finer detail of Fig. 8 when this technique was used. Most laboratory-type oscilloscopes have a gated sweep system necessary to produce this type of photography. By adjusting the gate trigger level, one sweep of the trace can be initiated by means of an internal, manually operated push-button, or by an external trigger voltage.

Photographs of this type require a larger aperture opening, more beam intensity, or perhaps both—depending on the sweep rate used. This is necessary since a triggered sweep, when adjusted properly, only permits one pass of the trace which cuts down the exposure time proportionately. For transient signals requiring extremely fast sweep rates, generally only *Polaroid* types 47 and 410 film will yield satisfactory results.

Several methods can be used to increase the "writing speed" of films. Writing speed is a term used to more accurately describe the photographic efficiency of film used for CRO photography. It is usually designated as the maximum CRT beam sweep rate in cm. per μsec. that will produce a readable trace on the photograph. Pre-fogging the film or decreasing the developing time will substantially increase the writing speed. A combination of the two can increase the maximum writing speed by as much as three times.

Pre-fogging is accomplished by pre-exposing the film to a controlled light source. The amount of illumination and exposure required for optimum pre-fogging of a particular film type can best be determined by experiment. Generally the optimum point is reached when a fully developed print background changes from a normal black to a lighter gray.

An underdeveloped print is one that has been removed from the camera prior to normal development time. This is the simplest method for increasing maximum writing speed. As the developing time is decreased, the normal dark background of a fully developed print will change to progressively lighter shades of gray. Contrast is correspondingly reduced but finer detail will be visible which otherwise would not be apparent.

Some oscilloscopes do not provide sufficient graticule lighting to give good reproduction using a fast shutter speed and one of the slower speed films. If this is the case, a good reproduction of the graticule can be obtained by operating the shutter several times with the beam intensity turned off. This permits adequate exposure of the graticule before the trace is photographed.

The shutter "time" position is valuable for taking photo-

(*Continued on page* 74)

THE SECRET'S IN THE CIRCUIT

BLONDER-TONGUE TV/FM COUPLERS

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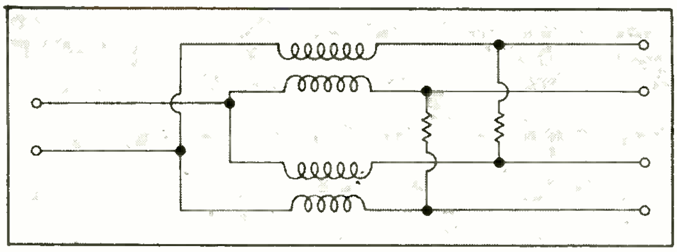

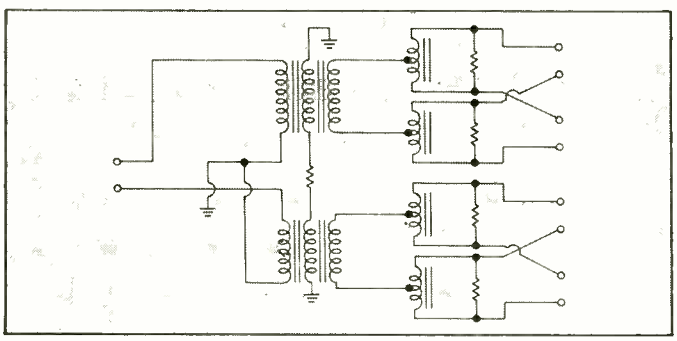

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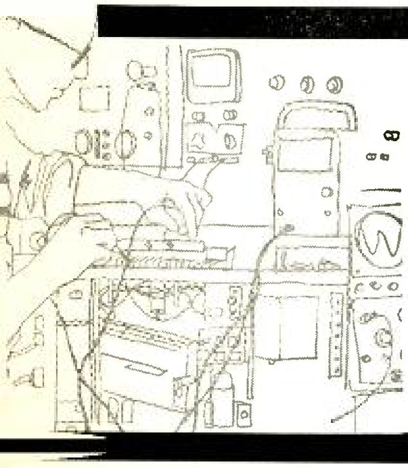

MAC'S ELECTRONICS SERVICE

By JOHN T. FRYE

The Caduceus & the Electron

MAC entered the door of his service shop for the first time in a month. Gall stones impacted in his common bile duct and producing jaundice had made quick surgery imperative, and he had spent twenty-three days in the hospital and several more days recuperating at home. Now he was back on his feet, although moving a little more slowly and carefully than usual.

The welcoming smiles of Matilda, the office girl, and Barney, Mac's right hand, warmed the owner of the shop. "Welcome back, Boss; you look great!" Barney lied, ignoring Mac's pale face and his loss of at least twenty pounds.

"We're certainly glad to have you back," Matilda said as she took off her glasses and dabbed at her eyes with a wisp of a handkerchief.

"I'm glad to be back, too," Mac said with convincing sincerity; "but I'm warning you both: the first one who makes a crack about always knowing I had too much gall is automatically fired. I've had about all of that witty remark I can take. But come on, Barney; let's go back into the service department. These lily-white hands of mine are literally aching to wrap themselves around some tools. I used to lie in bed and think about how good it was going to be to feel the solid heft of a solder gun in my hand again or to be gripping a screwdriver handle while my muscles tensed against the resistance of a stubborn screw. Believe me: work *is* a blessing. If you've any doubts, a few days of enforced idleness in a hospital bed will make a believer of you."

Mac was running his fingers lovingly over the bezel of the oscilloscope as he talked, and Barney noticed his fingers had picked up a smudge of dust. The youth tossed a clean cloth to his employer.

"No, thanks," Mac said with a faint grin. "I told the nurses the first thing I intended to do when I escaped from their clutches was to get good and dirty. They scrub you within an inch of your life, and everything about you is kept antiseptically clean. When washing, you have to remember where you left off so you will know where to start, for you certainly can't tell by looking. It sounds wacky, but a little honest dirt on these mechanic's hands is going to look good to me."

"Well, you had a long vacation from electronics anyway. I noticed you didn't even have a radio or TV set there in the room."

"That's true. I spent my spare time reading thoroughly the trade magazines I usually just skim through looking for something of immediate application to our work; and I was amazed at how much interesting and eventually useful information I had been glossing over. I made a resolution to take time to read these magazines more carefully from now on, especially those forward-looking articles that try to prepare us for problems we'll meet in the future and to keep us abreast of what's going on in adjacent electronic fields."

"I'll bet you missed having someone to talk shop with."

"Oddly enough I had someone. The radiologist at the hospital, a Dr. Beam, is an acquaintance of mine interested in electronics; and when he found out I was a patient, he came down to the room and brought some medical magazines that had articles in them on electronic instruments used in diagnosis and treatment. These really opened my eyes as to the part electronics is playing in medicine these days and the more important part it is undoubtedly going to play in the future."

"You mean like the x-ray, the electrocardiograph, and the electroencephalograph?"

"Not necessarily, although those instruments have certainly blazed the trail. Incidentally, speaking of the electrocardiograph, Dr. Beam was telling me about the remote-indicating electrocardiograph now in use. The patient wears a miniature transmitter that's modulated by signals picked up by the electrodes fastened to his body. The transmitted signal radiates several hundred feet into a receiver feeding the recording mechanism. The patient can run up and down the hall, climb stairs, do gymnastics, or even drive a car without the restricting encumbrance of connecting wires while a continuous record is made of his heart's action.

"A related instrument monitors continuously the pulse, respiration, temperature, and blood pressure of a seriously ill patient; and any one of these factors can be instantly examined at a remote console that will handle sixteen patients at a time. Furthermore, if any one of the conditions being monitored exceeds preset limits, an alarm sounds at the console."

"That should help the trained nurse shortage."

"Right. Some of the other things Dr. Beam and the magazines mentioned were more exotic. One was a pressure-sensitive paint. The resistance of this paint changes as pressure is applied to it. A tiny speck of the paint in the end of a catheter with leads coming from it can measure the variation in pressure inside the heart itself."

"Don't forget the pacemaker that keeps an erratic and feeble heart beating regularly with carefully timed electric pulses."

"I was getting around to that, but it reminds me of another use of electronics in connection with the heart I found particularly fascinating. We both learned in safety classes that one of the greatest dangers in electric shock—even comparatively weak shock—is that the heart will start ventricular fibrillation. When that happens, the heart's timing system goes haywire and the lower chambers of the heart just flutter feebly without pumping any blood. Either the heart is persuaded to pick up its beat quickly or the owner dies.

"In the past a low-voltage shock of a.c. current has been used to start the heart beating again, but sometimes this works and sometimes it doesn't. A few months back Dr. Morris J. Levy of the University of Minnesota and Surgeon C. Walton Lillehei discovered that a high-voltage d.c. 'defibrillator' was much more dependable. In fact, it is so dependable that they deliberately subject heart surgery patients to fibrillation and then start the heart beating again when the operation is over.

"The reason they do this is that it is very difficult to operate on a heart when it is pumping away. After all, there is no need for it to be pumping, for its work is taken over by a heart-lung machine that circulates the blood and chills it. The heart is set into fibrillation with a low-voltage current and is left in that comparatively quiet state during the entire operation, which in one case lasted two and a quarter hours. At the end of the operation, a d.c. shock up to 7000 volts but lasting only a twenty-fifth of a second restores the heart beat. In at least two cases, the d.c. machine started the heart beating again when the electrodes were simply applied to the skin. That makes me think we may soon see one of these machines going right along with the inhalator on emergency calls."

"One thing that bugs me," Barney remarked, "is how quickly electronic developments are put to medical use. I'm think-

ing about that article on lasers that appeared in the December, 1962 issue of ELECTRONICS WORLD. According to it, lasers were only developed about the middle of 1960; yet before the end of 1962 they had already been used to burn tumors from the back of the eye of a human being and to weld detached retinas in rabbits. Probably by now their sharply focussed, intensely hot beams are being used as a sort of electronic scalpel and for cauterization. Someone must really be hustling things from the laboratory to the operating room."

"Dr. Beam and I talked about that. He thinks the medical field presents a wonderful opportunity for the serious, young, top-flight electronics technician. You see the field of medicine and the field of electronics are each too big for a single human being to master both; yet a deep knowledge of both fields is necessary for worthwhile medical electronics development. That's why Dr. Beam says the greatest success is being made by teams composed of a doctor—often a specialist—and an electronics technician or engineer. The doctor outlines what is needed; the technician builds up the hardware to supply the need. Working together, they test the equipment, iron out difficulties, and refine it until it has the necessary safety and reliability."

Mac paused a bit and then went on with a grin: "I must admit I was a flat failure at helping Dr. Beam with the electronic problem he handed me. He and Dr. Klever, who reads the electrocardiographs at the hospital, are good friends and often attend medical meetings together. Dr. Klever is a fine wood worker, and he built up a little portable lectern with a speaker in the front, an amplifier inside, and a microphone on a flexible gooseneck coming out the top. The idea was to place this on the table in front of the doctor speaking so that his remarks would be amplified and easily heard by the others present. See anything wrong with the idea?"

"Feedback," Barney answered.

"Right. The speaker and microphone are simply too close together for appreciable gain to be obtained without howling. Dr. Beam thought there ought to be some way of getting around this because electronic megaphones have their speakers and microphones close together."

"Yeah, but the speaker and microphone used in those jobs are both of special highly directional types, the frequency range is restricted, and the overall gain is comparatively low because you shout directly into the mike. A sensitive mike feeding into a high-gain, full-range amplifier driving a non-directional speaker is a horse of another hue. He had better just use a couple of small portable outboard speakers he can place some distance from the mike."

"That's what I suggested—hey, what are you drawing?"

"Oh I'm just working out the insignia I'll be wearing when I'm a successful medical electronics technician," Barney said jokingly. "This winged staff with the two snakes twined about it is the caduceus, one of the symbols of a physician. As you can see, I'm just sketching in an electron symbol whirling around the wings and the snake heads. Pretty sharp, huh?"

"Not bad, and in all seriousness you could do a lot worse than think about a career in that field. It has rewards greater than money. In this shop we get a lot of satisfaction out of knowing that we are helping to keep people entertained and well informed; but to know that through your work people were being kept alive and healthy—well that would provide real satisfaction. ▲

INTERFERENCE MYSTERY

By ROY JESSE

AN EXPERIENCE with the author's own TV set parallels a common service embarrassment. Shortly after a repair, the family complained, "You didn't fix this thing!" Sure enough, there were occasional bending, light flashes, and what seemed like sound bars. Such symptoms are induced by poor contact somewhere in the antenna system, but only one of three stations received, channel 4, was affected. Since the source seemed to be at a specific frequency, suspicion fell on two local hams.

Possible transmission troubles were ruled out by a call to the station engineer. Several tricks were tried in vain to recognize the voice or otherwise identify the source. I asked my wife to report at what times during the day interference occurred and dropped the matter.

There were no effects in the daytime, but the symptoms returned that night—when the amateurs were active. Evidence was too circumstantial for a direct complaint, but this seemed like the right track. A week later, however, the interference showed up during the daytime. A check with neighbors showed the problem wasn't widespread. This turned me back to my own installation.

On an evening when there were no symptoms, shaking the transmission line to my conical antenna induced them. No defects could be found in the wire. I shook the antenna itself. Interference was pronounced. I then noted that one of the reflector bars had moved somewhat out of position, through the hole in its support bracket. The set screw holding it had come loose, permitting the element to vibrate—when the wind was strong enough, day or night.

After the bar was repositioned and the screw tightened, the problem vanished. I won't try to explain why the mechanical fault affected one channel only. There are more important lessons from this incident. When we are stumped, we look for a scapegoat, and the maligned amateur is still the most convenient victim. Also, as long as there will be baffling defects that do not fall into customary categories, we must keep an open mind instead of jumping to hasty conclusions. ▲

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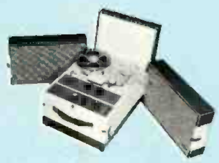

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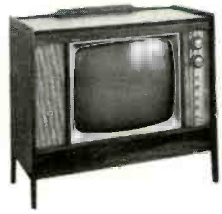

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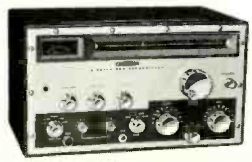

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Bionic Computers
(Continued from page 28)

In 1960 the Air Force called a conference, coined the term "bionics" to describe what the meeting would be about. (The word doesn't come from a combination of biology and electronics as has been frequently reported, but from the Greek word "*bion*," which means "unit of life.") To everyone's surprise, more than 700 scientists showed up, presented dozens of papers reporting on work they had done.

Bionic Pilots

Intensive investigation has been underway in scores of company and university laboratories ever since. The Air Force is particularly interested in the field, hopes eventually to have such advanced devices as bionic pilots. "Airplanes," said one officer, "are getting too fast and too complicated for men to handle. If two 1500-mph jets come out of clouds 10 miles apart on collision course, they'll smash into each other before the pilots have a chance to react and change course."

The effectiveness of a future bionic pilot was demonstrated in an experiment performed by *Melpar* under an Air Force contract. During major overhauls, the ailerons of an airplane are sometimes wired up backwards. When the pilot takes off and a wing dips, he automatically tries to correct it. But with the mis-wired aileron, his action makes the dip worse instead of correcting it. "I've never known a pilot to fly out of such a situation alive," said one observer.

Melpar simulated the same situation on a computer, found that a bionic brain would react so fast that it would realize what was wrong and retrain itself to apply the proper kind of corrective action before a dangerous situation could develop.

Bionic brains, if they live up to promise, seem perfectly suited for thousands of jobs where the ability to assimilate volumes of information, sift out the relevant, and make logical decisions, is important. Weather forecasting, language translation, predicting business trends: all are possible examples.

No Unanimity

As is usually the case in areas of new discovery, opinions of leaders in the field are sharply divided as to the possible future benefits to be gained from bionic computing devices. L. D. Harmon of *Bell Labs*, who has done much of the trailblazing work in artificial neurons, feels that in general predictions tend to take too rosy a view. Living brain systems, says Harmon, are so complex that we may never be able to understand them completely—let alone build machines to imitate them. What is needed now is a more basic knowledge of such dimly understood attributes as thought, intelligence, and reasoning ability.

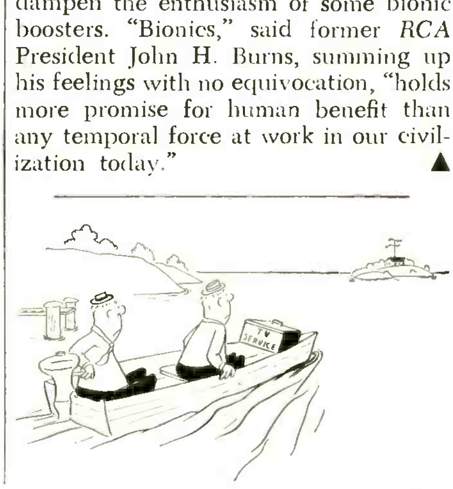
Dr. Arthur Samuel of *IBM* tends to agree that although some progress may come out of bionic research, probably the best way to advance toward machine intelligence is to delve more deeply into the basic mechanism of thought. "To call to mind a rather trite analogy," he says, "when man first attempted to fly, he studied the birds, and the early, unsuccessful flying machines were mechanical birds. It was not until man stopped studying birds and began to study aerodynamics that much progress was made. The modern jet airplane," he continues, "must cope with the same aerodynamical problems with which birds contend, but the mechanisms used in the solution of the problem of flight are quite different."

Dr. Samuel believes that if and when man really understands what thought is, he'll probably be able to build machines or even program conventional computers to think. Further, the process may imitate the precise functions of the brain about as accurately as a *Boeing* 707 imitates a seagull. Fastest progress, he feels, will probably come from research aimed at basic understanding of thought processes and intelligence, rather than from attempts to imitate the brain.

At the same time, Samuel and many others who take the same general view, believe that no promising approach to the problem should be neglected, and that the field of bionics, particularly in view of its early accomplishments, is a worthwhile line of investigation.

Others are more enthusiastic. Gordon Pask, for example, of *System Research, Ltd.* of Richmond, England, envisions future bionic brains in almost human terms. "A biological computer would be capable of elaborating concepts we could understand. We might argue with it and lead it to modify its attitude. I intend these remarks," he added for skeptics, "quite literally."

Even the fact that little actual bionic computing hardware now exists doesn't dampen the enthusiasm of some bionic boosters. "Bionics," said former *RCA* President John H. Burns, summing up his feelings with no equivocation, "holds more promise for human benefit than any temporal force at work in our civilization today." ▲



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Transistorized Amplifier

(Continued from page 47)

can be made to the collector of *Q7* by fastening a solder lug to one of its mounting screws with a second nut.

The use of a printed circuit simplifies construction considerably. The bases of *Q1* to *Q4* are internally connected to their cases hence the cases of these transistors must not be allowed to make any electrical contact. The ground connections are laid out to eliminate ground loops and should not be changed without keeping this in mind.

For the utmost in power output, adjust the value of *R2* for symmetrical clipping with the load impedance you will be using.

Using the Amplifier

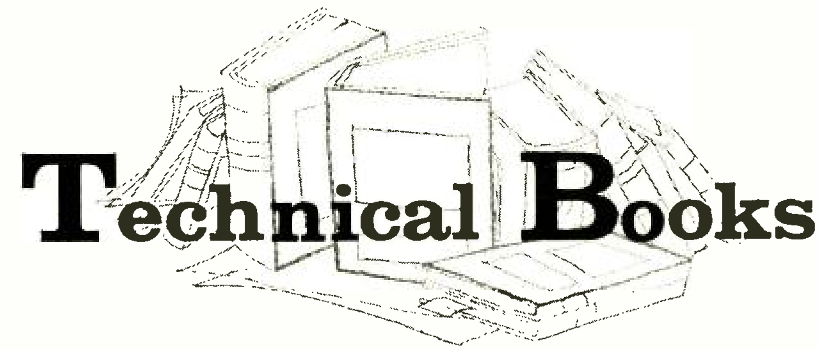
As with any electronic equipment, there are a few operating precautions which should be observed. This amplifier is not intended for steady, near-maximum output. Under such conditions it can overheat. The amplifier should not be operated in ambient temperatures much higher than room temperature. On the other hand, one need never worry about its being turned too loud when listening to program material and when operating the amplifier near normal temperatures.

As mentioned before, the output impedance is very low. Therefore, never short the output terminals because this will draw excessive current which will, in all probability, damage some of the transistors. The minimum permissible load value is approximately 3.2 ohms which is the lowest commonly encountered speaker impedance. The higher the load impedance, the easier it is on the amplifier. However, 8 ohms is about the best load value because at 16 ohms the power begins to drop off. In contrast to some transformer-output amplifiers, leaving the output open will not harm the amplifier. The performance of the amplifier insofar as power response and harmonic distortion are concerned is illustrated in Fig. 2.

This amplifier will not tolerate capacitive loads. More than .01 μf. will cause oscillation which, if continued, will cause transistor damage. More than .1 μf. will be likely to damage some transistors instantly.

The amplifier should lend itself to portable battery operation but 24 volts d.c. is the maximum permissible operating voltage. Operation at as low as 6 volts is possible, but with a corresponding drop in maximum power output.

Sensitivity is good—.4 volt is sufficient to drive the amplifier to full output. Input impedance is moderately high—above 15,000 ohms. This is adequate for most signal sources. ▲



Technical Books

"THE LP/STEREO RECORD GUIDE & TAPE REVIEW" by Warren DeMotte. Published by *Argyle Publishing Corp.*, New York. 318 pages. Price 95 cents. Soft cover.

This is a revised and up-dated edition of this author's earlier "Long Playing Record Guide" and reflects not only the swing to stereo but the advent of a great many excellent pre-recorded tapes. The material is compiled alphabetically by composers with the various recordings of each work listed and analyzed. The author has indicated his preferences (mono, stereo, and over-all) based on the performance, technical excellence of the recording itself, and sound qualities. Poor recordings, off-beat and local record labels, etc. are not covered so the analysis is among the better recordings of each selection. This guide is intended to supplement standard disc and tape recording catalogues, not replace them.

* * *

"SERVICING HORIZONTAL SWEEP CIRCUITS" by Wayne Lemons. Published by *Howard W. Sams & Co., Inc.*, Indianapolis. 109 pages. Price $2.50. Soft cover.

Since many technicians agree that the horizontal oscillator-sweep circuits are the most troublesome ones in a TV receiver, a book devoted exclusively to such sections is perhaps justified. The author covers typical circuit designs, specific trouble symptoms, and servicing procedures based on actual case histories. Circuit measurements, tests, and adjustments are covered in detail.

* * *

"ELEMENTARY INDUSTRIAL ELECTRONICS" by Leonard C. Lane. Published by *John F. Rider Publisher, Inc.*, New York. Two volumes. Price $7.80 per set. Soft cover.

This is an elementary treatment of the subject of industrial electronics prepared for the enlightenment of service technicians and trade school students. The author has assumed that the reader is familiar with electricity and electronics so these volumes take off from that point.

The books cover relays, symbols, switches, counters, thyratrons, motors, power supplies, motor controls, magnetic amplifiers, timing, transducers, instrumentation control systems, induction heating, dielectric heating, digital instruments, computer arithmetic, and electronic switching.

* * *

"MODERN COMMUNICATIONS" by Crowley, Harris, Miller, Pierce & Runyon. Published by *Columbia Universtiy Press*, New York. 333 pages. Price $9.75.

This is a joint contribution by five *Bell Laboratories'* engineers who describe the principles of communication for the benefit of laymen in non-technical terms. Since their background is in the telephone field, most of the examples in this book are based on telephony but since *Bell* has pioneered many of the innovations in the communications field, the material is highly pertinent.

The text consists of fifteen chapters covering such subjects as speech communication, modulation theory, pulse modulation multiplex, transmission media, amplification and signal generation, transmission systems, trunking and switching central office control, communication theory, the noise channel, and continuous signals and channels.

* * *

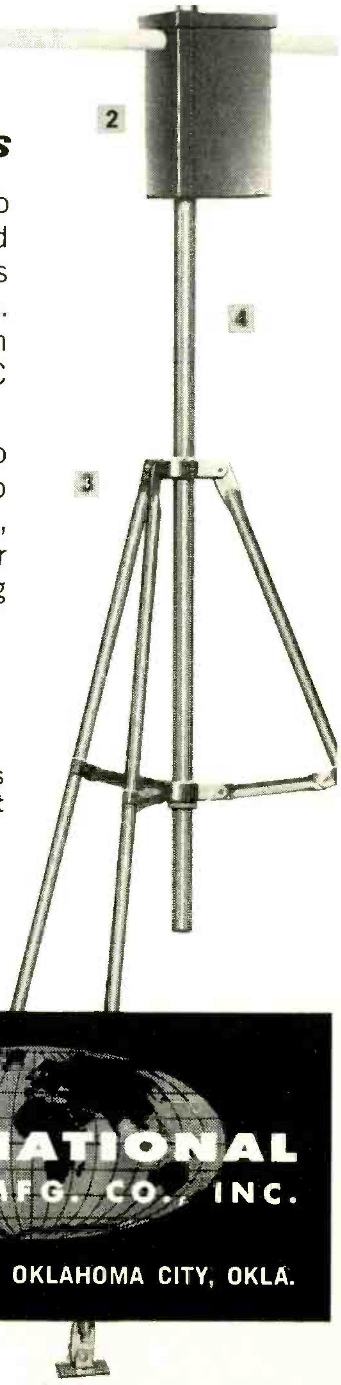
TUBE & TRANSISTOR MANUALS

The following new tube and transistor manuals have been received in this office: **"RCA TRANSISTOR MANUAL"** published by *RCA Commercial Engineering*. 304 pages, $1.50 soft cover; **"RCA TRANSMITTING TUBES"** published by *Electron Tube Division, RCA*. 320 pages, $1.00 soft cover; **"TELEVISION TUBE LOCATION GUIDE"** published by *Howard W. Sams & Co., Inc.* Unpaged, $1.25 soft cover; **"TUBE SUBSTITUTION HANDBOOK"** (Vol. 5) published by *Howard W. Sams & Co., Inc.*, 127 pages, $1.50 soft cover: **"RECORD OF SEMICONDUCTOR OUTLINES"** published by *Electronic Valve and Semiconductor Manufacturers' Association* (England) 56 pages, 8 s./6 d. (post-paid) from Association. Mappin House. 156-162 Oxford Street, London, W1, England; **"TUBE AND TRANSISTOR HANDBOOK"** published by *De Muiderkring N.V.*, Netherlands. Available from *N. Yeager Associates*, 680 Liege West, Montreal, Quebec, Canada. Price in North America $3.95; **"UNDERSTANDING TRANSISTORS—AND HOW TO USE THEM"** published by *Allied Radio Corp.* 96 pages, 50 cents soft cover. ▲

NEW!

INTERNATIONAL EXECUTIVE TRANSCEIVER

Model *1500*



Designed for the Hobbyist . . . Complies with FCC Part 15 (no license) requirements

Here is International's new Model 1500 Executive transceiver for radio communication within the 27 mc frequency range. Designed and engineered for phone and cw (code), you can talk from 1 to 10 miles with other Part 15 stations depending on the height of the antenna. You are also permitted to work skip signals 1,000 miles or more with other Part 15 stations when a band opening occurs. And . . . no FCC license is required.

This feature packed transceiver puts the maximum RF power into the antenna by combining the transmitter and antenna for rooftop mounting. A second unit houses a supersensitive receiver and exciter, while a preamplifier at the antenna boosts weak signals for better reception. Other features include a special crystal filter for reducing interference from adjacent channel Class D two-way radios.

- **100 milliwatts input / 60" antenna**
- **115 vac operation**
- **Phone and CW**
- **Eight channels . . . crystal controlled**
- **27 mc frequency range**

A complete, "ready to go", package. 1 receiver/exciter complete with 8 sets of crystals, 2 transmitter/antenna assembly, 3 antenna mount, 4 5 foot mast, 5 100 feet of control cable, 6 microphone, 7 key for (CW)

Model 1500 transceiver complete $299.50*

See the Model 1500 transceiver at your International dealer.
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Write today for International's 1963 catalog.

CIRCLE NO. 122 ON READER SERVICE PAGE

REPORT on NEW V. F. O.

Circuit description and performance of the Eico Model 722 amateur variable-frequency oscillator.

For copy of manufacturer's brochure, circle No. 60 on coupon (page 21).

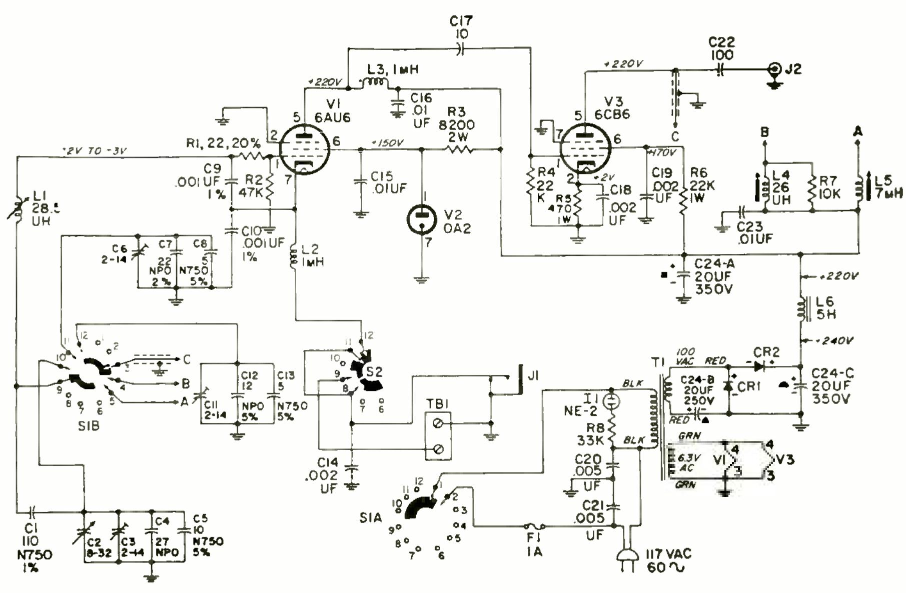
IN ORDER for the ham to get anywhere in today's crowded amateur bands, he needs either a large handful of crystals or else a v.f.o. The *Eico* Model 722 v.f.o., which we have just constructed and tested, will permit the ham to squeeze into a clear spot on any of the five bands from 80 to 10 meters. The 5-inch-long, clearly marked dial makes it very easy to put the rig at any frequency chosen. One big problem with v.f.o.'s is to get as close as possible to the crystal-controlled rig in stability. By using excellent mechanical and electrical design, this v.f.o. achieves this kind of stability. At the same time, the unit has a high enough output so that it can easily drive just about any modern transmitter.

The oscillator is a series-tuned Clapp e.c.o. using a large slug-tuned coil and temperature-compensating capacitors to prevent drift. A high *LC* ratio for the tank keeps circulating current low and minimizes heating and losses. The main tuning capacitor uses double bearings for good mechanical stability to prevent frequency shift. Also, a voltage-regulated oscillator screen supply keeps this important voltage constant in spite of line-voltage changes. Finally, extra shielding around the oscillator circuits prevents hand capacity, outside mechanical movements, and heat from affecting the operating frequency. The oscillator operates on 80 meters at all positions of the bandswitch.

Output from the oscillator is then fed to a buffer-multiplier. This stage serves to isolate the oscillator from the transmitter being driven. When the v.f.o. is set for 80 meters, the buffer is a straight-through amplifier. On all other bands the buffer is tuned to the second harmonic of the oscillator and calibrated output is available on 40 meters and, by use of harmonics, on 20, 15, and 10 meters. The power supply is a voltage-doubler using a pair of silicon diodes into a *pi*-type *LC* filter.

The actual construction of the kit took us just under 8 hours, thanks to the clear, well-illustrated construction manual. We then calibrated the v.f.o. very carefully against a good communications receiver with a built-in crystal calibrator. A little extra time spent here will pay off later in dial calibration accuracy, so we went back and forth over the various adjustments until they were just as close as possible.

We then measured output voltage on 80 meters, with the v.f.o. loaded only by a high-impedance scope probe (15 meg.). Output was 24 volts r.m.s., but this signal dropped to 7 volts with a 1-meg. load. Since most transmitters can be driven with only a couple of volts, this output is more than adequate. Next, we checked the dial calibration accuracy on all bands, taking readings every



NOTES

1. All resistors are in ohms, 1/2W, 10%, unless otherwise specified.
2. All capacitors are in uuf, 10%, unless otherwise specified.
3. M = Megohms (1,000,000), K = Kilohms (1,000)
4. "BAND" switch S1 shown in "OFF" Extreme counter-clockwise position.
5. "MODE" switch S2 shown in "SPOT" position.

100 kc. and checking them against our crystal calibrator. On 80 meters, there was absolutely no error in dial reading at any point—at least all readings were as close to the crystal readings as could be read by the pointer. On 40, 20, 15, and the low portion of the 10-meter band, the maximum error in reading was only +0.10%, and this occurred at the very top end of the bands. Had these bands been calibrated at their center instead of at the low end, then all our readings would have been within ±0.05%. On the high portion of the 10-meter band (covered separately), the maximum dial error was only +0.03%. This small amount of error, by the way, is about one pointer thickness. While taking these measurements, we noted the clean, hum-free carrier that was produced by the Model 722 v.f.o.

Next, we checked the amount of frequency drift with changes in line voltage to see just how voltage-stable the unit is. We set the v.f.o. to 80 meters and measured the frequency at a line voltage of 117 volts. At 105 volts, the v.f.o. drifted higher in frequency by only about 20 cps. At 125 volts, we found a downward shift in frequency by only about 20 cps. This frequency shift amounts to only ±0.0005%—which is certainly good voltage stability.

In summary, the Model 722 v.f.o. is a well-designed piece of equipment that is a useful addition to the ham shack. It is available for $44.95 in kit form. It is also available for $55.95, factory-wired. ▲

SOME USES FOR DEFECTIVE TUBES

By THOMAS R. HASKETT

NORMALLY the best thing to do with a defective tube is to break the glass envelope and throw it away. That avoids the possibility of inadvertently getting it mixed up with good tubes and also prevents a tube racketeer from picking it up and reselling it. But there are exceptions to every rule.

If you do any sort of electronic construction, whether from kits or starting from scratch, it is handy to keep an assortment of burned-out tubes on hand. Whenever you mount a tube socket on a new chassis, insert a dummy that will fit. Then when you drill, file, or otherwise work on the chassis, no scrapings or filings can find their way into the base-pin receptacles, where they can cause trouble later.

If the dummy is the same size and shape as the tube that belongs in the socket, it can guide you in the physical layout of nearby components (in terms of heat dissipation, shielding, unwanted stray coupling, etc.). And be sure to leave the dummy in place while wiring the equipment. You should be careful anyway, when wiring to tube sockets, to prevent solder from flowing down into pin receptacles. But the dummy is extra insurance against such clogging.

A dummy is also helpful in FM or TV sweep alignment. The good mixer tube is removed and replaced with a dummy of the same type, except that the heater pins have been clipped off (if the equipment has parallel filament wiring) or it is disabled in some other way. This retains normal tube capacitance in the circuit (don't use a shorted tube) while killing local-oscillator action.

By the way, it is a good idea to paint an "X" on the envelopes of dummies you save, so that they will not be mistaken for good tubes. ▲

BINARY NUMBERS & BOOLEAN ALGEBRA

By WALTER S. ANDARIESE

An introductory look into two important areas of mathematics utilized in digital computers.

MODERN digital computers are playing a major role in the ever increasing takeover by automation. Personnel in other fields of electronics aspiring to become computer technicians or engineers must stand ready to acquire some background in a very unfamiliar type of mathematics.

Although unfamiliar, this mathematics is logical and readily understandable. However, it will be found to somewhat oppose and contradict the following two areas in our conventional mathematics: the decimal number system and conventional algebra. Instead, the *binary number system* and *Boolean algebra* almost completely dominate modern computer technology. Why this is so will be subsequently explained. But before going on, something must be said for the conventional type of algebra that is universally taught.

Although it is cast aside in computer mathematics, regular algebra must not be considered an inferior type. In reality, there are hundreds of different algebras, each superior for a particular application. While conventional algebra is a universal type of algebra, it can't be effectively utilized in all possible mathematical situations. In computer mathematics, Boolean algebra is the optimum algebra to be used. As an analogy, it's just a case of using a ¼" wrench to tighten a ¼" bolthead instead of a pair of pliers.

An identical argument can be made for the choice of the binary number system.

Boolean Algebra

How are Boolean algebra concepts employed in the digital computer? Its use is twofold. First, it permits the engineer to design a logical and relatively simple computer. Second, it enables another person to understand and follow the logical operation of the computer. It's no more than that. Once the commercial digital computer is out in the field earning its keep, its operators and programmers are little concerned with Boolean algebra.

Actually, the Boolean type of algebra is employed over other types of algebra in the design of the computer because it readily fits in with binary counting techniques. This other important area in computer mathematics must now be briefly discussed.

Binary Numbers

In our *decimal* method of counting, we are familiar with and use ten digits (0, 1, 2, 3, 4, 5, 6, 7, 8, 9). When counting beyond the number 9, we simply place a one in front of a zero and continue on with 10, 11, 12, 13, . . . and so on to 19. Here, a two in front of a zero (twenty) will keep us going with 20, 21, 22, 23, . . . and so forth (using the same pattern) to 99 or 199 or for as high as we want to go.

In the *binary* method of counting, only two digits, 0 and 1, are ever used. For counting, the pattern remains the same as in the decimal system. The counting sequence is 0, 1, 10, 11, 100, 101, 110, 111, 1000, 1001, 1010, . . . and so on for as high as we wish to go. While very, very awkward, it is not impossible to use this system in everyday life. We are just used to our present decimal system. There is nothing extra special about the decimal type. We probably started using it far back in history for the simple reason that man has ten fingers on his hands. It must be admitted, however, that the more digits there are in a number system, the more convenient it becomes for human computation. Had we adopted the binary system in our society, we would say that a horse has 100 legs (the horse wouldn't look any different because of it), we have 101 fingers on a hand, and there are 1100 items in a dozen.

Why, then, is the binary system used in computer circuitry? A little concentration will reveal that ordinary electrical current may be considered as a binary (two-state) phenomenon. Current flows or it doesn't flow—two possible distinct condi-

CONVENTIONAL ALGEBRA	BOOLEAN ALGEBRA
A. $x+x=2x$	A. $x+x=x$
B. $x+0=x$	B. $x+0=x$
C. $x \cdot x=x^2$	C. $x \cdot x=x$
D. $x \cdot 0=0$	D. $x \cdot 0=0$

Table 1. A number of theorems or rules employed in conventional algebra compared to those used in Boolean algebra. Note that theorems B and D agree for both algebras but disagree for A and C. In Boolean algebra "+" stands for "or" and the dot symbol represents the "and" condition.

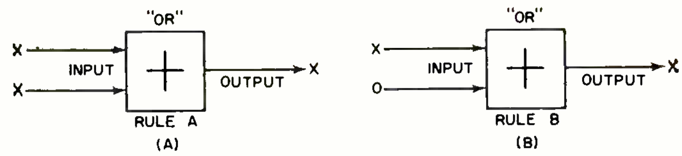


Fig. 1. Function of the "or" circuit is illustrated.

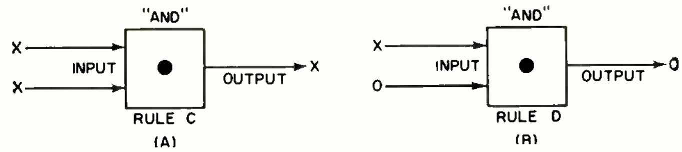


Fig. 2. Function of the "and" circuit is illustrated.

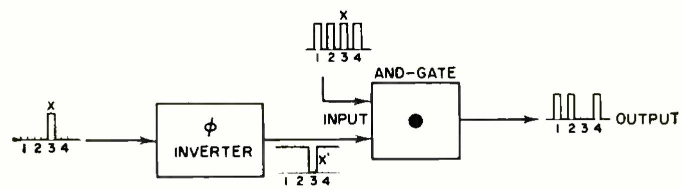


Fig. 3. In this example, a single pulse must be removed.

tions. Why not then use the binary number system in computer circuit designs as it can be made to work hand-in-hand with on or off electric current, thus enslaving the current to perform a multitude of simple and accurate arithmetic computations.

Again, for the average man, using the binary system in his daily living would be awkward and tedious. As for the digital computer, its unbelievable speed and ease of operation would obscure this awkwardness and tediousness of binary counting. In fact, a high degree of dependability and operation efficiency are realized if comparison is made with the results of using other number systems. This is the reason why the binary system is used.

The first digital computers were mechanical and naturally slow operating. They were designed on the decimal system. The first electronic digital computers that followed were based on the decimal system. Their bulkiness, inefficiency, and unreliability gave way finally, *via* trial in other number systems, to the superior binary type with its simple "on-off" operating property.

Returning to Boolean algebra, this algebra, itself, is binary in nature. Hence, it has been employed with the binary system of operation.

Boolean Theorems

There are numerous theorems or rules associated with Boolean algebra (as there are with other algebras). A few will be examined here. (See Table 1.)

Notice that the algebraic theorems *B* and *D* agree for both algebras but disagree for *A* and *C*. One big difference is in the meaning of the "+" sign. In Boolean algebra it does not stand for addition in the sense that it does for regular algebra. It represents the condition "or." Thus, theorem *A* in Boolean reads "*x or x* is *x*."

Likewise, the dot symbol does not stand for typical multiplication. In Boolean, it represents the condition "and." Thus, $x \cdot x = x$ is read "*x and x* is *x*." Bear in mind, the "and" denotes that *both x's* are required to obtain a value of *x*. It does not denote addition.

It should now be evident that the identical symbolism of the two algebras does not completely possess the same meaning. Each tells a different story. Each tells a true story. Each is completely mathematical in its own way.

Taking another approach, these four Boolean theorems may be investigated electronically with the aid of block diagrams. Within each block, diodes, voltage dividers, and proper source voltages are easily made to deliver the desired results.

Two equal signal voltages (usually pulses of any convenient fixed magnitude), each called *x*, are applied to the two separate inputs of the "or" circuit block in Fig. 1A. The output will be found to be *x*. If signal *x* is removed from either input (not both), the output will also be signal *x*. (See Fig. 1B). Hence, either input (not necessarily both) requires a signal to produce an output. No signal at either input will result in an output of zero.

Rearranging the circuitry for an "and" circuit, a signal *x* must be present at *both* inputs for an output of *x* (see Fig. 2A). As shown in Fig. 2B the output will be zero if either input (or both) lacks a signal voltage.

Notice that any single input to either circuit will either produce a signal output or it will not (zero signal). This is a true binary condition.

Perhaps the formal names for the "or" and "and" circuits best describe their general computer function. The terms "or-gate" and "and-gate" indicate that they are a sort of "connecting" circuit designed to accept and pass on binary information, only under the special Boolean conditions as described before.

One other Boolean concept in computer electronics must be mentioned. The relation $x' = 0$ holds much meaning. x' (called "*x* not") is another way of stating the "opposite of *x*." As there can only be two possible conditions (*x* or 0), this binary relationship is obvious (conversely, $0' = x$). Since $x \cdot 0 = 0$ it follows that $x \cdot x' = 0$.

Actual circuit operation clearly displays this relationship and its possible practical utilization. See Fig. 3.

Typical Example

Suppose it is required that a specific pulse be removed from a train of voltage pulses being supplied by a pulse generator. If a single pulse can be produced elsewhere at the exact time the undesired pulse is being generated, a conventional phase inverter (with its 180° phase shift) and an "and-gate" circuit can be made to perform the desired elimination.

Let the pulse (in the train) being removed be called *x*. The pulse train is fed directly to one input of the "and-gate." The single pulse (also called *x*) is fed to the phase inverter and because of inversion, leaves the inverter as x'. This x' is then fed to the other input of the "and-gate."

When x' is not present, the output of the phase inverter (an output of the "and-gate") is held at a d.c. level comparable to the *x* signal amplitude. When each pulse of the train appears at the other input, the "and-gate" effectively has an *x* signal at each input and passes the entire pulse train through unaffected (since all other pulses have the same amplitude as pulse *x*).

When x' does appear at the input to the "and-gate," pulse *x* of the pulse train at the other input is refused passage through the gate and is effectively removed from the train. Thus, $x \cdot x = x$ represents the mathematical operation of the "and-gate" when no pulses are being eliminated and $x \cdot x' = 0$ is the mathematical representation of the "and-gate" removing a pulse.

Finally, it is interesting to note that George Boole of England invented his algebra in the middle 1800's. It was his idea to investigate the process of human thought by pure mathematical reasoning. His work immediately triggered important research by mathematicians in other fields, resulting in a lot of new mathematical discoveries. It was not until the years just prior to World War II, however, that science brought Boolean algebra to bear on electronic digital computer operation. Truly, mathematics never goes out of style. ▲

Oscilloscope Photography

(Continued from page 56)

graphs which require the shutter to be open for extended periods of time. In this position the cable release is actuated once to open the shutter, and again when it is desired to close the shutter. It is possible to photograph traces lasting for several minutes in this manner if one of the slower speed films is used. A small aperture opening, low beam-intensity setting, and a low level of graticule illumination is required to prevent over-exposure of the film. It is not unusual for the beam intensity to be set to a value that is barely visible to the eye through the camera viewer for an extended time exposure of this type. Most conventional oscilloscopes do not have a sweep system that will permit a single sweep lasting several minutes, so an external sweep voltage must be used.

Cameras Using 35-mm. Film

Certain applications require photographing transient signals that occur at random or unpredictable intervals. This is very difficult to do with a conventional CRO camera since there is no way of knowing exactly when the event will occur. A high-speed camera employing 35-mm. strip film is very useful in such cases. Such cameras are not movie cameras as they contain no shutter or frame-pulling mechanism. The film, instead, is drawn past the lens at a constant rate of speed which can be changed to suit requirements. A drawing of such an arrangement is shown in Fig. 9. The film speed is changed by selecting the appropriate gear ratio and may vary from a few inches-per-second up to several hundred inches-per-second.

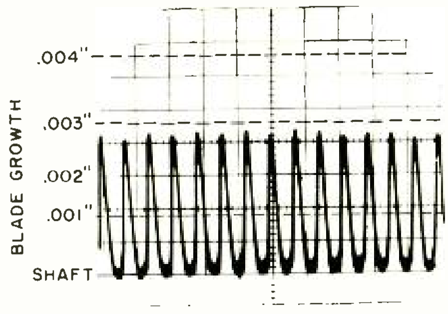
The CRO sweep system is turned off when using this type of camera and only the vertical or Y axis is displayed. The constant speed of the film along the X axis substitutes for the usual internal sweep system. Finer definition or "spreading out" the trace is accomplished by increasing the rate at which the film passes the lens.

Once exposed, 35-mm. film must be developed and processed in the usual manner. It is very helpful to have a 35-mm. editor for this type of work since a great deal of film may have to be viewed before the point of interest is found.

Typical Examples of Use

This section will illustrate the use of a CRO camera to solve specific measurement problems typical of those found in industrial instrumentation.

Fig. 10 is a *Polaroid* reproduction showing changes in the blades on a turbine wheel. The photo was taken while the unit was running at maximum speed. The height of the spikes indicates the



SWEEP RATE 0.2 MSEC./CM.

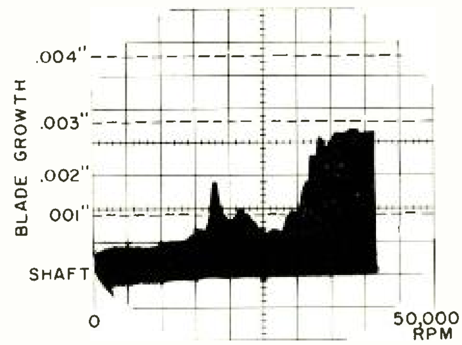
Fig. 10. Turbine blade growth is shown by the height of the pulses in this photograph.

amount of blade growth caused by centrifugal force, temperature, and shaft run-out. Fig. 11 shows the equipment and circuitry necessary for a measurement of this type. The capacity meter is a device used to detect small changes in length of a metallic object by measuring the capacity between the object and a fixed probe. Note that in this example we are measuring minute changes in thousandths of an inch. The special scale for the Y axis, calibrated in thousandths of an inch, is necessary since the output voltage for this type of device is not linear and the CRO centimeter scale cannot be used. (Note: The scope's internal sweep was used to obtain the waveform in Fig. 10. Then, the external d.c. sweep arrangement shown in Fig. 11 was used to obtain the waveform in Fig. 12.)

The CRO sweep rate was chosen in this example for convenience in observing the waveshape and frequency of the signal. A .2 msec./cm. sweep rate was used which required 2 msec. for one complete sweep. A camera shutter setting of 1/100 second (10 msec.) yielded five complete sweeps of the signal for a uniform exposure. Aperture setting was $f/5.6$ and the beam intensity was medium-bright. (All sample photographs were taken with *Polaroid* type 46-L film in order to facilitate reproduction.)

Fig. 12 is a time exposure of the capacity-probe signal which was made with an external X-axis input signal in place of the normal saw-tooth sweep voltage, as in Fig. 11. A d.c. output voltage from the electronic tachometer that is analogous to turbine shaft speed is used to drive the beam across the X axis, providing a scale calibrated directly in rpm. The capacity meter signal is connected to the Y axis in the normal manner.

The shutter for this photograph was set at the "time" position and opened as soon as the turbine was started. About two minutes' exposure time was required for this particular test. An extended time exposure of this type generally requires the aperture to be stopped down to $f/16$ with an extremely faint beam intensity setting. Graticule lighting must also be cut down to a very low level. When



X-AXIS CALIB. 5000 RPM/CM.

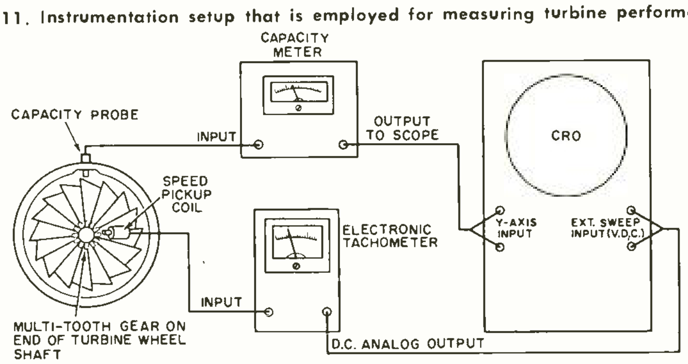
Fig. 12. Time exposure of capacity-probe signal made with external X-axis signal.

using type 47 or 410 film, special precautions must be taken to prevent external light leakage from occurring within the camera.

Using this technique a complete record of the performance is provided in one photograph at any point on the speed range. Of course it is not possible to discern any frequency information from a photograph of this type since the signal is greatly compressed along the X axis. It must be spread out by using the normal internal sweep system if this is the object.

Fig. 13 is a simplified drawing of an instrumented system used for testing the impact strength of materials by subjecting them to a sudden blow from a dropped weight. The sample is instrumented with four strain gages connected in a conventional bridge circuit. The flexing produced in the sample caused by the impact from the hammer changes the resistance of the strain gages and unbalances the bridge circuit in di-

Fig. 11. Instrumentation setup that is employed for measuring turbine performance.



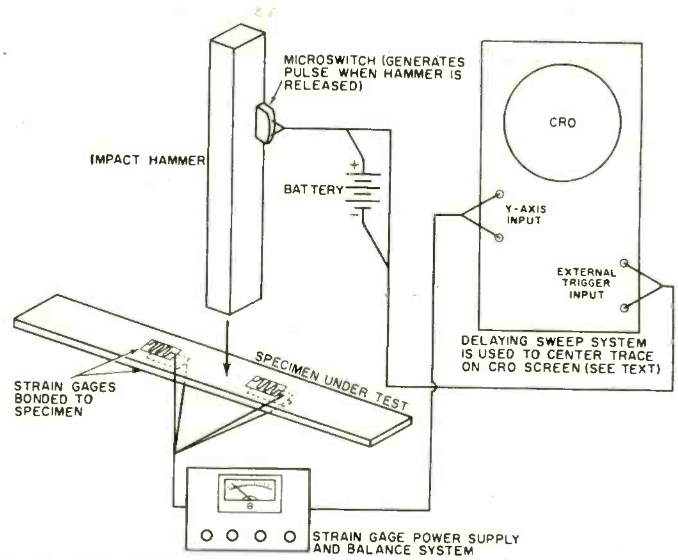


Fig. 13. Instrumented system employed for the testing of impact strength.

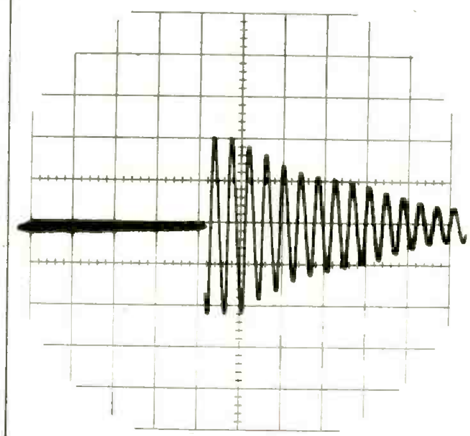


Fig. 14. Acceleration experienced by the specimen as a result of the hammer impact.

rect proportion to the amount of flexing of the specimen.

An oscilloscope having a delayed sweep system is very convenient for this type of testing. Note the triggering circuit consisting of the *Microswitch* and battery which is connected to the external trigger input on the oscilloscope. This is designed to provide a time delay from the instant the weight is released and the trigger pulse is generated until the hammer strikes the specimen. This provides a pulse to start the sweep across before the impact occurs. However, in order for the strain signal to occur at approximately the center of the CRT screen, the sweep rate used would have to be twice the length of the time delay provided. This is very rarely the case since transient signals of this type generally require a rapid sweep rate. An oscilloscope with a delayed sweep allows us to delay the start of the sweep to a point suitable for displaying the signal in any position we wish on the CRT screen. The delayed sweep dial is usually calibrated in unit-time and can be set quite accurately for any sweep rate when the hammer drop time is known.

An example of a photograph that may be produced by such an impact test is shown in Fig. 14. Since the shutter is only required to be open a short time, the "bulb" position can be used. With type 46-L film one of the larger apertures would be required in conjunction with a bright beam intensity setting. The procedure calls for opening the shutter before the hammer is released and closing the shutter just after it strikes the specimen.

An article of this type can only cover some of the more important aspects of oscilloscope photography. If the reader is interested in more information, the various CRO camera and film manufacturers will supply further details about their products. ▲

MORE FAMOUS NAMES

By JOE TERRA

A GREAT many principles, components, and phenomena are referred to by the names of the men who developed them. Can you match the group of names in the first and second columns with the respective instruments, components, or principles listed in the third and fourth columns? Try it and then check your answers on page 101.

1. Allen	10. Heising	A. Storage cell	J. Layer
2. Appleton	11. Hertz	B. Scale	K. Coil
3. Barkhausen-Kurz	12. Kelvin	C. Cathode	L. Tube
4. d'Arsonval	13. Leyden	D. Sounder	M. Effect
5. Dellinger	14. Morse	E. Curves	N. Screw
6. Edison	15. Mueller	F. Oscillations	O. Antenna
7. Fleming	16. Rohmkorff	G. Modulation	P. Bulb
8. Fletcher-Munson	17. Tungar	H. Jar	Q. Galvanometer
9. Hay	18. Wehnelt	I. Rule	R. Bridge

Fiber-Optic Brain Cell

(*Continued from page 37*)

The type of mask just described is called a rejection mask: it operates by rejecting light. However, we would not know if a signal were received at all if all the light were successfully masked out. In current practice, two Sceptrons are used, one containing a static mask only, which provides a reference output. The photocells of the static mask and the memory mask are balanced against each other in a bridge circuit. Both Sceptrons are simultaneously excited by incoming signals. Any signal other than the one which was programmed will produce a large output from each photocell, which will cancel each other. For the right signal, there will be an unbalanced output from the cells, which is a measure of recognition. (Both functions can be included in one Sceptron.)

The acceptance mask is a combination of the static mask and the negative of the rejection mask, *i.e.*, the photographic plate of the signal is developed as a positive, and the static dots are superimposed. This mask passes maximum light when the programmed signal is received. (See Fig. 2.)

From here, you can light a bulb, ring bells, operate a cash register, a typewriter, or what have you.

Key Features

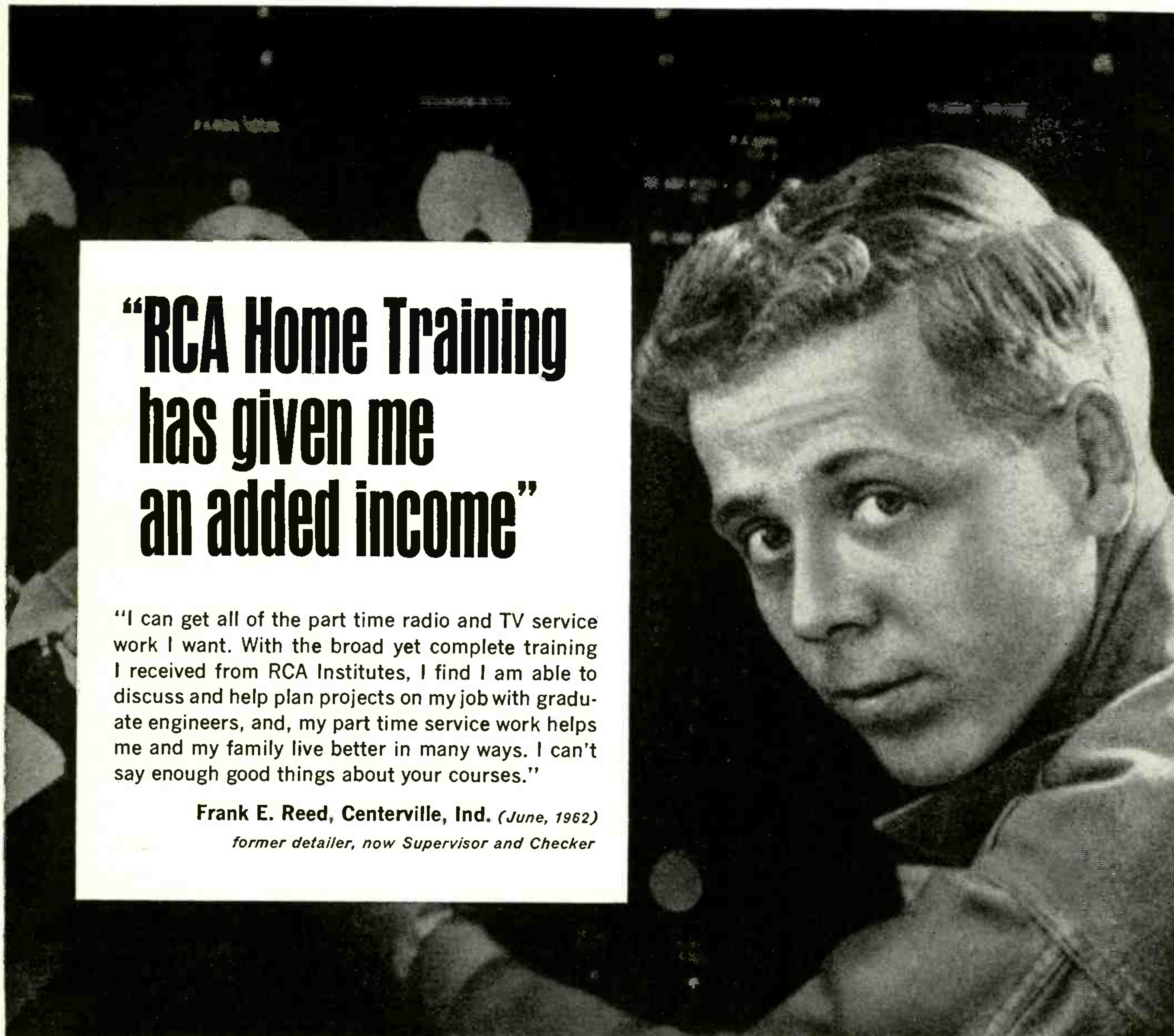
There are three key features of the Sceptron:

1. It is able to process more information in a smaller package than has ever before been possible.
2. It is self-programming: the signal makes its own memory mask.
3. It operates in "real time": decisions are made during the actual signal period, without recourse to storage and post-analysis.

In contrast, computers generally hold the signal while they go searching through their memory for the desired comparison. For multi-word applications, Sceptron memory units will be in parallel, and all will be simultaneously interrogated.

Although much more can be said about technical details of operation, or of the many variations possible in masking techniques, we have only attempted to describe the general operation of the device. The applications are numerous, and are practical because of the inherently low cost of the system. Material costs run about $2 per Sceptron, for instance, and with reasonable production, the cost of the finished product could be about the same as a radio tube. With newer fiber arrays, we can soon put 300 memories into a "match-box" console.

Most of us who are working with the Sceptron think of it as an invention as basic and important as the transistor. ▲



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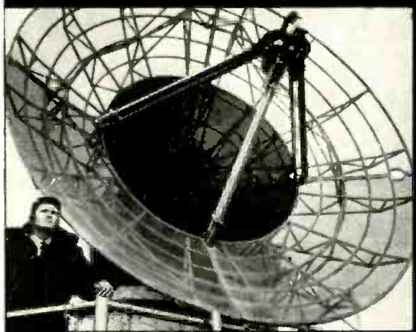
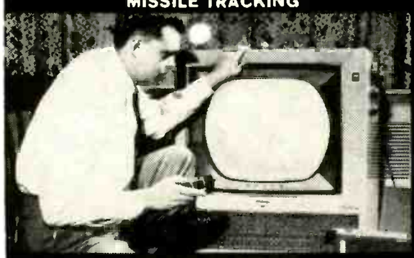

MISSILE TRACKING


COMPUTER PROGRAMMING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Turntable Testing at Home

(Continued from page 32)

It is therefore important to keep tracking error lowest at the record's inner grooves. This is done at the expense of allowing greater tracking error at the outside grooves. Clearly it is not enough to know the maximum tracking error of a given record player. An error of 2° at the outside grooves probably reflects excellent design, while the same 2° error at the inside grooves might indicate relatively poor design.

Tracking error can be measured with a protractor (the kind with a small pin hole at the origin) and a drafting triangle, as shown in Fig. 4. The triangle is carefully placed on the record so that its extension would pass through the center of the spindle. The protractor is then placed over the triangle, with the pin hole at the desired groove radius and directly over the triangle's edge. The stylus is placed in the pin hole.

The most critical part of this measurement, and the one that limits its accuracy, is the adjustment of the angle of the protractor. Keeping the pin hole on the edge of the triangle, the protractor must be turned with the stylus as pivot, until the protractor edge is parallel to the cartridge. This must be done by sight, and the alignment of the pin hole must be rechecked. The tracking error is the number of degrees off 90° marked by the triangle on the protractor scale. The larger the protractor the more accurate the measurement is likely to be. With care you may expect an accuracy of ± ½ deg.

Audiophiles sometimes spend hours arguing the merits and faults of different types of components. Perhaps the measuring techniques described in this article can settle at least some of the arguments about turntables. ▲

TUBE TESTER AS VARIABLE-VOLTAGE SOURCE

By RALPH E. ELLISON

WHEN you are in a tight spot for an odd value of voltage, a.c. or d.c., try using your tube tester. From its filament supply, it provides a wide range of directly available a.c. voltages, continuously available or adjustable in small increments, that generally go as low as 1 volt and as high as 117 volts.

To obtain these values conveniently, salvage the base of a discarded octal tube. Solder one length of flexible wire to pin 2 inside the base and another to pin 7. Also solder a clip to the other end of each lead. To tap the filament supply, you now only need to insert the octal base in the appropriate tester socket.

To obtain a comparable range of d.c. voltages, make up a small, simple rectifier-filter network for bench use and run the tapped-off a.c. voltages through this rectifier circuit. ▲

ELECTRONIC CROSSWORDS

By **BRUCE BALK**

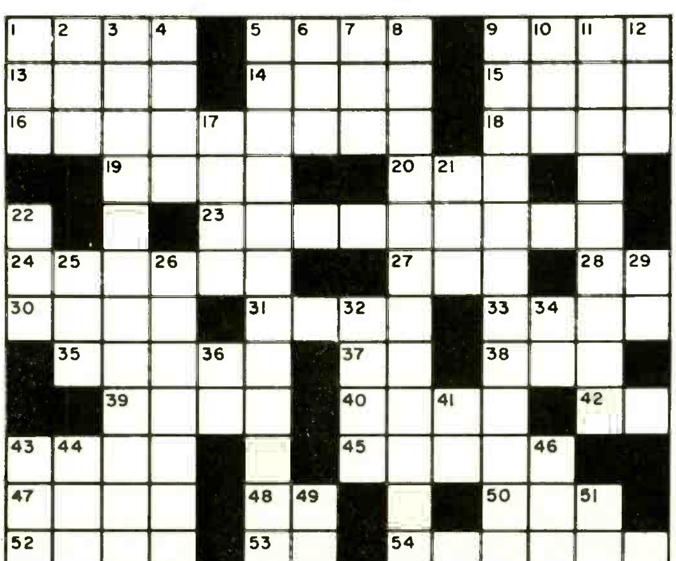
(*Answer on page* 101)

ACROSS

1. Assist.
5. Employer (slang).
9. Type of ham radio antenna often seen on automobiles.
13. Printers' term for "eliminate."
14. Lined up.
15. Near Easterner.
16. Essential component of a vacuum tube.
18. Test rooms.
19. Sound a locomotive makes.
20. Voltage (abbr.).
23. Type of vacuum tube used for output stages.
24. Surface of a cathode-ray tube.
27. By means of.
28. That is (abbr.).
30. Part of a horse's foot.
31. Signal that is produced by a radar target.
33. Opening.
35. Deduce.
37. He (Fr.).
38. Time zone (abbr.).
39. High-speed electron.
40. And others (Latin).
42. Band extending from 3 to 30 megacycles (abbr.).
43. Man's name.
45. Unit of equivalent absorption in acoustics.
47. Amplitude pulsation resulting from the combination of two waves.
48. Outer diameter of coaxial cable (abbr.).
50. Numerals (abbr.).
52. Devices used in mechanical push-button tuning systems.
53. Type of circuit (abbr.).
54. Electricity or heat, for example.

DOWN

1. Soft drink.
2. Unit of relative audio or sound power.
3. This does the work in klystrons and CRT's.
4. Short for one type of amateur radio license.
5. Test instrument used for adjusting vertical and horizontal linearity.
6. Gold (Spanish).
7. Earth.
8. One type of periodically varying electromotive force.
9. Cable having a certain specified length.
10. Parrot.
11. Speaker baffle used to enhance bass response.
12. Out of current usage (abbr.).
17. Device controlling flow of electrons in a circuit.
21. Me (French).
22. Residue of combustion.
25. Calm (French).
26. Doppler and Edison.
29. And (Latin).
32. Hurries.
34. Signal voltage (abbr.).
36. French "and."
41. Type of power pack.
43. Circuit used to adjust contrast in TV (abbr.).
44. Meadow.
46. Gate circuit.
49. Type of restorer used in some TV receivers.
51. Ratio of weight of substance to weight of an equal volume of water (abbr.).



Antennas for Business Radio
(*Continued from page 35*)

dipole, which is the industry standard.

There is no magic way to achieve gain. The radiation pattern must be compressed either vertically or horizontally by narrowing the radiated beam. The vertical pattern can be compressed by collinear stacking of a number of vertically polarized elements. This compression of the beam is brought about by increasing the vertical radiating aperture and over-all length. Pattern compression in the horizontal plane can be achieved by positioning parasitic elements to direct or reflect the radiated energy in the desired direction.

Mechanical Considerations

Once the electrical requirements of the antenna have been met, there are several mechanical considerations which also must be carefully weighed. For an antenna that is to have a specific gain, very little can be done to reduce the over-all length of the antenna and still maintain the necessary radiating aperture. However, by the use of metals such as aluminum, much can be done to produce an efficient radiating structure that is light in weight and small in cross-section, while retaining good mechanical strength.

Communications antennas are generally designed to withstand 100 mile-per-hour winds and ½" radial ice loads. Antennas to withstand 100 mile-per-hour winds must withstand a force of 30 pounds-per-square-foot of exposed area. For an antenna which is circular in cross-section, the *projected* area is used for calculation purposes. Thus, the total exposed length multiplied by the cross-section dimension of the antenna (in square feet) multiplied by 30 equals the mechanical force in pounds exerted against the structure in a 100 mile-an-hour wind. If radial ice is formed on the antenna, the cross-section dimension is increased and this increase must be considered when calculating the area of the antenna.

In seacoast and industrial areas chemical elements present in the atmosphere may tend to corrode most metals. Under these conditions, "hurricane model" stainless-steel antennas as well as those antennas using fiber glass or other non-metallic elements are recommended.

Proper Grounding

Good grounding techniques are always desirable. By grounding the tower and other structures, damage from lightning can be reduced considerably. A grounded point or rod tower-member placed above the highest extremity of the antenna is desirable since it acts as a static discharger. This discharger will effectively relieve the high potential of any cloud near the antenna and thus result in a much lower percentage of hits than if the tip were not used. However, to withstand direct hits, the antenna and structure itself must be designed to absorb the large amount of energy present in the bolt, usually in the order of 100,000-ampere surges. This is done in many broadcast antenna installations, such as the television antennas atop the Empire State Building, which are hit practically every time a storm occurs.

The economics of the average base-station installation do not warrant the expense of designs capable of absorbing the full energy of the hit each time. It is much more practical to write an extended-coverage clause into the over-all fire insurance policy for the installation to cover damage due to lightning and to replace a certain number of antennas which will invariably be hit. Reports indicate that less than 1 per-cent per year suffer hits requiring replacement of the antenna itself, although there may be a certain number of unreported cases.

Standard d.c. grounds also minimize the noise and precipitation static frequently attributed to antennas that accumulate static charges from high winds and dust. As these charges leak into the atmosphere, a continual "frying" noise is heard in the receiver, thereby reducing its sensitivity by masking weak signals. Grounded antenna elements drain this charge to reduce noise as well as any damage. Another expedient which has been used to minimize precipitation static is to coat the antenna with a dielectric substance. This coating effectively isolates the antenna elements from the atmosphere and minimizes static build-up.

Transmission Lines

A proper antenna-to-line impedance match is an important requirement for efficient two-way radio antennas. The ideal match is a resistive antenna equal to the characteristic impedance of the transmission line. The EIA has standardized on a nominal 50-ohm coaxial transmission line. Consequently, antennas are designed to exhibit a nominal 50-ohm load impedance. The amount that the antenna varies from this ideal match is usually expressed in terms of voltage-standing-wave ratio (v.s.w.r.). Any mismatch shows up as power returning down the transmission line instead of being radiated into space. The v.s.w.r. curves indicate an antenna's variation from an ideal impedance match and show the reflected power of an antenna over its frequency band.

The percentage of power lost in setting up standing waves is a function, for the most part, of antenna and connector. With a ratio of 2:1, for example, approximately 12% of the power transmitted by

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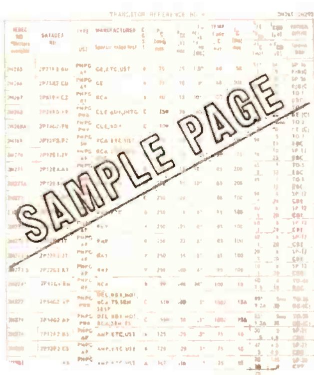

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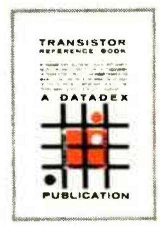

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CITY________________ZONE____STATE________ the base station is lost. If the v.s.w.r. goes up to 3:1, power loss rises to approximately 25%. In other words, 60 watts of base-station power is radiated as only 45 watts with 15 watts of power lost by reflection along the length of the transmission line.

The amount of signal strength lost along the transmission line depends on three construction factors. These are: (1) the size of the center conductor, (2) dielectric loss in the cable, and (3) conductivity of the inner and outer conductors.

The size of the center conductor in a coaxial transmission line is dictated by the characteristic impedance of the line, the type of dielectric material used, and the inside diameter of the outer conductor. The outer conductor size is limited by weight, space, and cost.

For example, a coaxial line with an outer conductor that has a one-inch i.d. and uses pressurized air as its dielectric material is limited in its center conductor diameter to about 7/16th of an inch. With the same i.d. outer conductor and polyethylene (a common solid dielectric) instead of pressurized air, the allowable diameter of the center conductor drops to 9/32nd of an inch. A reduction in center conductor size and the introduction of a "lossy" dielectric insulator in the line approximately doubles the attenuation of the line in db per 100 feet.

Coaxial transmission line using a foamed polyethylene dielectric material, which provides a dielectric constant between air and the solid dielectric extremes, allows the use of a larger diameter inner conductor. This results in lower losses than is the case with the solid dielectric material.

Corrosion resistance is also an important consideration for a transmission line since the line is exposed, as is the antenna, to humidity, rain, snow, salt air, chemical fumes, and other environmental conditions. Copper is one of the most corrosion-resistant of the common metals. Copper cable installations throughout the world are still serving communications systems faithfully after as many as 25 years, attesting to copper's durability.

Since the antenna in a system is usually its most exposed element, the transmission line immediately connected to the antenna termination can quickly get weather-worn. Vinyl-covered cable, not known for its weathering ability, suffers most. In its place ½" "Foam Heliax" is employed to connect to the antenna termination to offer greater weather resistance as well as equal flexibility. The use of this special jumper causes the initial price to be slightly greater than with ordinary RG-8/U coax jumpers. However, the value received in reliable, maintenance-free antenna system service more than offsets this cost difference.

Stated simply, the higher the antenna, the greater the range. Modifying this optimum concept are such qualifications as transmission-line losses, r.f. noise, terrain, surrounding structures, and cochannel interference; all contribute in some degree to resultant system degradation. To achieve height, and thus extend the radio horizon, most base-station antennas are located on building roofs, hills, mountain tops, wood telephone poles, structural towers, or a combination of these.

Irrespective of the type of mounting, the antenna should be above, free, and clear of any surrounding structures, terrain, power lines, or foliage. Although this is not always practical, as in the case of antennas side-mounted on towers or roof-mounted on smaller buildings in large metropolitan and industrial areas, antenna isolation is nonetheless desirable.

Coaxial and ground-plane antennas should not be side-arm mounted on a tower or other metal structure unless the almost inevitable radiation pattern distortion—from shielding, capacitance, parasitic excitation, phase cancellation and addition—can be tolerated. To minimize this effect, no active antenna element should be closer than three-quarters of a wavelength to the tower or other mounting surface. A further complication in out-rigging antennas on towers is the marked increase in windloading effect on the tower itself. Tower unbalance and weight limitations also must be considered and, in the case of two or more side-mounted antennas on lighter towers, diametric placement is virtually mandatory.

Directional antennas lend themselves more efficiently to side-arm installation, from a propagation viewpoint, but general considerations of tower balance, windloading, and weight load still apply. The basic concept of antenna isolation at tower or building top, irrespective of antenna type, implies installation simplicity and propagation efficiency. Keep in mind, however, that the antenna must be accessible for periodic checks.

Invariably, antennas mounted on building tops are fastened to stub pipe masts, building cornices, and even outrigged on upper walls. The importance of adhering to local building codes in both antenna and tower erection must be emphasized. Most municipalities strictly enforce code regulations and necessary compliance can entail higher initial installation costs.

To many technicians and engineers, antennas do not represent the interesting challenge presented by electronic circuitry. However, antenna systems should be given the respect they deserve, for without that "piece of wire sticking up in the air," we would not have efficient and effective radio communications. ▲

Color-Pattern Generators

(*Continued from page 52*)

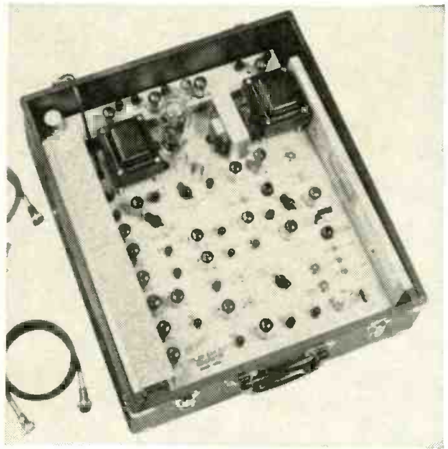


Fig. 7. Hickok 656XC NTSC-bar generator also produces dot and crosshatch patterns.

The pattern produced by the rainbow generator is a smooth transition or blending of colors like a spectrum. The generator's principal usefulness is in determining if the color circuits are operating. In conjunction with a scope, it can also be used to make chroma and demodulator phasing adjustments.

The pattern produced by the *gated*-rainbow generator is a serrated continuous color display with nine vertical black bars as shown in Fig. 9. Each of the ten color bars it produces, spaced precisely at 30° phase intervals, is a small segment of the rainbow pattern.

The gated-rainbow generator also produces its own horizontal sync pulse and a color-burst signal as well, to make receiver adjustment reliable. Since the rainbow pattern changes hue from the left to the right side of the screen, the horizontal sync pulse is necessary to lock the horizontal oscillator in the color receiver so that a stable color display can be produced. The horizontal hold control in the receiver must be accurately set to minimize an unstable display. This applies to both types of rainbow generator. The gated-rainbow generator utilizes one of its 12 gated bars as a burst signal whereas a plain rainbow generator makes use of the burst gate in the receiver to gate out a portion of the 3.56-mc. c.w. signal, following the horizontal sync pulse, to serve as the burst.

Rainbow Generator Circuit

The rainbow-generator circuitry is not complex. The block diagram of the *Hickok* Model 660 rainbow generator is shown in Fig. 5. A 3.563795-mc. crystal oscillator is the chroma oscillator. Note that this frequency is 15,750 cps below the 3.579545-mc. color subcarrier. When this frequency is fed to a color receiver, a rainbow pattern of all colors will be produced for each horizontal scan, that is, there will be a 360° phase shift between the subcarrier oscillator in the set and the 3.563795-mc. output of the rainbow generator for each horizontal scan. The reference for this operation is the free-running subcarrier oscillator in the set. Since the subcarrier oscillator is usually crystal controlled, stability will be satisfactory for most field applications. Fig. 6 shows how a rotating vector produces a rainbow display as its phase changes.

The visible color display on the screen of the picture tube starts at about 20° which indicates the end of the blanking period. The color blends from one end to the other starting with orange and ending in green. A correctly adjusted receiver will show, starting at the left side of the screen, 40% reds, followed by 40% blues, and ending with 20% greens. The hue control in the color set should be capable of varying this color combination to either the left or the right approximately ± 10% either side of the center hue-control setting. Since the output signal of the rainbow generator does not contain a brightness component, the contrast control will have little or no effect on the display. In addition to checking hue control during the installation of a set in the home, the rainbow generator can be of help in quickly locating a bad demodulator tube.

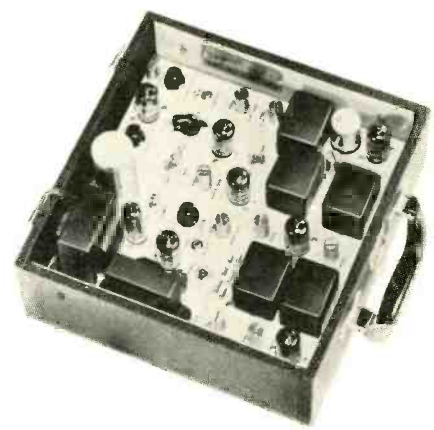


Fig. 8. Hickok 660 rainbow generator can also generate dot and crosshatch patterns.

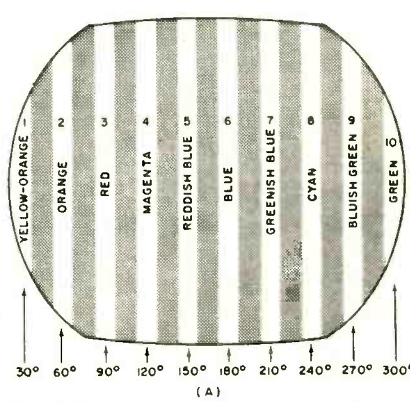


Fig. 9. Pattern produced by gated rainbow generator has black bars spaced 30° apart.

If the $B-Y$ or Z demodulator tube is bad, the blues will be missing. Should the reds be missing, this would indicate trouble in the $R-Y$ or X demodulator. If the greens are not present, the trouble is likely to be in the $G-Y$ amplifier or matrix. Reference to the tube location chart included in most sets should lead to the defective tube. It should be pointed out that an NTSC generator will locate the aforementioned faults in the same manner. The crosshatch and dot generator section of this generator is practically identical to that in the NTSC generator just discussed.

To sum things up, the rainbow generator is the less expensive and the more portable of the two generators. It is suitable for color receiver installation since only purity, convergence, and monochrome balance adjustments are usually made in the home. It also gives an indication that the color circuitry is at least working. However, color alignment with a rainbow generator is not recommended if a high-degree of accuracy is required.

An NTSC color-bar generator can be used to accurately align any receiver regardless of circuit design. It can check the performance of a receiver more critically because each fully saturated color requires a brightness component. Pure yellow, cyan, and magenta cannot be produced with a rainbow generator, although they can be with an NTSC generator. These complementary colors are critical and the slightest phase and brightness-adjustment errors will change them noticeably.

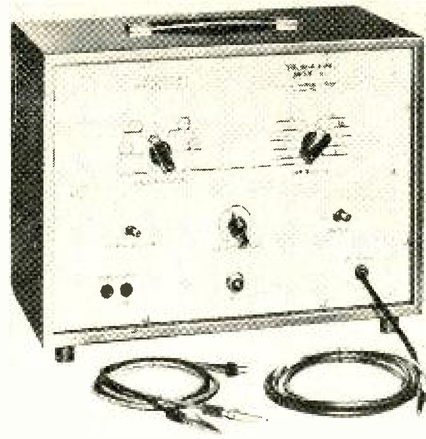


Fig. 10. Hickok 661 develops NTSC colors singly, each in full-screen display, rather than as simultaneous bars.

The NTSC color-bar generator is excellent for troubleshooting because it can properly energize all circuits of interest with stable, standardized signals. Also, it can never be rendered obsolete by changes in receiver circuitry. It is based on present *transmission* standards, and is useful as long as those standards are retained. ▲

EW Lab Tested

(*Continued from page 18*)

the manufacturer's specifications (listed second). Any differences between them are, in our opinion, minor.

IHFM Usable Sensitivity: 2.6 μv. measured and 1.8 μv. rated.

Hum (referred to 100% modulation): —60 db (including residual hum in our signal generator) as against —70 db.

Capture Ratio: 2.3 db *versus* 2.5 db.

Harmonic Distortion (100% modulation): 0.7% as against less than 0.5% according to the manufacturer.

Frequency Response: 20-15,000 cps ±2 db (mono) and 20-15,000 cps ±2.5 db (stereo) *versus* 20-15,000 cps ±1 db in both modes.

Output Voltage: 4.4 volts as against 2 volts.

Drift (from cold start): approximately 3 kc. by our measurements but not rated by the manufacturer.

Channel Separation: 26 db at 1 kc. and 14 db at 10 kc. Not rated by the maker.

These figures clearly describe an excellent tuner and that is what this unit is. In addition to fine electrical performance, it has the smooth flywheel tuning and general "feel" of factory-wired *Fisher* tuners, at an appreciably lower price. It sells for $169.50. ▲

Radio & TV News

Events in the Service Industry

FIRST ORDER of business this month, as promised, is resumption of the subject that filled our last column. We had dealt with an evaluation of service-industry problems by Frank J. Moch, executive director of NATESA, and his tentative proposals for future action.

One of his chief points was that the character of the industry, along with our entire economy, was undergoing certain basic changes. Many of these changes, since they are the result of powerful forces outside of service or any single segment of the economy, are not realistically subject to control or alteration by the independent service industry or by individuals within it. Therefore, instead of concentrating fire on convenient scapegoats, service would spend its energy more fruitfully by formulating a positive program for adjusting to forthcoming changes.

"Pool your resources," Moch's own phrase, is the key to his program. He feels that there are many areas in which his slogan can be applied effectively. These include advertising, the purchase of parts and equipment (along with the maintenance of stock, to avoid inventory duplication), the purchase of TV sets and other merchandise for retailing (to compete with high-volume, low-price entrepreneurs), and even the centralization of service facilities, including the best use of the skills of individual specialists.

He acknowledges that this approach involves some sacrifice of a traditional, "rugged individualism" that is jealously guarded by many owners of small shops. He doubtless anticipates resistance to his program on these grounds. He probably also feels that, in answering the advantages of "big-business" servicing by adapting some of its own techniques, the little people in the business stand their best chance of perpetuating their individual character and identity. Such ideas merit long and serious discussion. All we can do is start the ball rolling.

Can It Work?

Many who are disposed toward a traditional way of looking at things will find his suggestions unacceptable. In fact, some are sure to see in it a threat to a way of life. Others will simply shrug and say it is unworkable. All dissidents might take a hard look at some things going on in the service industry *right now*.

Any number of associations today offer medical and other insurance plans on a group basis. Many will automatically "cover" for a dealer member who becomes sick or is otherwise out of action, so that his business is kept intact until he can resume. Cross-checking between one dealer and another for the availability of hard-to-get parts is a practice that may be even older than the association idea. Swapping of technical expertise has been going on for years with no fuss. While these constitute evidence of successful cooperation, which is not the same thing as outright pooling, a recent trend toward the latter is also observable.

Present Examples

McWilliams Radio-TV Service of San Francisco is in the transistor-radio repair business quite actively because, says president John McWilliams, "the reluctance of most servicing dealers to tackle these little monsters" has created a need. The firm has been assigned warranty work by at least two major manufacturers or importers and is negotiating with others. "We would like to extend our service facilities to other dealers in the area . . . to service the transistor repair business they are now turning away," says McWilliams. If his plan succeeds, San Francisco will have centralized service in this specialty without the loss of dealer identity.

Another case: The members of TESA-Miami have set up and equipped a single shop to which they may all bring their tough dogs. It will be manned by expert members in various fields. More recently, this association has asked specialists on tape recorders, phonographs, intercoms, CB, auto radio, color TV, and other fields to place their names on a reference list that will provide a speedier interchange of needed information. What will be the next step?

We could cite other cases in which aspects of Moch's program, although not the entire package, are in use today. More interesting than added proof is this point: where such pooled activities exist, they have been accepted without great hue and cry. At least some change in this direction, then, is taking place informally today, without conscious planning toward a grand goal. Yet we are sure that the clear statement of possible results will arouse opposition. Many will see in it a threat to a way of life.

As for ourselves, we neither endorse nor oppose the Moch objectives. They have received consideration at length because they represent a serious attempt to develop a positive program—and also because we frankly hope to stir up sorely needed discussion on this matter. We are interested in all shades of opinion, but dissidents can be most helpful if they keep one point in mind; it is not enough to reject someone else's answers. You should try to offer constructive alternatives.

Profit in "Wholesale Only"

A story in the "Newsletter" of TSA of northeastern New York points a moral for distributors. A relatively small distributor who operates profitably on a strictly wholesale basis noted the annual financial report of one of the larger, wholesale-retail, mail-order businesses. He noted that its losses for the year recently ended were $1,217,073, exceeding the losses of more than half a million for the year before. The "smaller" distributor (Ran Gardenier of Troy TV) is now boasting that his firm's profits exceed those of the larger organization by "more than $1,217,073." While he will not say exactly what his profits are, he makes the point that the large, impressive, and cumbersome electronic sales establishment that seeks business volume wherever it can get it is not necessarily following the shrewdest policy. "A wholesale-only distributor is a serviceman's friend," he says, "and this friendship can pay off."

Are You a Laborer?

For years, business advisers have been pounding away at the independent service industry to stop hiding behind markup on parts for income, to insist on due worth for their labor, and accordingly to mark reasonable labor charges clearly on their bills. We hate to confuse the issue, but we think A. Edward Stevens, writing in "TESA-Miami News," has a good point—and he doesn't like that word "labor," on the bill or elsewhere.

He's all for an honest fee, but feels that "technical services" or "professional services" carries more dignity than "labor." Come to think of it, technicians might feel less reluctant about charging their worth with that term. ▲

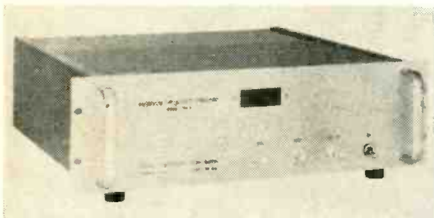
New Products and Literature

Additional information on the items covered in this section is available from the manufacturers. Each item is identified by a code number. To obtain further details, simply fill in the coupon appearing on page 21.

FREQUENCY STANDARD

1 **General Technology Corporation** has introduced its Model 304-B rubidium frequency standard designed for critical frequency applications.

Providing an extremely high accuracy of 1 part in 10^{10}, the unit has a long-term stability of

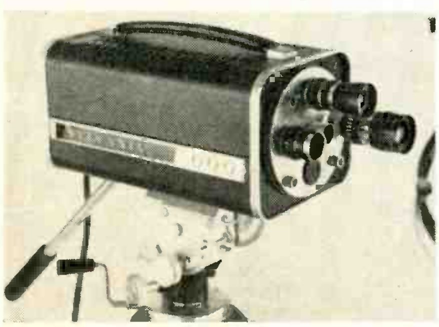


5 parts in 10^{11} over a 90-day period and a short-term stability of 1 part in 10^{11}. The instrument is designed as a primary frequency and/or time standard in communications, navigation and encipherment systems, at missile and satellite tracking stations, and for general laboratory and field use.

CCTV CAMERA

2 **Sylvania Electric Products Inc.** is now marketing a new high-resolution, direct-wire television camera which is designed to operate with home or special industrial TV receivers.

The new camera, Model VRF600, offers a minimum of 600 lines video or 300 lines r.f. resolution. It features automatic light compensation and incorporates a new electrical circuit that stabilizes and holds the focus even under varying voltage conditions. There is a four-position lens turret which uses standard C-mount lenses. Each camera is equipped with one general-purpose

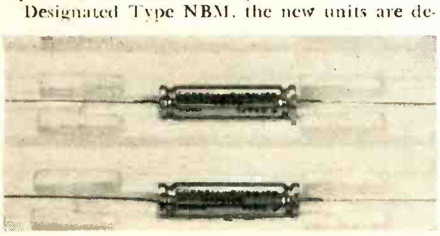


lens, four aperture caps, 15 feet of coax with video connectors, and 15 feet of coax with r.f. connectors, and an antenna impedance-matching transformer.

NIOBIUM FOIL ELECTROLYTICS

3 **Cornell-Dubilier Electronics Division** has developed a series of niobium foil electrolytics which are said to weigh up to 25% less than equivalent tantalum foil capacitors.

Designated Type NBM, the new units are de-



signed with either plain or etched niobium foil in both polar and non-polar ratings. Units are rated at 6 volts through 50 volts d.c. and have an operating temperature range of −55 to +85 degrees C. Capacitance values are from 1.5 μf. to 200 μf. with tolerances of ±20% for plain foil units and −15, +75% for etched foil units.

TEST SCORING MACHINE

4 **Electronics for Education, Inc.** has developed an electronic test scoring machine which is engineered and designed to give teachers a reliable and accurate method of grading objective tests.

The "Grademaster" marks each wrong answer, counts the total incorrect answers, and prints that number on each page. The machine automatically feeds, grades, marks, and stacks the answer sheets. The unit will grade 150 student answer sheets in 30 minutes.

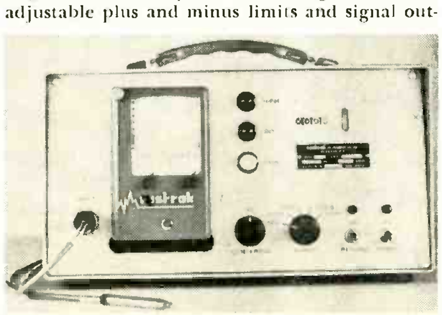
The device is transistorized and operates on

standard 117-volt, 60-cycle power. It measures 27" long, 14" wide, and 13" high and weighs 60 pounds.

COMPARATOR GAUGE

5 **Rustrak Instrument Company** has developed a new instrument which combines a direct-reading comparator gauge, a recording comparator, and a control system.

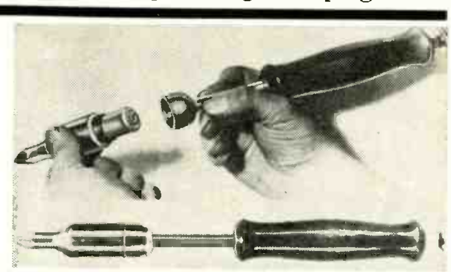
The Model 102 measures to within 3 millionths of an inch. The instrument is designed to be used under extreme service conditions and with large variations in power-line voltage. There are adjustable plus and minus limits and signal out-



puts are provided with this feature for use with remote circuits or automated production. Special integrated controls are available as accessories to provide semi- or fully-automated production and control.

CARTRIDGE SOLDERING IRON

6 **Kemode Mfg. Co., Inc.** has developed a new chemical-cartridge soldering iron which requires no electric current or external heat source. Known as the "Quik Shot," the new unit reaches



a temperature of 850 degrees F in 20 seconds and maintains temperature for at least 7 minutes.

The cartridge, a thermit mixture, resembles a small flashlight cell. It is actuated in the tip of the iron by a trigger at the back of the handle. Five interchangeable tip sizes (from 1/8" to 1") are available.

TRANSISTOR-SWITCHED MOTOR

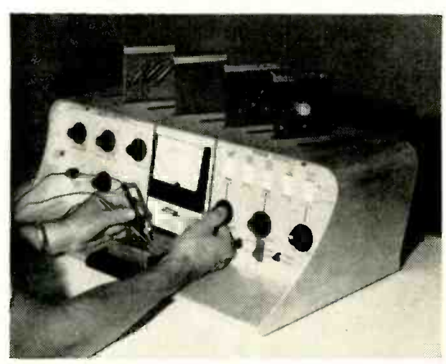
7 **Lamb Electric Division of Ametek, Inc.** has developed a small electric motor that substitutes transistor switching for the traditional brush and commutator methods.

The "Komlectro" brushless motor is being offered in a full range of fractional sizes from 1/20th to one full h.p. Higher ranges are possible. Among the features claimed for the new units are reduced electrical noise, reduced acoustical noise, and the elimination of arcing at high altitudes.

With the substitution of transistors and, in some cases, silicon-controlled rectifiers for the usual commutators, maintenance problems have been drastically reduced or virtually eliminated, according to the company.

ELECTRONIC "TUTOR"

8 **Universal Scientific Co., Inc.** has recently introduced its "Crow Model 31," a new device for teaching fundamental electronics using the



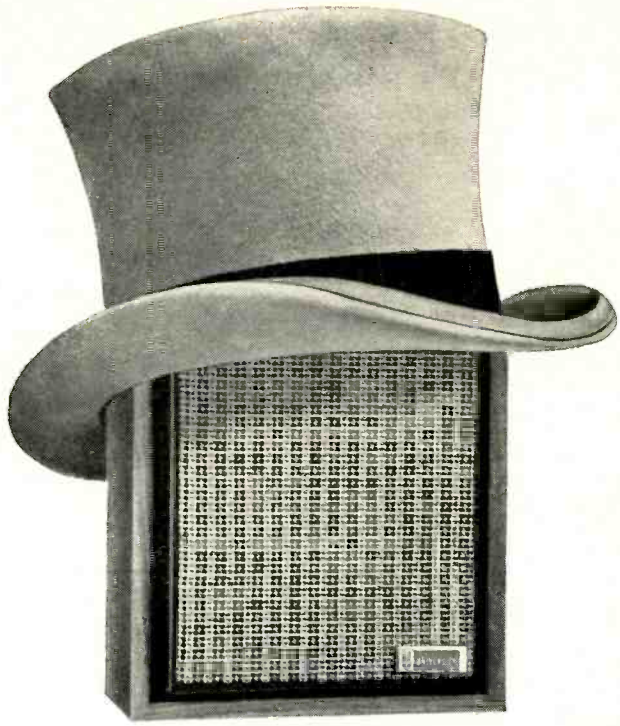
modular tutor technique. The console itself is a combination of five precision power sources, a sophisticated switching and jack arrangement, and an integral v.o.m.

The module circuits to be analyzed are printed circuit cards. They are easily stored and provide clear and compact construction detail. The circuitry is designed to become progressively more complex as the student's knowledge increases.

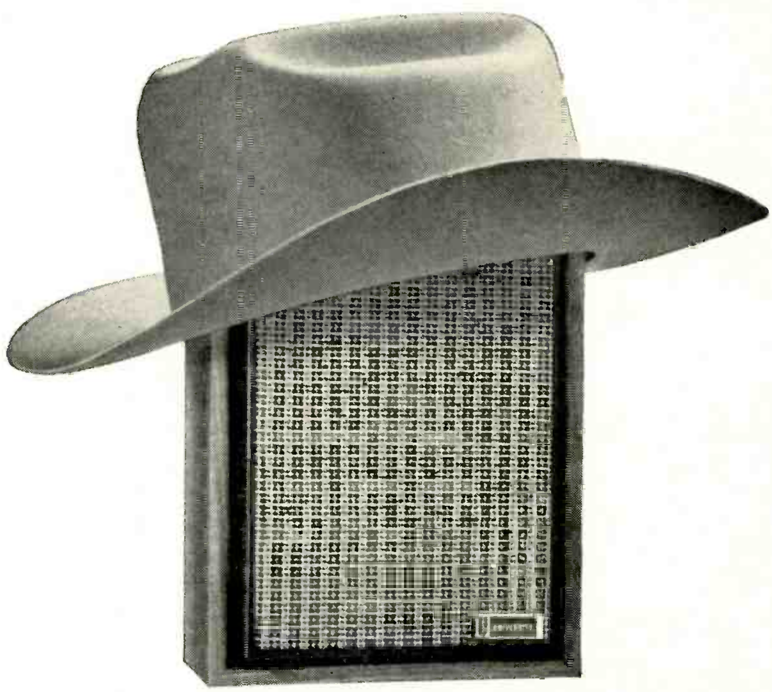
HI-FI—AUDIO PRODUCTS

SPEAKER SYSTEM

9 **Paco Electronics Co., Inc.** has recently introduced a new speaker system featuring three 6-inch speakers reinforced with struts and in-



University is moving from New York



to Oklahoma City!

University's huge new plant will be located in the heart of the 71 acre Ling-Temco-Vought electronic center by summer's end. It will be the most modern, semi-automated speaker plant in the U.S.—with the ultimate in production and test equipment, including the industry's most advanced anechoic chamber and instrumentation installation.

This move opens vast possibilities: new University products... new standards for loudspeaker and microphone performance... new sales potential for you.

During this relocation however, our most valuable asset—our relations with you—will be our primary concern.

Every phase of this move is being programmed by computer to minimize the possibility of delays in production and delivery... even while we're in transit! In addition, we are adding to our extensive national warehouse facilities.

So, westward ho! The future holds promise of big and bright prospects for our distributors and dealers—for their customers and ourselves.

UNIVERSITY LOUDSPEAKERS
80 SOUTH KENSICO AVE., WHITE PLAINS, N.Y.
A Division of Ling-Temco-Vought, Inc.

corporating a special ball diffuser and a sensitive 3" tweeter.

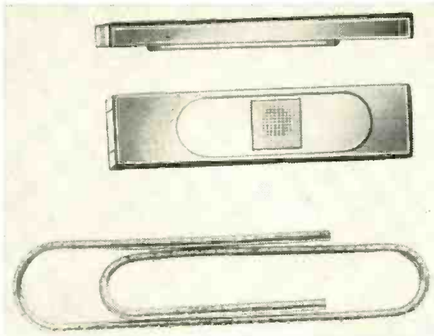
The special ball diffuser on each 6-inch speaker breaks up the normal narrow axis beam from the voice coil to provide smooth response in the mid-range. The tripod struts attached to each 6-inch cone provide a piston effect to 7-8000 cps. Over-all response of the system is 45-18,000 cps with a single crossover network.

The L-4 slim silhouette system operates on 80 ohms and measures 6 5/16" deep x 20" wide x 26 3/4" high. It is housed in a walnut cabinet.

MINIATURE MICROPHONE

10 **Shure Brothers, Inc.** has developed a new miniature microphone designed especially for use in hearing aids, small head-worn microphones and hand-held transmitters, "hidden" microphone installations, pocket tape recorders, and dictating machines.

Called the CA5A, the new unit is just 1" long x .250" wide x .100" thick. It weighs 3/4 gram. The microphone incorporates a specially designed



lead zirconate element which provides excellent stability under varying conditions of heat, ranging from 20 to 200 degrees F, and humidity. Frequency response is 50-5000 cps. Output level is —73 db referred to 1 v./microbar, open circuit. Impedance is high (equivalent to 400 $\mu\mu$f.).

TRANSISTORIZED RECORDER

11 **Concord Electronics Corporation** is introducing its first transistorized four-track stereo tape recorder as the Model 550.

The new unit records and plays back four-track stereo as well as records sound-on-sound. It also

features transistorized electronic components and includes separated 6-inch speakers, dual 10-watt amplifiers, transistorized preamps, and all-push-button operation. It comes complete with two dynamic microphones, necessary patch cords, and take-up reel.

TELEPHONE ANSWERING SET

12 **Electronic Secretary Industries, Inc.** is offering a redesigned version of its answer-only telephone answering set as the Model AO-3.

The new device automatically answers the phone with a tape recorded message. Transistor circuitry on printed-wiring boards reduces maintenance. The unit has messages recorded on a 1-minute continuous magnetic tape. The message can be changed at any time by the user through a microphone supplied with the unit. Recording the new message erases the old one. Applications include announcements and sports scores, daily

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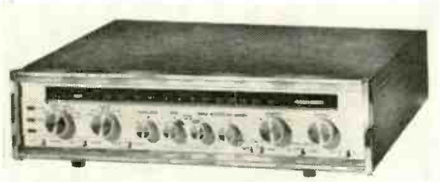
INTEGRATED MULTIPLEX UNIT

13 Sherwood Electronic Laboratories, Inc. is now offering its S-8000 II, an integrated unit combining an FM multiplex stereo tuner and a stereo amplifier on a single chassis.

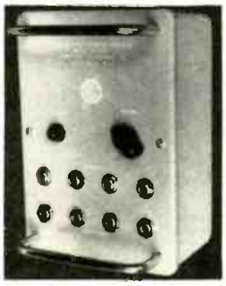
FM sensitivity is 1.8 μv. for —30 db noise and



distortion (IHFM) and FM selectivity is 200 kc. at —3 db. Power output is 32 watts music power each channel or 30 watts continuous at 1.5% IM distortion. There are stereo low-noise phono or tape head playback preamps. The circuit uses 21 tubes plus two silicon rectifiers and nine diodes. The cabinet measures 16¼" x 4" x 14".

PORTABLE INTERCOM AMPLIFIER

14 Cambridge Electronics is currently marketing a transistorized portable intercom amplifier which has been designed for applications where voice exchange is vital in noisy environments.



The Model CE-1300 consists of a transistorized intercom amplifier with facilities to accommodate four headset - microphone plug-ins, and 125 feet of audio cable. It operates from an integral battery. The unit, with batteries, weighs four pounds. It measures 5½" x 8" x 3½". Output is 1 watt maximum.

TAPE CARTRIDGE

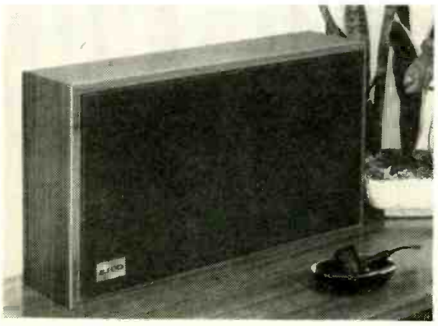
15 Unireel, Inc. has developed a continuous loop tape cartridge especially for broadcast station programming, background music, instrumentation system, and audio-visual display applications.

The new unit features positive tape braking and simplicity of reloading. The cartridge is available in all standard lengths from 25 to 562 feet. Teflon bearings provide extra long life and Styrofoam pressure pads are used to insure proper head wrap. The unit fits all commercial broadcast machines and meets NAB proposed specifications for tape cartridges for broadcast use.

THREE-WAY SPEAKER SYSTEM

16 Eico Electronic Instrument Co. Inc. has added the HFS-6 speaker system to its line of audio equipment for the home.

The new system, which comes in a hand-rubbed oiled walnut enclosure, measures only 5¾" deep which makes it suitable for wall or narrow shelf mounting. Speakers include a 10" woofer with free-air resonance of 30 cps, an 8" closed-back mid-range speaker, and a dome radiator ultra-tweeter. Coil capacitor crossover is at 600



cps and the bridging capacitor crossover is at 4000 cps. Over-all response is to 20,000 cps. The unit will handle 25 watts and rated impedance is 8 ohms. A minimum of 10 watts is required to drive the speaker.

STEREO TAPE DECK

17 **Allied Radio Corporation** has recently introduced a stereo tape deck as the "Knight KN-4400." Measuring only 13" x 13" x 6¼", this two-speed tape deck provides complete four-track

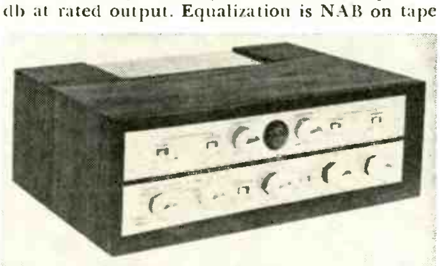
stereo and mono tape facilities. It has a laminated four-track record-play head and a double-gap erase head. A built-in stereo record-play preamp includes dual vu meters for precise recording level adjustment.

Frequency response is 50-15,000 cps ± 3 db at 7.5 ips and 50-10,000 cps ± 3.5 db at 3.75 ips. Signal-to-noise ratio is better than 40 db and flutter and wow is less than 0.2% r.m.s.

STEREO AMP/PREAMP

18 **Vidaire Electronics Manufacturing Corp.** has entered the hi-fi components field with the introduction of the Model VC-50 stereo amp-preamp.

Power output is 50 watts (25 watts per channel) with 80 watts peak. Response is 30-30,000 cps ± 1 db at rated output. Equalization is NAB on tape



and RIAA on phono. Channel separation is 45 db.

The unit is housed in a cabinet measuring 15¼" wide x 10¾" deep x 5¼" high. The firm plans to market a multiplex tuner in the near future designed to operate with the VC-50.

PRECISION RECORDERS

19 **Crown International** has developed a new series of tape recorder/reproducers especially for industrial and government applications. Designated as the BX800 series, six models are available according to number of tracks and recording time required.

Each model features three heads, three drive motors, and three equalized standard speeds of 3.75, 7.5, and 15 ips. Additional speeds of 15/16 and 1⅞ ips are available for a total of five speeds with 99.8% timing accuracy. The series has a 10½-inch reel capacity with ¼-inch tape. Individual certified performance data is furnished with each instrument.

Complete electrical, mechanical, and performance specifications on this new series are available from the manufacturer.

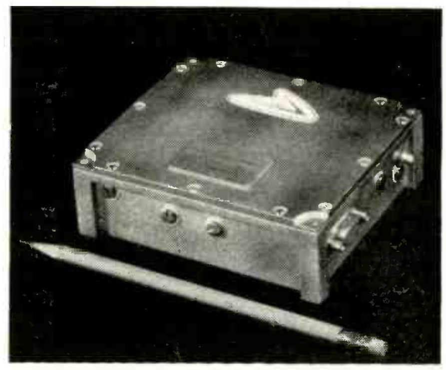
CB-HAM-COMMUNICATIONS

POCKET-SIZE TRANSCEIVER

20 **Arvin Industries, Inc.** is marketing a compact CB transceiver which measures only 6½" high x 1-9/16" deep x 2¾" wide. Powered by standard batteries, this 9-transistor unit operates in the range 26.97-27.27 in license-free service. The transceivers are sold in pairs complete with genuine leather carrying cases and leather shoulder straps. A supply of 12 batteries is packed with the transceivers.

AEROSPACE TRANSMITTER

21 **Tele-Dynamics Division of American Bosch Arma Corp.** has developed a solid-state, one-watt transmitter for aerospace applications. The



Type 1054 is a crystal-stabilized FM transmitter which will cover any frequency in the 215 to 260 mc. telemetry band. The transmitter employs silicon transistors and is enclosed in a pressure-sealed aluminum case.

The unit measures 4 9/32" wide x 4 15/16" long x 1⅝" deep and weighs 27 ounces. It is provided with a 9-pin power connector and r.f. output connector. The pressure-sealed case is suitable for unlimited altitude and affords complete protection against humidity, salt spray, sand, and dust.

COMPACT CB TRANSCEIVER

22 **Standard Radio Corp.** is currently marketing a compact CB transceiver as the "Unitalky 10." Offering a broadcast range of 2 to 3 miles over average terrain and a marine range of 10 or 11 miles, this 9-transistor unit is designed for heavy industrial field use as well as for the hobbyist.

Powered by eight "AA" penlite cells, the circuit incorporates a meter which functions as a battery-condition indicator in "receive" and as a modulation-level indicator in "transmit." A built-in noise limiter reduces interference during standby and reception phases.

The unit is housed in a rugged all-steel case which measures 1⅗" x 7 1/10" x 2¾". The unit is tropicalized, moisture-resistant, and fungus-proofed. It weighs 1¾ pounds including batteries.

MARINE RADIOTELEPHONES

23 **Sonar Radio Corporation** has added two new units to its line of marine electronic equipment—the Models 45 and 70 radiotelephones.

The Model 45 (45 watts) features a standard broadcast band and six channels. The receiver

has an automatic noise limiter and adjustable r.f. sensitivity control. Front-panel tuning is provided for simplicity of tune-up. A transistor power supply provides high efficiency and low battery drain.

The Model 70 (70 watts) has the same features as the Model 45 but is designed to meet FCC regulations for commercial boatmen.

LOW-COST FACSIMILE UNIT

24 **Dictaphone Corporation** is marketing and servicing a new facsimile transmission system which is said to be simple to operate, fast, and low cost.

The "Datafax/Data-phone" setup is small enough to be maintained at a secretary's work station and can be operated both automatically and manually. Under the automatic system, the sender dials the number of the person at the

receiving machine and when connected inserts the copy to be transmitted. It takes 6 minutes to send 90 square inches of visual image. The transmission is completed by hanging up the phone. The facsimile machine is made by **Stewart-Warner** and the companion phone unit is a development of **A.T. & T.**

TELEMETRY TRANSMITTER

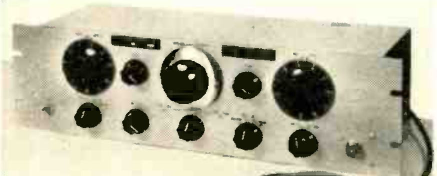
25 **Vector Manufacturing Company, Incorporated** has announced the availability of a 5-watt solid-state telemetry transmitter, the TRPT-5V.

Output impedance of this rugged and ultrastable transmitter is 50 ohms; frequency range is 215-260 mc. with frequency stability of $\pm 0.005\%$. Power output is 5 watts with a power input requirement of 28 volts d.c. $\pm 10\%$ at 1.6 amp. Temperature range is —20 to +80 degrees centigrade.

INTERFERENCE SUPPRESSORS

26 **The Pioneer Electric & Research Corporation** has developed a series of compact adapters for radio receivers which are being marketed as "QRL Interference Suppressors."

Designed to prevent frequency jamming as well as eliminate interference, the new devices operate on the principle of phase selectivity and

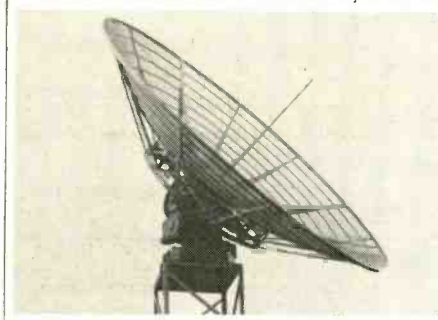


are to be connected ahead of any radio receiving system. They will reject man-made interference such as a broadband spark discharge or encroaching radio signal by 60 db or more. Various models cover specific bands within the range of 150 kc. to 25 mc. When not in suppression service, the units double as tuned preselectors providing improved signal-to-noise and image ratios, while reducing intermodulation responses.

STEERABLE PARABOLIC ANTENNAS

27 **Technical Appliance Corporation** has announced the availability of steerable parabolic antennas for telemetry applications in 12, 14, 15, 16, 18, 19, 24, 28, 30, and 32-foot diameters with a choice of feeds and frequency ranges.

These servo-controlled antenna systems are



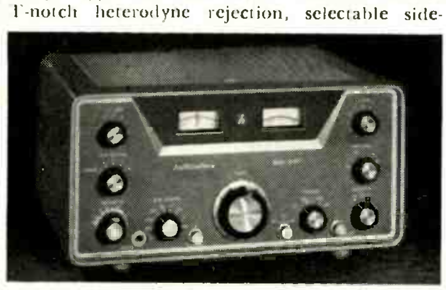
capable of rotation through 360 and 180 degrees in the azimuth and elevation planes respectively. Operation is performed remotely from a control panel, providing accuracies of 0.05" in azimuth and 0.10" in elevation.

COMMUNICATIONS RECEIVER

28 **The Hallicrafters Co.** is currently introducing a new triple-conversion communications receiver, the Model SX-117.

Equipped for SSB, CW, and AM operation, the receiver will cover thirteen 500-kc. segments between 85 kc. and 30 mc. when coupled with its low-frequency tuner accessory unit. It is equipped with crystals for the 80- through 10-meter amateur bands.

The SX-117 features a crystal-controlled high-frequency oscillator on all ranges. It has two detectors: a product type for SSB/CW and an envelope type for AM. Other features include T-notch heterodyne rejection, selectable side-



bands, a backlash-free tuning mechanism, and v.f.o. which can be locked on any frequency within the tuning range.

TUBE FOR MOBILE USE

29 **Westinghouse Electronic Tube Division** is now offering a new frequency-multiplier tube for use in mobile communications equipment operating from a six-cell storage battery power source. The Type 8084 is a seven-pin miniature sharp cut-off r.f. pentode suitable for compact equipment because of its small size and low power requirements.

The heater of the tube is designed to operate over a voltage range of 12 to 15 volts with momentary excursions from 10 to 16 volts. A coiled heater insures dependable operation under these adverse conditions.

AMATEUR TRANSMITTER

30 **Allied Radio Corp.** has recently added the "Knight-Kit T-150" AM-CW transmitter to its line of kits for the amateur radio operator.

The new unit operates with 150 watts peak

AM/CW input on 80 through 10 meters and 100 watts peak AM/CW on 6 meters. It features controlled carrier screen modulation for maximum power. A specially designed v.f.o. provides stable frequency control on all bands. The v.f.o. has an indirectly lighted dial scale and planetary drive for easy tuning without backlash. A socket is provided for optional crystal operation and is switch-selected by means of the variable-frequency oscillator.

The case is styled in gray satin metal and measures 8½" x 17" x 10½". It comes complete with plugs, wire, solder, and assembly instructions. The mike, key, and crystals are available as accessories.

CB-AM ANTENNA

31 **The Antenna Specialists Co.** has developed a new antenna which combines both Citizens and AM broadcast bands in one unit. Although the M-103 is peaked for maximum CB performance, it is said to operate equally well for broadcast AM reception. An automatic dividing harness switches the antenna from AM to CB when the respective unit is operated.

The M-103 is center-loaded, cowl mount, and fits in the ⅞" to 1-3/16" hole normally provided for the average car radio antenna. It is only 46" high in operation and telescopes to 31".

MANUFACTURERS' LITERATURE

DIODE REFERENCE GUIDES

32 **National Transistor** has available two new subminiature glass diode reference guides, each a four-page publication giving characteristics and test specifications on EIA-registered types. Arranged in simple numerical order, the publications cover germanium and silicon types. Characteristics covered include p.i.v., forward current and voltage, reverse current and voltage, high-temperature reverse current, reverse recovery time, test circuit, and capacity.

CAPACITOR LIFE-TESTS

33 **Arco Electronics, Inc.** has issued a 4-page bulletin which contains the results of a 10,000 hour life test on its type PJ tubular polystyrene capacitors.

The tests were conducted in a calibrated temperature chamber on regular production lots of the firm's 100-volt units, representative of single dielectric, and 400 volt units, representative of dual dielectric types. Results at 1000, 2000, 3000, and 10,000 hours are tabulated.

AIR-CORE INDUCTORS

34 **Illumitronic Engineering Corporation** has issued a 10-page folder covering its complete series of air-core inductors designed especially for the amateur rig or for prototypes of r.f. transmission equipment.

The folder gives technical data on the coils which may be used for pi output circuits, conventional LC output circuits, interstage, and oscillator circuits. The new series, featuring high heat resistance up to 500 degrees F, consists of a standard coil type, a variable pitch type, and an indented type in a range of diameters from ½ inch to 5 inches.

ELECTRONIC "BUILDING BLOCKS"

35 **Magnetics Research Co., Inc.** is offering a 14-page catalogue which illustrates a new line of transistor and magnetic core digital building blocks. The publication provides complete

specifications, simple rules for logic and loading, and full data on assembling these units into systems.

Various available aids are described, such as "Sew-A-Circuit" cards for mounting modules, racks, power supplies, layout, and logical symbol sheets.

DIRECT-WRITING RECORDER

36 **Brush Instruments Division** has just published a 20-page illustrated booklet that describes uses of the direct-writing recorder as applied in supervision, troubleshooting, and maintenance of telecommunications equipment.

The booklet shows how a two-channel unit provides a method for locating malfunctions where established testing procedures fail to locate the source of trouble. The booklet also discusses how the recorder can be used to check out telephone equipment in those areas where standard testing procedures have not been established.

FACILITIES BROCHURE

37 **Kearfott Division** has published an illustrated brochure describing its expanding hydraulic facilities and capabilities. The publication outlines in photographs and text the advancement and accomplishments achieved in the field of hydraulic and electrohydraulic control. A complete presentation of the firm's plant facilities is also given.

DIODE TESTER DATA

38 **Test Devices, Inc.** has released a new technical bulletin on its Model 1050 diode tester. The bulletin contains range selection charts, typical oscilloscope traces, specifications, and ordering information.

MAGNETIC STORAGE DEVICES

39 **LFE Electronics** has included specifications and applications for its lightweight, compact Bernoulli Disk rotating magnetic storage devices in its technical data bulletin series 2200. The 38 pages of information in the series employ copious illustrations to present the simplicity of design, storage capabilities, and environmental range of shock-and-vibration-insensitive units. Also included is a technical article on "The Development of the Flexible-Disk Magnetic Recorder" reprinted from the "Proceedings of the IRE."

POWDER METAL PRODUCTS

40 **Gilman Engineering & Manufacturing Co.** is offering an "idea book" for design engineers on the application and use of powder metal components. Components featured are stainless steel acoustical filters for communications, sound, and sonar equipment. Other powder metal specialty components are also discussed.

Illustrated throughout are examples of the firm's facilities and capabilities. Application studies round out the descriptive material in the brochure.

ALTERNATOR DIODE GUIDE

41 **Tung-Sol Electric Inc.** has available a comprehensive replacement guide for silicon rectifiers used in all makes of automotive alternators.

The guide, Form A-301, lists by manufacturer's number and current rating all 30 original equipment automotive alternator diodes and shows which of the 14 of the firm's units serve as exact replacement. Each of these replacements is the full electrical equivalent of the type it replaces.

REPLACEMENT PARTS

42 **Workman Electronic Products, Inc.** has issued a 60-page catalogue (No. 100) which covers replacement components for radio and television applications.

Included in the catalogue are antenna coils, auto radio resistors, wirewounds, carbon bar resistors, chemicals and chemical fuses, circuit breakers, dummy loads, fused and glass resistors, i.f. transformers, power transistors, service aids and accessories, silicon rectifiers, test accessories, among others.

Items are pictured, along with pertinent technical specifications and information on the part or parts in the original equipment they replace.

DIGITAL MODULES

43 **Abacus, Incorporated** has published a three-page folder which describes its line of digital modules, as well as custom digital systems manufactured by the company.

In addition to picturing and describing the equipment, facility and personnel information is included.

FRAME-GRID TUBES

44 **Sylvania Electric Products Inc.** has available a new booklet entitled "Strap Frame Grid Subminiature Tube Manual" which it is offering free of charge.

The booklet details the characteristics of ten of the firm's new strap frame grid receiving tubes designed for industrial and military applications. Data sheets, performance information, mechanical and electrical ratings as well as characteristics curves are included.

TOGGLE SWITCHES

45 **Control Switch Division of Controls Company of America** is offering a 24-page catalogue (No. 180) which describes the partial but most popular line of toggle switches produced by the firm.

The publication pictures the switches in actual-size photos, and includes specifications and dimension drawings. The copy is indexed by model numbers and definitions of electrical and mechanical terms are included.

HALL-EFFECT DEVICES

46 **Instrument Systems Corp.** describes a line of Hall-effect products in its new 8-page, 2-color catalogue No. H-20014.

The catalogue provides detailed engineering specifications and application data on more than 50 "Hall*istor" devices and components immediately available from stock for a broad range of detection, measurement, computation, and control functions. Included are probes, multipliers, modulators, tape heads, signalers, current measuring rings, and pick ups.

NOISE-LIMIT INDICATOR

47 **B & K Instruments, Inc.** has available a 4-page technical brochure covering the Model 2211 noise-limit indicator and its applications for production-line noise and vibration analysis for quality-control applications.

The brochure contains a general description of the instrument, applications, and specifications on the unit.

CB NEWSLETTER

48 **Browning Laboratories, Inc.** is now publishing an informative newsletter, "The CBeat," which it is offering without charge to any Citizens Band radio club.

The newsletter will be issued periodically and is designed to keep the reader informed of the latest happenings in the world of CB communications. CB clubs wishing to receive the newsletter should send their name, address, and number of members to the company.

AUDIO COMPONENTS

49 **Grommes Division of Precision Electronics, Inc.** has just issued an attractive brochure which illustrates and describes the company's line of stereophonic amplifiers, multiplex stereo tuners, and stereo receivers.

In addition to providing full technical specifications on the equipment, the brochure describes and illustrates cabinetry and suggested settings.

ELASTOMERIC ADHESIVES

50 **Minnesota Mining and Manufacturing Company** is now offering a revised 12-page illustrated catalogue which describes the properties and typical uses of newly developed elastomeric adhesives, coatings, and sealers for the general metalworking, electrical manufacturing, and appliance industries.

The catalogue lists and illustrates representative examples of how these new adhesives, coatings, and sealers can be used to improve product performance and reduce costs.

A.C. VOLTAGE STABILIZER

51 **General Electric Company** has issued an 8-page bulletin covering its "Stabilitron" for precise voltage control applications in computers, communications equipment, radar, industrial process control, and medical and industrial x-ray equipment. The publication details performance, features, and characteristics to simplify application in electrical and electronic equipment requiring precise voltage control.

CONDENSED CATALOGUE

52 **General Radio Company** has published a 20-page condensed catalogue which provides salient features of the most popular items in its line. Included are a variety of test instruments, measuring equipment, coaxial connectors and accessories, laboratory standards, sound and vibration measuring equipment, autotransformers, and small parts. Photographs and complete technical specifications are provided on each item.

KIT CATALOGUE

53 **Heath Company** now has available copies of its complete catalogue of kits covering units of interest to audiophiles, hams, boating enthusiasts, educators, and technicians and professional electronics personnel.

This elaborate 100-page publication provides photographs, complete specifications, mechanical details, physical dimensions, shipping weight, prices, and special features on the firm's entire line of kits and wired equipment.

MICA CAPACITORS

54 **General Instrument Corporation** has released a new 12-page engineering bulletin, MC-1, which provides comprehensive electrical performance data on its entire commercial mica capacitor product line as well as the recently revised military specifications on mica capacitors (Mil-C-5B).

In addition, the bulletin describes the firm's subminiature molded mica capacitors with complete specifications and ratings.

POWER SUPPLY DATA

55 **Acopian Technical Co.** now has available a complete set of bulletins describing six series of plug-in power supplies. These "Application Hints" cover the use of unregulated power supplies designed for operating relays and lamps. The publications also include information on using power supplies in series or parallel, reducing ripple, as well as how to vary the output on power supplies designed for fixed voltage.

RECORD PLAYBACK COMPONENTS

56 **Empire Scientific Corp.** is offering copies of its 4-page brochure which describes the technical features of a comprehensive line of record playback components. There are details and diagrams of the firm's "Troubador" turntable, the 980 playback arm, the 880p cartridge, and the "Dyna-lift" stylus. Also included are product prices and a comparison specification chart.

COIL-FORM CATALOGUE

57 **National Radio Company** has just published a new brochure cataloguing its complete line of coil forms. Six series of forms are detailed, with break-away diagrams illustrating the special features of the units.

The publication covers the XR-50,60,70,80, and 90 series of coil forms. In addition, the brochure provides complete specifications on the new XR-100 series.

There are complete specifications and descriptions, along with a large photograph and engineering drawings of each series with complete dimensional details. The catalogue has been designated Bulletin CO-8.

TECHNICIANS' AID

Sprague Products Company has issued a revised edition of its electrolytic capacitor replacement manual which has been expanded to show 35 set suppliers not found in the previous edition.

Manual K-106 now covers 256 makes from "Acme" to "Zephyr" and includes TV sets as well as home, auto, and portable radios manufactured from 1947 through July 1962. The manual lists original part numbers for each manufacturer, followed by ratings, recommended **Sprague** replacements, and list prices.

The manual is available without charge from any of the firm's distributors when requested in person. ▲

V.H.F. SOCIETY DINNER

THE East Coast V.H.F. Society Inc. will hold its Fifth Annual Dinner and Hamfest on February 23rd at the Swiss Chalet, Passaic Street, in Rochelle Park, New Jersey.

Scheduled to begin at 7:30, the event will feature awards, prizes, dancing, a contest, a well-known speaker, and surprises. ▲

Answers to "More Famous Names"

(Appearing on page 76)

1. N	7. I	13. H
2. J	8. E	14. D
3. F	9. R	15. L
4. Q	10. G	16. K
5. M	11. O	17. P
6. A	12. B	18. C

Answer to Electronic Crosswords

(Appearing on page 83)

A	B	E	T	■	B	O	S	S	■	H	A	L	O
D	E	L	E	■	A	R	O	W	■	A	R	A	B
E	L	E	C	T	R	O	D	E	■	L	A	B	S
■	■	C	H	U	G	■	■	E	M	F	■	Y	■
A	■	T	■	B	E	A	M	P	O	W	E	R	■
S	C	R	E	E	N	■	■	V	I	A	■	I	E
H	O	O	F	■	E	C	H	O	■	V	E	N	T
■	I	N	F	E	R	■	I	L	■	E	S	T	■
■	■	B	E	T	A	■	E	T	A	L	■	H	F
A	L	E	C	■	T	■	S	A	B	I	N	■	■
B	E	A	T	■	O	D	■	G	■	N	O	S	■
C	A	M	S	■	R	C	■	E	N	E	R	G	Y

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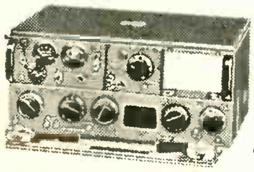
AN/ART-13 100-WATT XMTR



11 CHANNELS
200-1500 Kc
2 to 18.1 Mc

$69.50 exc. used

Complete with Tubes

Famous Collins Autotune Aircraft Transmitter. AM, CW, MCW. Quick change to any of ten preset channels or manual tuning. Speech amplifier/clipper uses carbon or magnetic mike. Highly stable, highly accurate VFO. Built in Xtal controlled calibrator. PP811s modulate 813 in final up to 90%. class "B". A Real "HOT" Ham buy at our low price! Orig. cost $1800.

AN/ART-13 XMTR as above, Like New .. $79.50
0-16 Low Freq. Osc. Coil for ART-13 .... 7.95
24V Dynamotor for ART-13 .... 11.95
Same as above less meter 39.50
We carry a complete line of spare parts for above.

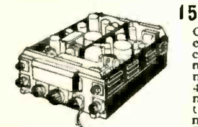
AN/APR-4 RECEIVER only. 38 to 4000 Mc in 5 tuning unit ranges. High precision lab instrument. Input 115 V60 cy. **Like New** $79.50
Tuning Units TN16, 17, 18 each $39.50
Tuning Unit TN19. **Brand New** $89.50
Tuning Unit TU54 .... $149.50

NAVY AIRCRAFT RADIO RECEIVER

ARB/CRV 46151—190 to 9050 Kc in 4 bands. 6 Tube Superhet communications receiver, with local and remote tuning, band change. Sharp and broad tuning. AVC, CW, Illuminated dial. Complete with tubes and dynamotor.
BRAND NEW $49.50
Pwr Supply 110 V. AC. Wired 14.95
All Accessories for ARB Receiver in Stock

FAMOUS BC-645 TRANSCEIVER

15 Tubes 435 to 500 MC

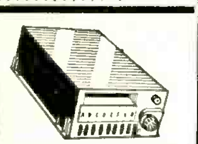


BRAND NEW

Can be modified for 2-way communication, voice or code, on ham band 420-450 mc. citizens radio 460-470 mc, fixed and mobile 450-460 mc. television experimental 470-500 mc. 15 tubes (tubes alone worth more than sale price!): 4—7F7, 4—7H7, 2—7E6, 2—6F6, 2—955 and 1—WE-316A. Now covers 460 to 490 mc. Brand new BC-645 with tubes, less power supply in factory carton.
Shipping weight 25 lbs. **SPECIAL!** **$19.50**
PE-101C Dynamotor, 12/24V input $7.95
UHF Antenna Assembly 2.45
Complete Set of 10 Plugs 5.50
Control Box 2.25

SPECIAL "PACKAGE" OFFER:
BC-645 Transceiver, Dynamotor and all accessories above. COMPLETE, BRAND NEW, While Stocks Last **$29.50**

ARC-3 RECEIVER!



Complete with All Tubes Exc. Used **$19.95**

Like NEW ...... $29.50.
Crystal-controlled 17-tube superhet, tunes from 100 to 156 MC., AM., on any 8 pre-selected channels. 28-volt DC power input. Tubes: 1-9002, 6-6AK5, 1-12SH7, 3-12SG7, 1-9001, 1-12H6, 2-12SN7, 1-12SL7, 1-12A6.
110 V A.C. Power Supply Kit for above 15.00
Factory Wired and Tested **19.95**

ARC-3 TRANSMITTER

Companion unit for above, tunes 100 to 156 MC on any 8 pre-selected channels. 9 tubes, crystal controlled, provides tone and voice modulation. 28V DC Power input. Complete with all Tubes: 3-6V6, 2-832A, 1-12SH7, 1-6J5, 2-6L6. Exc. Used .... Only **$18.95**
Like new condition $28.50
ARC-3 PUSHBUTTON CONTROL BOX $5.95

ACCESSORIES for BC-603, 683 RECEIVERS

EXTRA SET OF 10 TUBES FOR ABOVE brand new in original boxes $3.95
12 or 24V Dynamotor for Above. Exc. Used $4.25 .... Brand New **$5.50**

AC POWER SUPPLY FOR BC603, 683
Interchangeable, replaces dynamotor. Has On-Off Switch. NO RECVR. CHANGE NEEDED. Provides 220 VDC @ 80 Ma. 24VAC @ 2 Amps $12.95
Complete 240-page Technical Manual for BC-603, 604 .... $3.15
BC-604 TRANSMITTER—Companion unit for BC-603 Rcvr. above. With all tubes. BRAND NEW **$8.95**
4-Section Antenna for BC-604, 684 Transmitters. Complete with mounting base. BRAND NEW. $4.95
We carry a complete line of spare parts for above.

APN-1 FM TRANSMITTER-RECEIVER
420 to 460 Mc Aircraft Radio altimeter equipment. Tubes: 4-955, 3-12SJ7, 4-12SH7, 2-12H6, 1-VR150; Complete with tubes, brand new **$11.95**
APN-1 Exc. used, like new $8.95

AN/ARR-2 RECEIVER 234-258 Mc., UHF tunable receiver, including 11 tubes: 3-6AK5, 1-12A6, 7-9001. BRAND NEW, with tubes **$8.88**
Used, with tubes $5.95

ARC-5/T-23 TRANSMITTER 100-150 Mc., includes tubes: 2-832A, 2-1625. BRAND NEW, with tubes **$21.50**
Excellent Used, less tubes $5.95

ARC-5/R-28 RECEIVER, 2-meter superhet, 100 to 156 Mc in 4 crystal channels, complete with 10 tubes. BRAND NEW, with tubes **$26.50**
Excellent Used, with tubes $23.50

TG-34A CODE KEYER. Self contained automatic unit for code practice tapes from 5 to 25 words per minute. Like New, tested **$26.50**
Set of 14 Reels Army Code Practice Lessons. Brand New .... P.U.R.

IMPORTERS—EXPORTERS of ELECTRONIC EQUIPMENT

We specialize in the export of military surplus electronic equipment:

- All at LOWEST PREVAILING PRICES.
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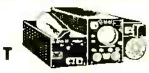
- **IF YOU DON'T SEE WHAT YOU WANT HERE, WRITE US YOUR NEEDS. LET US QUOTE ON ANY GOV'T SURPLUS ELECTRONIC EQUIPMENT YOU SEE ADVERTISED ANYWHERE. INQUIRIES WELCOMED.**
- All packing and shipping is made directly from our own warehouse in NYC to give you substantial savings in handling costs!

SEND FOR LATEST FREE G & G BULLETIN OF SURPLUS MILITARY ELECTRONIC EQUIPMENT.

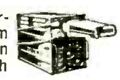
LORAN APN-4



FINE QUALITY NAVIGATIONAL EQUIPMENT

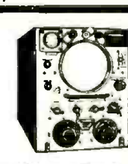
Determine exact geographic position of your boat or plane. Indicator and receiver complete with all tubes and crystal.
INDICATOR ID-6B/APN-4, and RECEIVER R-9B/APN-4, complete with tubes, Exc. used **$49.50**
Receiver-Indicator as above, BRAND NEW **$88.50**
Shock Mount for above $2.95
INVERTER POWER SUPPLY for Loran. Made by Eclipse—Pioneer Div. INPUT: 24 V DC @ 75 A. OUTPUT: 115 V AC @ 10.5 Amps, 800 cycles. Complete with two connecting plugs BRAND NEW $49.50
12-Volt Inverter Power Supply, Like New. P.U.R.
We carry a complete line of spare parts for above.

LORAN R-65/APN-9 RECEIVER & INDICATOR



Used in ships and aircraft. Determines position by radio signals from known xmitters. Accurate to within 1% of distance. Complete with tubes and crystal. Exc. used.
Value $1200.00. Our Price **$79.50**
Used, less tubes, crystal and visor, but with 3BP1 C.R. tube **$29.50**
INVERTER POWER SUPPLY. INPUT: 24 V DC. OUTPUT: 115 V AC. 800 cy. BRAND NEW $49.50
12-Volt Inverter Power Supply, Like New .. P.U.R.
Shock Mount for above $2.95
Circuit diagram and connecting plugs available.
We carry a complete line of spare parts for above.

LORAN APN/4 OSCILLOSCOPE



Easily converted for use on radio-TV service bench.
LIKE NEW! Less tubes, but including 5" Scope, type 5CPI only **$14.50**

BENDIX DIRECTION FINDERS

For commercial navigation on boats.
MN26Y 150-325 Kc; 325-695 Kc; 3.4-7 Mc. Complete with tubes, dynamotor, BRAND NEW **$19.50**
MN28Y Receiver Control Box .... $ 4.95
MN26C Receiver 150-1500 Kc continuous tuning with 12 tubes and dynamotor. Used... 18.95
MN26C Receiver as above. BRAND NEW 27.50
MN20E Rotatable Loop for above 4.95
MN52 Azimuth Control Box 2.95

SCR-274 COMMAND EQUIPMENT

ALL COMPLETE WITH TUBES

Type	Description	Used	Like NEW
BC-453	Receiver 190-550 KC	$12.95	$14.95
BC-454	Receiver 3-6 Mc	12.45	17.95
BC-455	Receiver 6-9 Mc	11.50	13.95
1.5 to 3 Mc.	Receiver Brand New		$17.95

110 Volt AC Power Supply Kit, for all 274-N and ARC-5 Receivers. Complete with metal case, instructions **$8.95**
Factory wired, tested, ready to operate .. $12.50
SPLINED TUNING KNOB for 274-N and ARC-5 RECEIVERS. Fits BC-453, BC-454 and others. Only **49c**

2.1 to 3 Mc. Transmitter, Brand New $12.95
BC-457 TRANSMITTER—4-5.3 Mc. complete with all tubes and crystal, BRAND NEW .. **$9.75**
Like New $7.95
BC-458 TRANSMITTER—5.3 to 7 Mc. Complete with all tubes and crystal. BRAND NEW **$10.95**
Like New $7.95
T19 TRANSMITTER 3/4 m.c. complete with all tubes and crystal. Exc. Used **$9.95**
BC-696 TRANSMITTER 3-4 Mc Complete with All Tubes & Crystal. Like New **$11.95**
BC-456 Modulator .... USED 3.45 NEW 5.95
MD7 Modulator, Like New $9.95
ALL ACCESSORIES AVAILABLE FOR ABOVE

SCHEMATIC DIAGRAMS For most equipment on this page, each **65c**

Please include 25% Deposit with order—Balance C.O.D., or Remittance in Full. 50c Handling Charges on all orders under $5.00. All shipments F.O.B. Our Warehouse, N.Y.C. All Merchandise subject to Prior Sale and Price Change.

G & G RADIO SUPPLY CO.
Telephone: CO 7-4605
77 Leonard St. New York 13, N. Y.

BC-929 3-INCH SCOPE

Low cost station monitor and/or bench scope. Has Horiz., focus, sweep, intensity controls. Tubes: 2—6SN7, 2—6H6, 1—6X5, 1—6G6, 1—2X2, 3BPI CR Tube. Voltage req. 115V 400 cy. and 24 VDC. Complete with tubes, exc. used **$9.95**
BRAND NEW $12.95
Conversion instructions for 110V 60 cyc. AC... 65c

TEST EQUIPMENT IE-36. Provides trouble-shooting tests of SCR-522A and SCR-542A sets: Starting & stopping mechanisms, channel selection circuits, switching etc. Complete with instruction manual. In sturdy carrying case.
BRAND NEW **$8.95**

LM FREQENCY METER

Crystal calibrated modulated. Heterodyne. 125 Kc to 20,000 Kc With Calibration book. **Complete. Like New** **$58.50**

BC-906 FREQ. METER—SPECIAL

Cavity type 145 to 235 Mc. Complete with antenna. Manual and original calibration charts included. **BRAND NEW. OUR LOW PRICE** **$11.88**

BC-221 FREQUENCY METER

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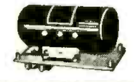

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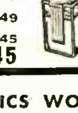

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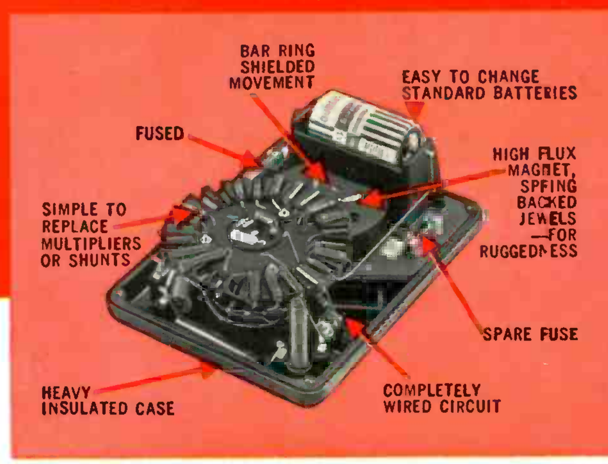

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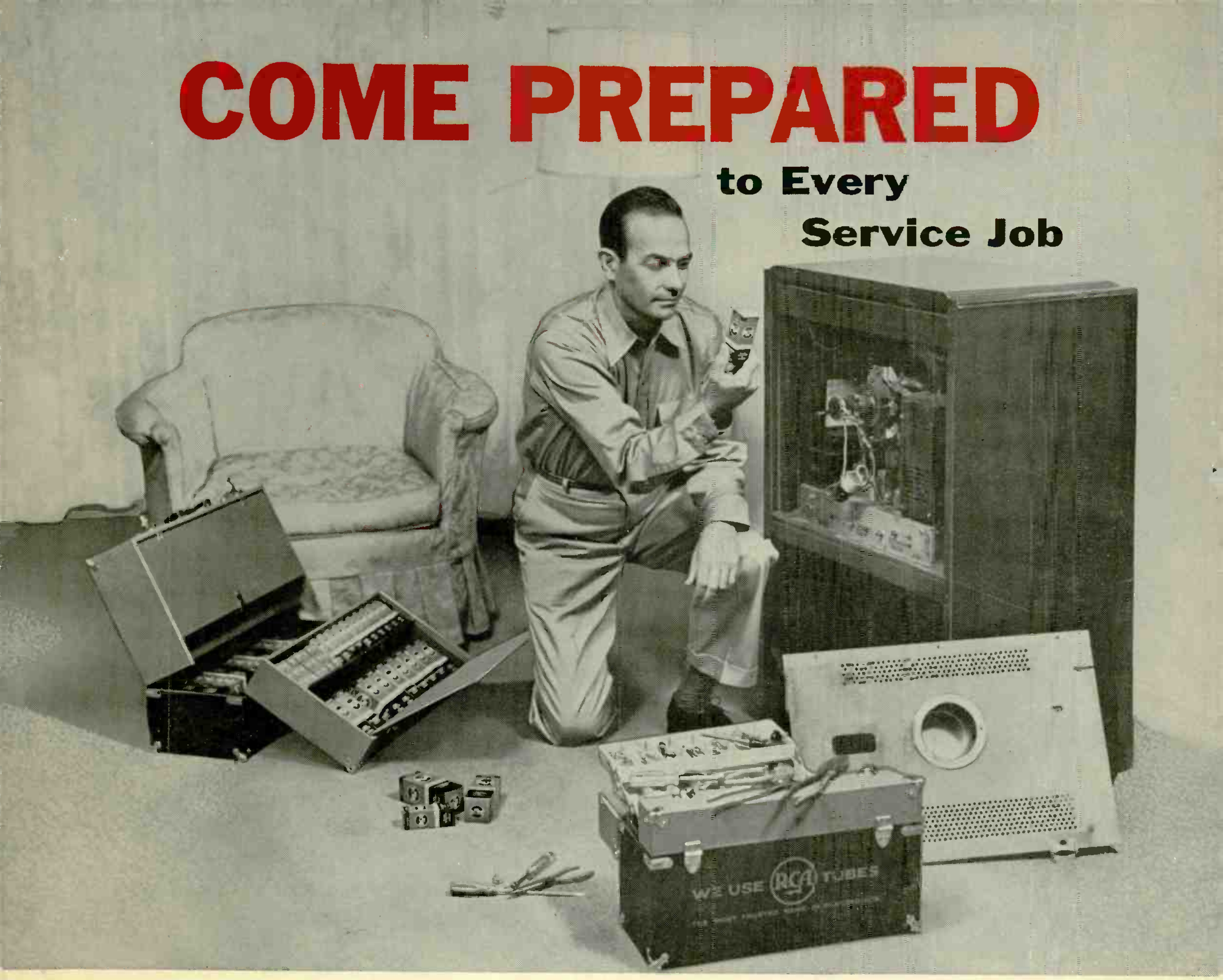

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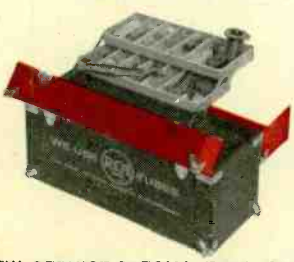

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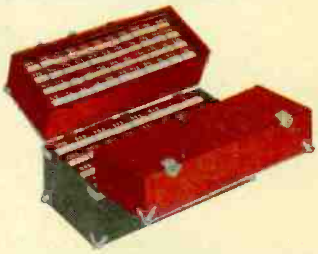

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