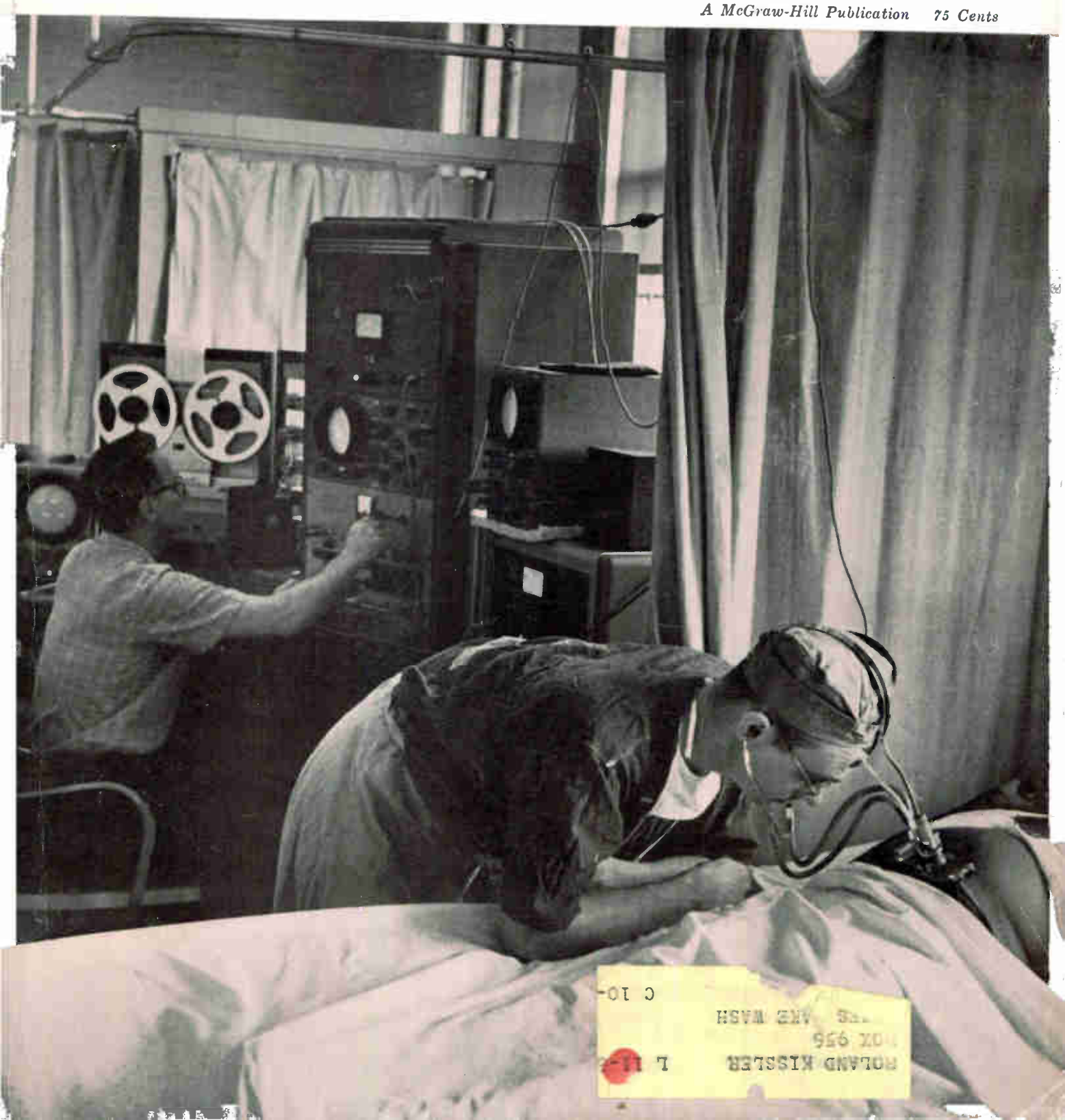
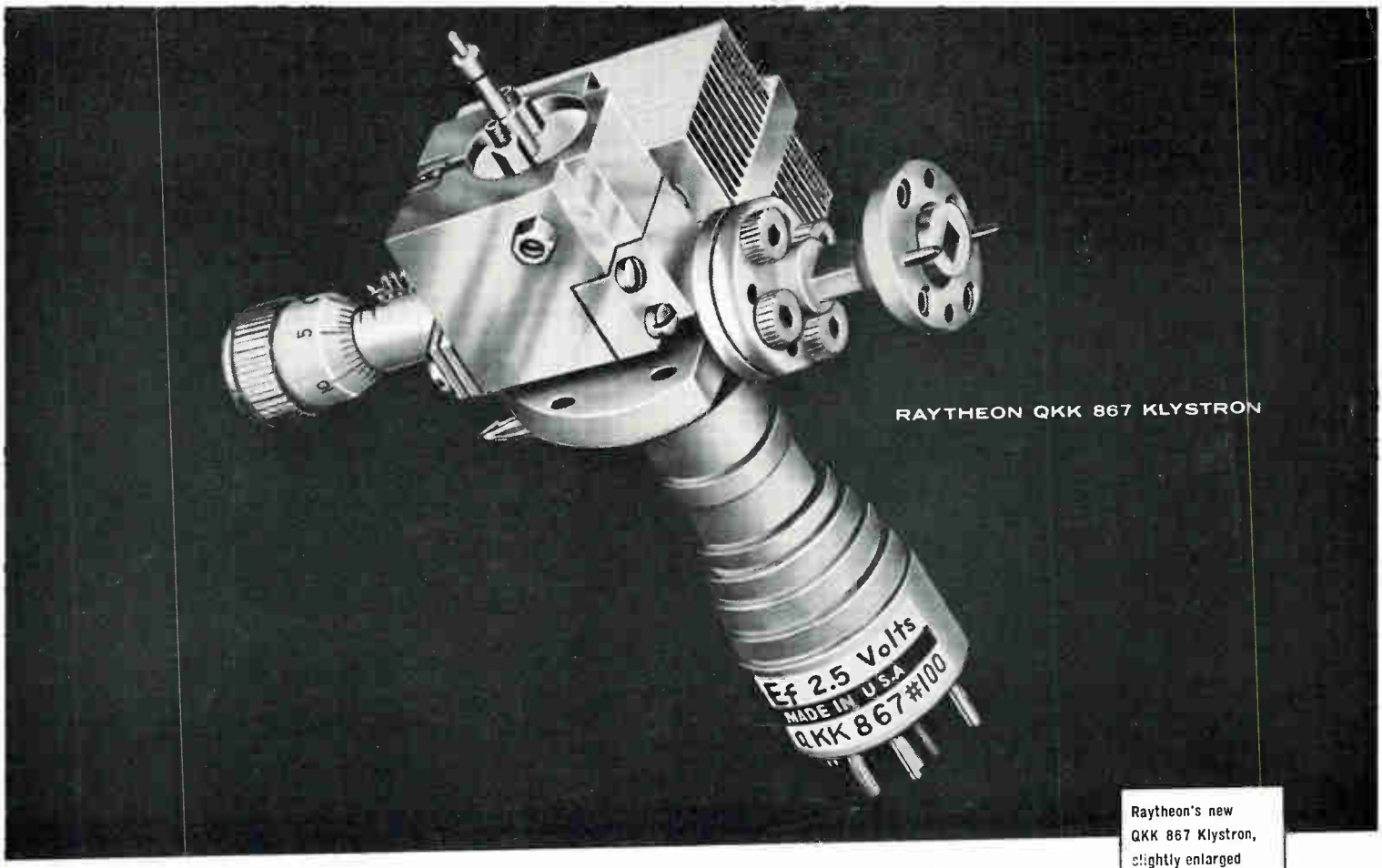
January 20, 1961

electronics

Phonocardiotachometer indicates beat-to-beat changes in fetal heart rate to determine possible distress. See p 49 for details on this and other electronic instruments for medical diagnosis

A McGraw-Hill Publication 75 Cents





Raytheon's new QKK 867 Klystron, slightly enlarged to show construction details. Actual maximum dimension: 4⅞ inches.

Now Raytheon offers 250-hour life with new klystrons for 50-101 kMc range

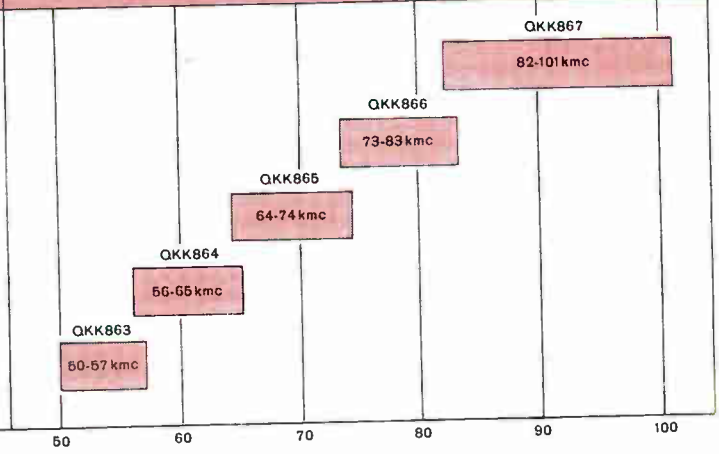
Raytheon announces five new reflex klystrons in the 50 kMc to 101 kMc frequency band. Featuring smooth vernier tuning, these integral-cavity tubes require unusually low voltages and can be operated from a single power supply. They are designed and constructed to withstand vibration of 10 G's (60 cps)—and are rated by Raytheon for 250 hours of operation.

Write for detailed application information and special development service to: Microwave and Power Tube Division, Raytheon Company, Waltham 54, Massachusetts. In Canada: Waterloo, Ontario.

TYPICAL OPERATING CHARACTERISTICS

	QKK863 thru QKK866	QKK867
Anode voltage	1400V	1700V
Anode current	40ma	50ma
Power output	40-400mW	15-40mW
Reflector voltage	-100 to -300V	
Focus voltage	-150V	
Heater voltage	2.5V	
Heater current	1.5A	
Tuner turns	10	
Power output (min)	25 mW	10 mW

FREQUENCY RANGE IN KMC



RAYTHEON COMPANY

MICROWAVE AND POWER TUBE DIVISION

RAYTHEON

January 20, 1961

electronics

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BUSINESS

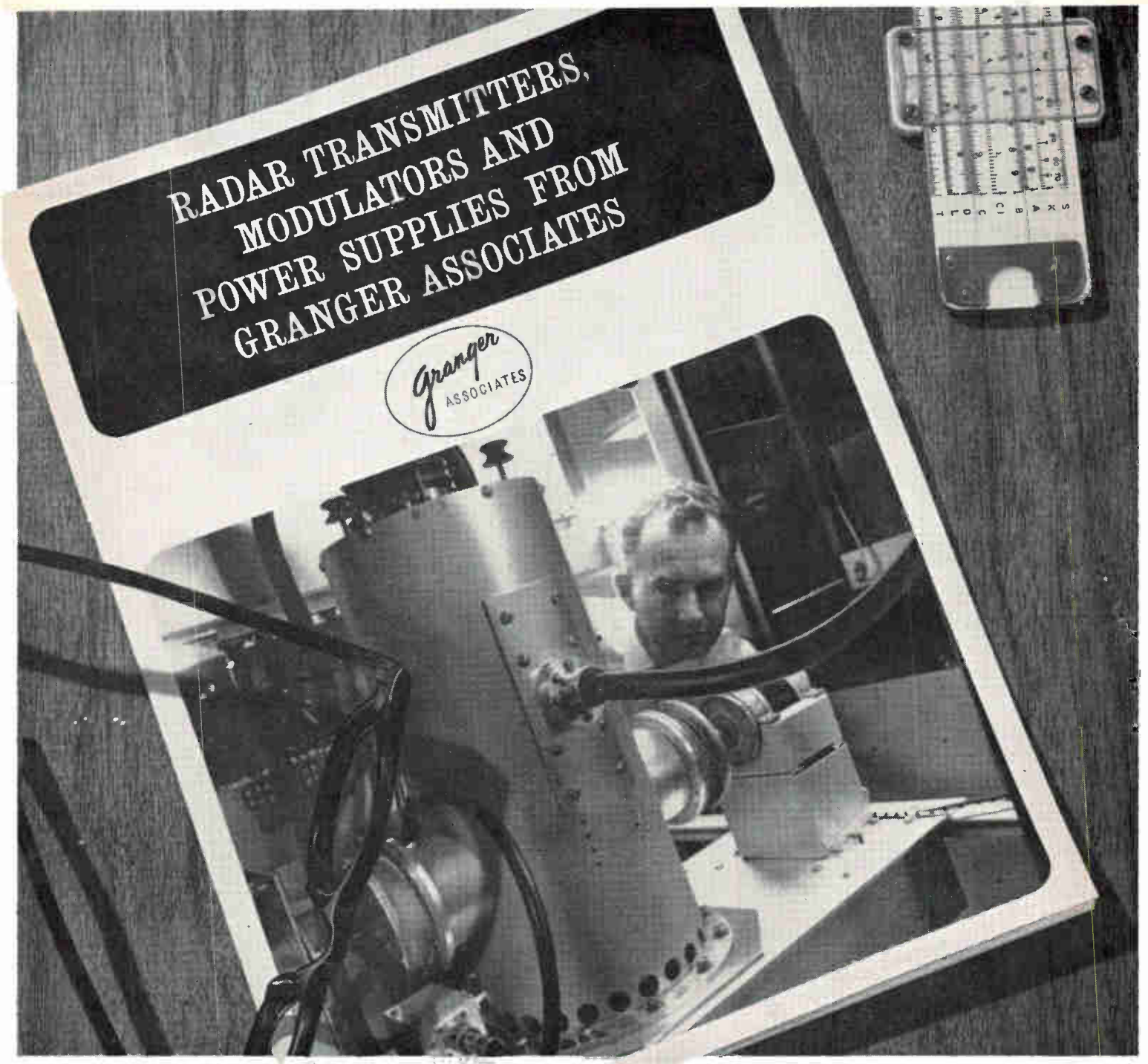
ENGINEERING

DEPARTMENTS

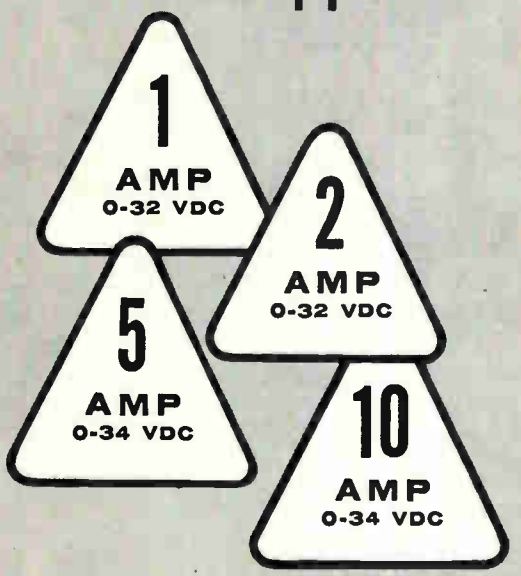
Some specific examples of equipments listed in the new Granger Associates report: a coherent 500 kw VHF radar transmitter with pulse lengths of 100 microseconds; modulators for TWT, klystron, magnetron and negative grid tube applications —a typical unit providing 170 kv pulse at 180 amperes; pulsed and CW r-f sources covering the entire radar spectrum; a coherent rapid-stepping ionosphere radar transmitter and receiver; pulse distributed amplifiers—a typical unit covering 4 to 32 Mc at 100 kw; extremely stable, regulated d-c power supplies up to 20 kv at 2 amps with 20 millivolts ripple. These and other Granger Associates radar system components have evolved out of G/A's practical contributions in the field of experimental and developmental radar. The report shown below gives you complete specifications on these special purpose equipments. You will either want to use it immediately—or save it for ready reference. May we send you a copy—airmail?

This new report from Granger Associates gives you complete specifications on a broad range of special purpose equipment ..... available now.

Granger Associates / 974 Commercial Street / Palo Alto, California / DAvenport 1-4175



LAMBDA
Transistorized Regulated Power Supplies



- **Convection cooled—no internal blowers to wear out.**
- **Guaranteed for a full 5 years.**
- **Compact. 1, 2, and 5 Amp only 3½" high, 10 Amp 7" high.**

- Ambient temperature 50°C.
- Excess ambient thermal protection.
- Special, high purity foil, hermetically sealed long-life electrolytic capacitors.
- Hermetically sealed transformer designed to MIL-T-27A.
- Remote sensing and DC vernier.

CONDENSED DATA ON LT SERIES

LT 1095M	(with meters)	0-32 VDC, 0-1 AMP	$315
LT 2095M	(with meters)	0-32 VDC, 0-2 AMP	395
LT 1095	(without meters)	0-32 VDC, 0-1 AMP	285
LT 2095	(without meters)	0-32 VDC, 0-2 AMP	365

MODEL	VOLTAGE BANDS
LT 1095, LT 1095M	0-8, 8-16, 16-24, 24-32
LT 2095, LT 2095M	0-8, 8-16, 16-24, 24-32

Regulation: Line: Better than 0.15 per cent or 20 millivolts (whichever is greater). For input variations from 105-125 VAC. **Load:** Better than 0.15 per cent or 20 millivolts (whichever is greater). For load variations from 0 to full load.

AC Input: 105-125 VAC, 50-400 CPS.

Ripple and Noise: Less than 1 millivolt rms.

Ambient Temperature: 50°C—continuous duty.

Remote DC Vernier: Provision for remote operation of DC Vernier.

Remote Sensing: Provision is made for remote sensing to minimize effect of power output leads on DC regulation, output impedance and transient response.

Size:
LT 1095 3½" H x 19" W x 14⅜" D
LT 2095 3½" H x 19" W x 14⅜" D

CONDENSED DATA ON LA SERIES

LA 50-03AM	(with meters)	0-34 VDC, 0- 5 AMP	$425
LA100-03AM	(with meters)	0-34 VDC, 0-10 AMP	540
LA 50-03A	(without meters)	0-34 VDC, 0- 5 AMP	395
LA100-03A	(without meters)	0-34 VDC. 0-10 AMP	510

MODEL	VOLTAGE STEPS
LA 50-03A, LA 50-03AM	— 2, 4, 8, 16 and 0-4 volt vernier
LA100-03A, LA100-03AM	— 2, 4, 8, 16 and 0-4 volt vernier

Regulation: Line: Better than 0.15 per cent or 20 millivolts (whichever is greater). For input variations from 100-130 VAC. **Load:** Better than 0.15 per cent or 20 millivolts (whichever is greater). For load variations from 0 to full load.

AC Input: 100-130 VAC, 60 ± 0.3 cycle. This frequency band amply covers standard commercial power lines in the United States and Canada.

Ripple and Noise: Less than 1 millivolt rms.

Ambient Temperature: 50°C—continuous duty.

Remote DC Vernier: Provision for remote operation of DC Vernier.

Remote Sensing: Provision is made for remote sensing to minimize effect of power output leads on DC regulation, output impedance and transient response.

Size:
LA 50-03A 3½"H x 19" W x 14⅜" D
LA100-03A 7" H x 19" W x 14⅜" D

LA 115

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CIRCLE 3 ON READER SERVICE CARD

electronics
January 20, 1961 Volume 34 Number 3

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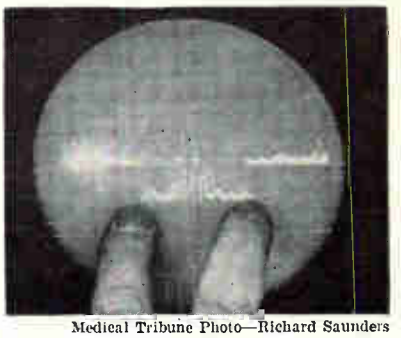


Medical Tribune Photo—Richard Saunders

MEDICAL ELECTRONICS—Starting in this issue is a set of articles by Associate Editor Bushor describing the role of electronics in the medical field. The first article discusses measurement techniques and instrumentation used in diagnosis. Physiological phenomena can be measured and recorded either directly using electrical potentials developed by the brain, heart, muscles and the like or indirectly using transducers to convert pressure, temperature, sounds and other parameters to electrical potentials. An example of the latter type is the conversion of the acoustic energy from a fetal heartbeat (cover) into the electrical signal shown in the photo (above).

These articles have been written in the hope that they will serve as a link in the chain of communication between our industry and medical science. Much work has already been done to establish this chain. The IRE's Professional Group on Medical Electronics has published an extensive bibliography on medical electronics that is constantly being updated. The annual conference on Electrical Techniques in Medicine and Biology, sponsored by the IRE, AIEE and ISA, with its digest of technical papers has been effective in getting the workers in the field together. Interchange of medical electronics information on a broader basis has been achieved by the three International Conferences on Medical Electronics held by the International Federation for Medical Electronics (IFME). Professional societies, foundations and universities throughout the world have contributed to this venture. The fourth conference is to be held in New York later this year.

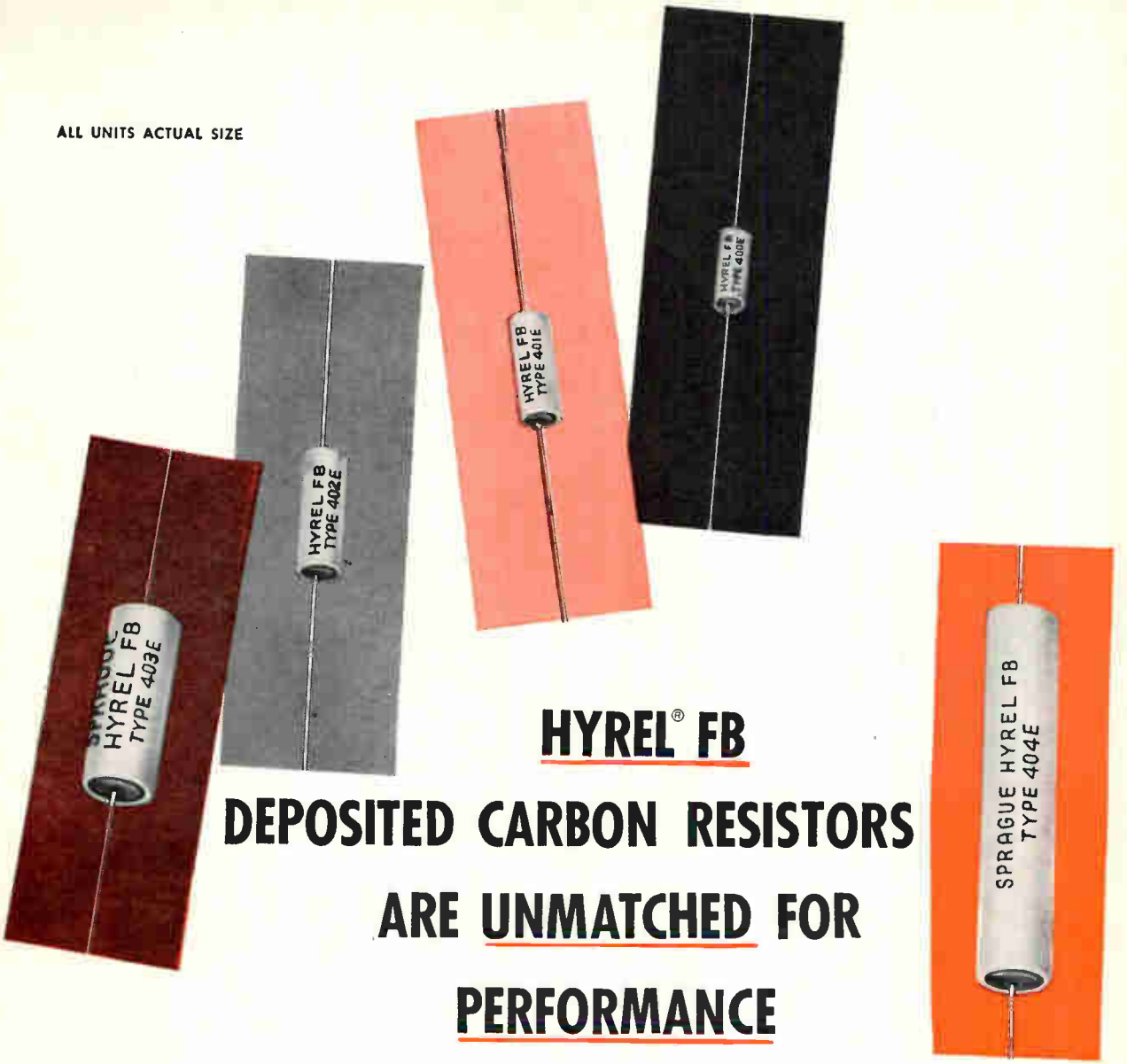
Not only has the medical profession benefited from the application of electronic techniques to the problems of medicine, but so has our industry. Because of the minute variations of electrical potentials measured by electrophysiological devices, electrodes of extremely high impedance are required. Invention of the cathode-follower amplifier was a direct result of filling this need.

Although each day brings a greater demand for electronic aids to medicine, the field must not be cheapened by quick marketing of ill-conceived, unnecessary, costly and gadget-type devices. It is absolutely necessary that our industry pay heed to the problems of operation, maintenance and special requirements in medical electronics. It has been suggested by Dr. Zworykin, president of the IFME, that independent facilities for engineering and testing medical electronics equipment should be made available to relieve instrument manufacturers of some of the risks and delays that now render some pioneering in medical electronics economically unattractive.

Medical electronics is just now starting to blossom as an industry. Anticipating numerous queries about the market, we can only offer our best prognosis—in another 20 years physicians will be heavily dependent on electronic equipment for routine office, hospital and clinical use. This timetable may be stepped up by the increasing interest in the field by the military—especially with regard to manned space vehicles.

Lastly, we would like to impart the heartening news that in one scientific area, at least, the Russians have admitted they are far behind the free world. In an internationally distributed paper, V. V. Parin of the Soviet Academy of Medical Sciences states their development of standard medical transducers is inadequate. According to Parin, each of their laboratories is compelled to use its own homemade transducers.

ALL UNITS ACTUAL SIZE



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COMMENT

Information Centers

Have just read the editorial "Information Centers" in Crosstalk, p 4, Dec. 16 '60, and wish to make a statement concerning this and other similar statements which have been made in various journals during the past few years.

In the first place, the statements made by William G. Alexander of Ryan Transdata are only partially true. Another reason that information centers do not now exist, nor will exist in the near future, is that there is a considerable amount of time and expense required in setting up such a program, during which no benefits can be expected. Management in general has therefore turned thumbs down on these projects. (This includes the military.) This may seem shortsighted, but since the program would not bolster profits during its initial stages, this attitude is justified from a practical viewpoint.

The information center, like all projects of any size, requires a great deal of outlay and training. The problems are now all easily solved; however, the factors which withhold these centers from our engineering staffs are not going to be overcome easily . . .

C. A. PRITCHARD
HUACHUCA CITY, ARIZ.

Platyphonic Sound

Three cheers to reader K. Melonas for his small tutorial paper on some pseudo-Greek terms (Comment, p 6, Dec. 16 '60). May I please be allowed to support reader Melonas' comment, even if I do not speak English as my maternal tongue. The reason is that the use or misuse of any term in the Anglo-Saxon literature is soon transferred to other languages (as has already happened with *monophonic*) and we can never extirpate the misuse.

Of course, the use of *monophonic* in the sense of "one-source sound" is a misuse, and reader Melonas is not alone in his protest. There has been, if I remember correctly, another protest in the industrial press that made the suggestion to adopt the term *monodic* with the meaning "coming through one channel (*hodos*) only," a rather nice proposal.

On the other hand, I do not think that we should dig out *monaural* and *binaural* again. These terms apply to hearing only; we listen to platyphonic sound with two ears, too; for stereophonic sound it seems to be important that it comes to us from two sources or through two channels.

We may now choose between *platyphonic* (very descriptive but rather degrading) and *monodic;* in no case should we proceed to misuse the term *monophonic* any longer. Here a technical magazine like yours could help appreciably!

W. CHLADEK
STANDARD ELEKTRIK LORENZ AG
ESSLINGEN A N., GERMANY

Unfortunately monodic *also has another meaning, also in music. It is the adjective describing monody, from Greek* monoidios, *meaning* singing alone; *a monody is "an ode sung by one voice, as by one of the actors in a tragedy; hence a mournful song." Guess we're still stuck with* platyphonic.

And an Error

I was pleasantly surprised to see my material published in your Research & Development department ("Algebraic Method Finds Target Information," p 134, Nov. 25 '60) so soon after submission to you. The article was generally faithful to my intended communication; I note, however, a possibly confusing omission in the final sentence of the fourth paragraph. That sentence should read: "For three-dimensional applications, $n \geqq 5$, and for plane applications, $n \geqq 4$." Your printed version omits the "greater than" sign, thus restricting unnecessarily the system applicability.

Would it be possible for you to correct this faulty sentence? Its present form conceals much of the generality of Mulcap/Mulcave methodology.

J. H. MORRISSEY
PHILCO CORP.
PHILADELPHIA

Our fault. Sorry to have misrepresented Mulcap.

WHAT HAPPENS WHEN A NATION SPENDS MORE ON GAMBLING THAN IT SPENDS FOR HIGHER EDUCATION?

If you can find any Romans around, ask them. They lived pretty high on the hog in their day. That is, until some serious-minded neighbors from up North moved in. The rest is ancient history.

You'd think their fate would have taught us a lesson.

Yet today we Americans spend twenty billion dollars a year for legalized gambling, while we spend a niggardly four-and-a-half billion for higher education. Think of it! Over four times as much! We also spend six-and-a-half billion dollars a year for tobacco, nine billion dollars for alcoholic beverages, and billions more on other non-essentials.

Can't we read the handwriting on the wall?

Our very survival depends on the ability of our colleges and universities to continue to turn out thinking men and women. Yet today many of these fine institutions are hard put to make ends meet. Faculty salaries, generally, are so low that qualified teachers are leaving the campus in alarming numbers for better-paying jobs elsewhere.

In the face of this frightening trend, experts estimate that by 1970 college applications will have doubled.

If we are to keep our place among the leading nations of the world, we must do something about this grim situation before it is too late. The tuition usually paid by a college student covers less than half the actual cost of his education. The balance must somehow be made up by the institution. To meet this deficit even the most heavily endowed colleges and universities have to depend upon the generosity of alumni and public spirited citizens. In other words, they depend upon *you*.

For the sake of our country and our children, won't you do your part? Support the college of your choice *today*. Help it to prepare to meet the challenge of tomorrow. The rewards will be greater than you think.

It's important for you to know what the impending college crisis means to you. Write for a free booklet to HIGHER EDUCATION, Box 36, Times Square Station, New York 36, New York.

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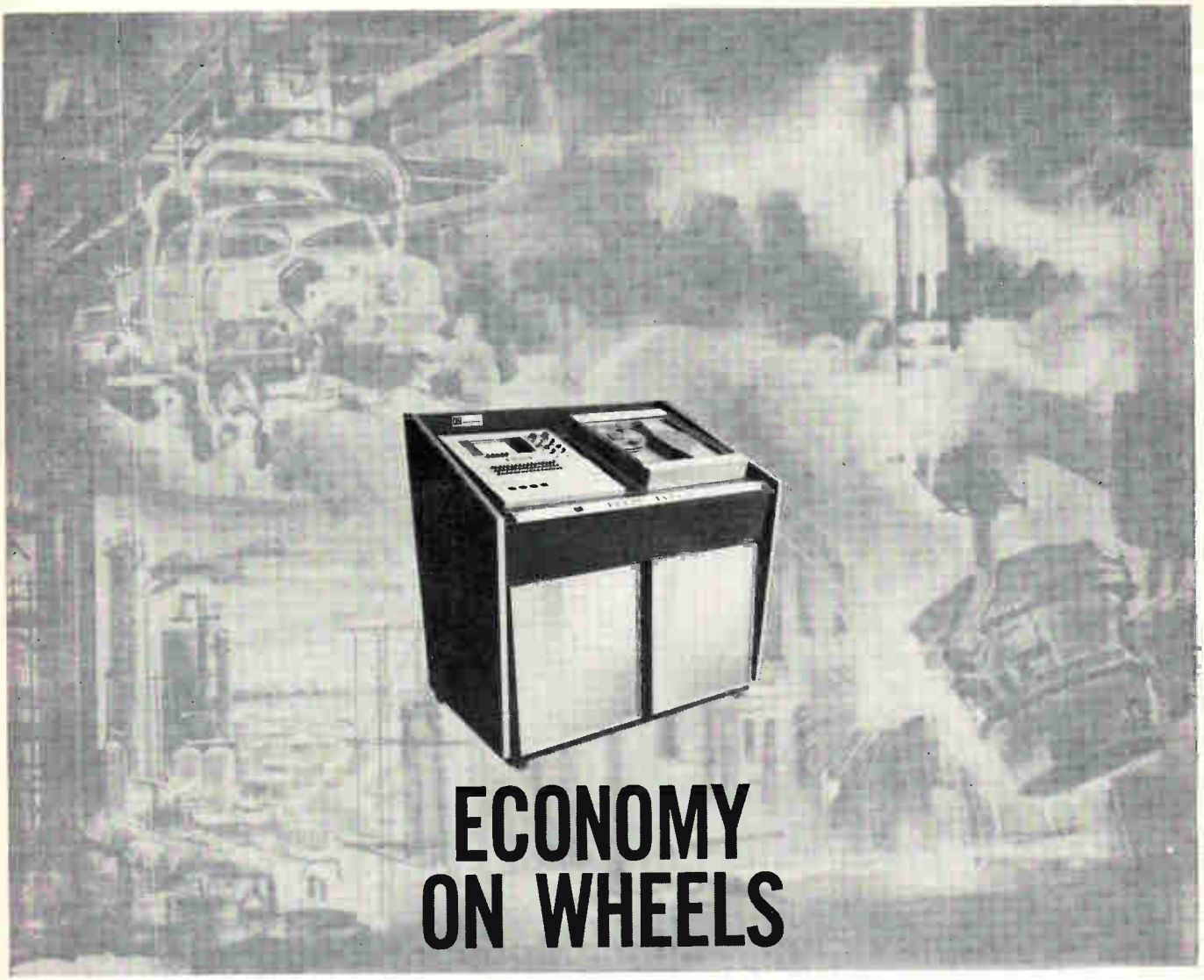

ECONOMY ON WHEELS

With RADAC I, Radiation's portable, low cost data acquisition system

Selecting data from low-level analog pick-offs and putting them into the *right* format for entry into a digital computer is frequently the most costly step in a performance evaluation program. RADAC I (Radiation's Data Acquisition Cart) permits you to take this step directly and rapidly—eliminating much expensive data processing equipment and appreciably reducing computer time.

RADAC I combines Radiation's Radicon analog/digital converter, Radiplex low-level electronic commutator, and an Ampex tape recorder (with the necessary logic circuitry and power supplies) into a single mobile unit. The system handles up to 48 analog inputs from resistive or thermocouple sources (as low as ± 5 mv full scale) with a resolution of ± 10 μv. After digital conversion, the information is recorded in computer format on magnetic tape. Data formats are available which are directly compatible with most large and medium scale digital computers.

For more complete data on RADAC I, write to Dept. EL-1R, Radiation Incorporated, Products Division, Melbourne, Florida.

THE ELECTRONICS INDUSTRY ALSO RELIES ON RADIATION FOR...

RADIPLEX 89 – a 48-channel low-level multiplexer with broad data processing applications. Features rugged solid-state circuitry, almost unlimited programming flexibility, unique modular construction for compactness and exceptional ease of operation and maintenance.

RADICORDER – Multistylus recorder provides high-speed instantaneous readout for wide range of data acquisition or processing systems. Eliminates necessity of electronically translating complete data, thereby reduces computer work loads.

TDMS – Telegraph Distortion Monitoring System pinpoints type and source of trouble on teletype, data processing and similar communications links without interrupting traffic. Ultra-compact TDMS can replace most test equipment now required for teletype maintenance and monitoring.

RADIATION INCORPORATED

ELECTRONICS NEWSLETTER

Navy Will Build Antisub Test Range

NAVY has firmed up its plans for an antisubmarine-weapons test range of the quality of the Atlantic and Pacific Missile Ranges. The range, which will use advanced sonar and electromagnetic space-position techniques, will be surveyed into the tongue of the ocean around Great Exuma Island in the Bahamas group.

Great Exuma was leased from Great Britain for 99 years during World War II.

The range—dubbed AUTEC (Atlantic Underwater Test & Evaluation Center)—will be used to test torpedoes, underwater missiles like Subroc and Asroc, and advanced techniques and equipment for locating, tracing, and verifying submarine contacts. Related oceanographic surveys are also planned. Installation will cost over $100 million.

As recently as last October, an alternate location off Key West, Fla., was planned. Developments in the Caribbean have apparently persuaded the Navy to seek out the more secure site in the Bahamas.

Joint Operation Doubles Thermal Conversion Efficiency

COMBINATION of thermionic and thermoelectric techniques in a single energy converter produces twice as much power as a thermionic converter alone without additional heat input. The thermocouple, in experiments at GE's power-tube labs, used waste heat rejected by the thermionic converter. Device takes advantage of the fact that efficient operating temperatures are lower for thermoelectric devices than for thermionic devices.

In GE's development, a production vacuum thermionic converter was sandwiched with a zinc-antimonide constantan thermocouple. Cathode temperature of the thermionic device was 875 C; it produced 0.2 watt. The thermocouple simultaneously produced 0.34 watt at a hot-junction temperature of 100 C. At cathode temperature of 1,150 C, the converter produces about 1 watt with about 2.5-percent efficiency; waste heat from such an operation applied to a zinc-telluride thermocouple would boost output to over 2 watt and efficiency to about 5-6 percent.

Camera Takes Pictures In Five Nanosec

AMONG NEW PRODUCTS released recently by Space Technology Laboratories is a camera that will take a photograph in less than 5 nsec, permitting resolution of current streak photos. The camera uses an image converter to change the optical image to an electronic image. STL expects the device to be useful in plasma physics and hypervelocity research.

Electron Microscope Photographs Living Bacteria

RESEARCHERS at the Toulouse, France, electron-optics laboratory of the National Center for Scientific Research (CNRS) report having photographed living bacteria at a magnification of 25,000 times with the 1.5-million-volt electron microscope there.

Customary objective stage was replaced by a hollow container 0.1 cu mm in volume in which the biological specimen was held in normal atmosphere. Two windows 0.1 micron thick admitted the scanning beam but kept the atmosphere intact. Objective was scanned at acceleration voltages of 750 to 1,000 Kv, producing electron velocities close to the speed of light. Bacteria reproduced in a culture after being photographed.

Canadian Postal Gear Detects Stamp Values

CANADIAN POST OFFICE department has ordered $150,000 worth of automatic mail-sorting equipment from Elliott Brothers, London, for its Winnipeg, Manitoba, postoffice. Installation will comprise a segregating machine, two grading machines and four facer-cancellers.

The three mechanical devices sort the mail by size and thickness. Facer-cancellers detect the presence of stamps, face the envelopes all in the same direction and cancel the stamps.

In Elliott's equipment, ultraviolet light illumines the envelopes as photocells locate the stamps and, by phosphorescence from phosphor pigment lines printed on each stamp, checks the stamp values. Conveyor system sorts letters into four basic stacks of different stamp values prior to destination sorting.

Facer-canceller equipment currently in use in the U. S. does not detect stamp values, can pass Christmas seals, food stamps, etc., as valid postage.

FCC Authorizes Moon-Bounce Tests

FEDERAL COMMUNICATIONS COMMISSION last week authorized ITT Laboratories to build and operate an experimental space radio station. ITT will use the station to bounce signals off the moon and passive earth satellites as part of its research into space communications theory. FCC requested that experiments include tests on interference between space communications and microwave transmitters on earth.

In another action, the Commission leased space on the 80th floor of New York's Empire State Building for a high-power uhf television transmitter antenna. Contract negotiations are underway for construction of the station. FCC wants to evaluate the capability of uhf to provide tv service in the New York City area.

Color-Tv System Uses Filter Wheel, Two Vidicons

AN APPROACH to color-tv broadcasting is reported by W. L. Hughes of Iowa State University. System uses two camera tubes and a rotating blue-red filter wheel operating with a 262-line delay network, generates compatible National Television Standards Committee color and monochrome signals.

Luminance signal goes through an encoder directly; alternating

blue and red chroma signals are sent through an amplifier and gamma corrector, then split. One path goes directly to a trigger-pair field switch synchronized by the vertical sync pulse. The other path goes through the 262-line wideband delay and through the switching circuit. Both signals are then fed to the encoder, which adds and subtracts among its three inputs to make up an NTSC color signal.

Hughes says his camera system costs about $26,000 for both camera and associated electronics, compared with $65,000 for a color camera. He adds that monochrome gear can be economically converted to the color system.

Micromachining Helps Thin-Film Fabrication

HIGH-SPEED machining techniques activated by electron beams are aiding in development of fabrication methods for film materials used in electronic data-processing systems, according to a Navy research report.

Navy's process employs an electron beam to form a chemically resistant film on the material being machined, which is subsequently etched in a vacuum by a molecular beam. Technique has resolution capabilities of several hundred angstrom units. It can handle electronically clean materials with minimum contamination and may ultimately be suited for the economical production of data-processing systems one cubic inch in volume with 10^{11} active components.

Plasma Electric Generator Making Shakedown Run

SECOND-GENERATION experimental electric generator using magnetohydrodynamic principles is undergoing shakedown tests at Avco research laboratory in Everett, Mass. Conversion of nuclear or other thermal energy directly into electrical energy is among promising applications of MHD, the discipline that exploits the interactions of ionized plasmas with magnetic fields. Generator at Avco is a step beyond the pioneer lab device announced last year by Avco in association with 10 utility companies, aims toward eventual full-scale power station. Earlier generator weighed 3 tons, produced 10 KW for brief periods.

Germany Eyes Closely Anglo-French Space Proposal

WEST GERMANY is taking a hard look at the British proposal for a joint European and Commonwealth space program which was sketched out last month in Geneva.

Aviation Minister Peter Thorneycroft met last week with West German ministers in hopes of winning a commitment for German participation in an international satellite effort that Britain would like to build around its Blue Streak rocket. This week, a German technical mission joins other NATO missions in England for a briefing on the use of the Streak as a vehicle for launching communications satellites.

Thorneycroft previously reached agreement with French space experts. The proposed launching vehicle would use a Blue Streak first stage and a second stage of unspecified French design.

Bonn wants to get into space activities, but is leery of any plans with military overtones. The German government also feels that any effort that would be in direct competition with U. S. and British rocket and missile enterprises would be economically foolish.

Illinois U. to Study Information-Retrieval System

COORDINATED electronic system for abstracting, storing and retrieving information in large masses is the subject of a University of Illinois study, funded by the Council on Library Resources and supplemented by a grant from the University's research board.

The report is to be completed in 1961, aims to make best use of services provided by a computer to be installed on the new campus at Chicago Navy Pier. Grant permits employment of General Electric technical team to help evaluate various input and storage media and new abstracting and retrieval methods. Cross-indexing in depth is expected to boost existing 1½-subject-per-volume file, taking advantage of new methods which provide up to 40 cross leads per document. A microwave link is under study for coordinating resources of branch campuses, or, in an expanded form, serving the 20-college midwest interlibrary combine.

Sub-Pacific Cable Planned for 1964

PLANS ARE UNDERWAY to lay a new undersea cable across the Pacific through Japan-U. S. cooperation, according to Japanese sources.

The cable is scheduled for completion in 1964, when Tokyo will host the Olympic games. The $80-million project is now being negotiated by AT&T and Japan's publicly owned Kokusai Denshin Denwa. Cable will hop from San Francisco to Hawaii, Midway, Guam and Tokyo, with a leg to Iwo Jima.

Japan Produces Handheld Citizens-Band Radio

EIGHT-TRANSISTOR handheld radio weighing 12 oz and measuring $4\frac{7}{8} \times 2\frac{3}{4} \times 1\frac{3}{4}$ in. is now being produced by Japan's Iwata Electric Co. Radio operates in the 27-Mc citizen's band, reaches from one to ten miles. Transmitter and receiver are crystal controlled on all channels from 26.96 Mc to 27.27 Mc. Power output is 90 mw; receiver sensitivity is 2 microvolts. Iwata expects to retail the set for about $70 in the U. S.

Forecast High Volume For 1961 Component Sales

CONTINUING HIGH VOLUME of electronic component manufacturing and sales in 1961 was predicted last week by L. B. Davis, general manager of GE's components division. He indicated that production would stay high "despite a leveling effect during the first two quarters."

Davis said factory sales of electron tubes of all kinds should total $827 million and semiconductors should hit $626 million. The latter figure is a 19-percent increase over 1960's estimated $528 million.

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Provides new degree of freedom in TV camera design

GEC's new 7522 electrostatic focus and deflection vidicon was developed to fill the need for smaller, lighter, more versatile image pickup tubes.

External components for magnetic focus and deflection have been eliminated and total power requirements for beam focusing and deflection have been reduced to less than 100 milliwatts.

The GEC 7522 is capable of any type scan . . . sawtooth to spiral, over a wide and variable range of frequencies.

The ruggedized version, the GEC 1343, was developed for aircraft and missile environments. Electrical characteristics are identical to the 7522.

features:

- ★ Resolution 500 Lines
- ★ Accelerating Voltage 300v
- ★ Deflection Voltage 30v per plate
- ★ Sensitivity .090 microamps / microwatts radiant energy at 4800A
- ★ Operates with completely transistorized circuits
- ★ Size 7522 1"x6-1/4"
  1343 1"x5-5/8"
- ★ Availability From Stock

For further information on this revolutionary new GEC Vidicon development, as well as our complete line of pickup, scan conversion, and image conversion tubes, write today for information.

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. . . solid electrolyte, metal case or encapsulated
. . . foil type, polarized and non-polarized

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Complete line of aluminum and tantalum electrolytics, motor start and run capacitors

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WASHINGTON OUTLOOK

INTENSIFIED DRIVE to ferret out illegal pricing practices by bidders on defense contracts and other government orders is shaping up here.

The antitrust and monopoly subcommittee of the Senate Committee on the Judiciary, under the chairmanship of Estes Kefauver (D., Tenn.), has prepared a massive compilation of bids submitted to the Defense Department between January 1958 and June 1959. The report is expected to show patterns of possible identical bidding in a wide range of products bought by the armed services. It won't draw any conclusions, but will provide a starting point for further investigations by the subcommittee into industry pricing practices.

The Senate study ties in with forecasts that Kennedy administration antitrust policy will put a new stress on measures to curb price-fixing in industry.

OFFICE OF CIVIL & DEFENSE MOBILIZATION has unofficially put the kibosh on Electronic Industries Association's petition for import restrictions on Japanese transistors and other semiconductors. EIA had asked for protection on the grounds that rising imports are eating away the profits U. S. firms put into R&D of military semiconductor devices.

A high-level official close to the case tells ELECTRONICS *that "there has been no evidence of distress in the industry. Our ruling will be negative on EIA's plea."*

The case has dragged on for over a year. OCDM heard briefs from EIA and several of its member companies, and from the Japanese. The agency has the responsibility of recommending to the President what action should be taken on such petitions. After hearing the initial EIA brief, OCDM director Leo A. Hoegh wrote the association for additional supporting evidence. With all evidence in, the agency concludes that transistor imports are not endangering national security, will thus recommend rejection to the new administration.

Another factor to justify the decision, ELECTRONICS learns, is the flow of U. S. capital to Japan. "Much of the production being shipped back here," a government spokesman says, "has been financed by American money."

GENERAL ACCOUNTING OFFICE has told the Pentagon to crack down on "make or buy" procurement regulations that require contractors to refund savings made by changing the schedules on what components will be made in their own plants and what will be bought from subcontractors.

GAO's recommendation stems from an investigation into an Air Force jet-engine contract with General Motors' Allison division. The contractor agreed initially to buy half the required components from other firms and to make half the parts in its own plant. The company ultimately bought only 15 percent of the parts elsewhere, produced 85 percent in its own plant.

The change in the approved schedule cut the project costs by about $393,000. GAO charges the contract's price was never adjusted in the Air Force's favor to reflect the savings.

ANOTHER OF THE PRESIDENT-ELECT's advisory groups has filed its report, this time on the nation's space programs. The report, prepared under direction of Kennedy's Special Assistant for Science and Technology, J. B. Wiesner, provides a hint as to possible policy changes.

Wiesner's report says that key missile programs have been "relegated to the category of routine management," recommends speedup of the program. It criticizes the duplication and overlap in the space effort, calls for single responsibility and management control, for all military space projects within the Pentagon.

National Aeronautics & Space Administration is rebuked for doing too much space activity in its own facilities and for placing a low priority on aeronautics research.

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hp 302A Wave Analyzer

easily convertible to a sweep oscillator-tuned voltmeter with this hp AC-97C Sweep Drive!

No calibration or stabilization is required with the hp 302A Wave Analyzer, a completely transistorized instrument which represents significant improvement in design. Operating as a highly selective tuned voltmeter, the instrument provides a front panel control which selects the frequency to be measured. Voltage then is read directly on the front panel meter. Basically, Model 302A separates an input signal into individual components so that each—the fundamental, harmonics and any intermodulation products—may be evaluated separately.

With the AC-97C Sweep Drive, the hp 302A is converted to a sweep oscillator-tuned voltmeter for automatic frequency response measurements, even in noisy systems. The AC-97C motor accessory permits sweeping the entire frequency range of the 302A, 20 cps to 50 KC; provides fast sweep for covering the spectrum rapidly, slow sweep for high resolution plot. The Sweep Drive with an X-Y recorder permits automatic plots of harmonics or intermodulation products. Model AC-97C attaches to the 302A panel, or may be bench mounted on an adjustable stand.

SPECIFICATIONS

hp 302A Wave Analyzer

Frequency Range:	20 cps to 50 KC
Frequency Calibration:	Linear graduation 1 division/10 cps. Accuracy ± (1% + 5 cps)
Voltage Range:	30 μv to 300 v, full scale, 15 ranges
Warm-up Time:	None
Voltage Accuracy	± 5% of full scale
Residual Modulation Products & Hum Voltage:	Greater than 75 db down
IF Rejection:	Intermediate frequency in input signal rejected by at least 75 db down
Selectivity:	± 3½ cycle b.w. — at least 3 db down ± 25 cycle b.w. — at least 50 db down ± 70 cycle b.w. — at least 80 db down Beyond ± 70 cycle b.w. — at least 80 db down
Input Impedance:	Determined by setting of input attenuator: 100,000 ohms on 4 most sensitive ranges, 1 megohm on other ranges.
Dimensions:	20¾" x 12½" x 14½" (cabinet), 19" x 10½" x 13½" (rack mount)
Weight:	43 lbs. (cabinet), 35 lbs. (rack mount)
Price:	hp 302A (cabinet), $1,750.00 hp 302AR (rack mount), $1,735.00

hp AC-97C Sweep Drive

Sweep Range:	50 revolutions
Sweep Limits:	Any interval from 50 revolutions to 5 degrees
Sweep Speed with hp 302A:	170 cps/sec and 17 cps/sec
Mount:	Front panel of hp 302A or bench stand, adjustable, 4" to 12"
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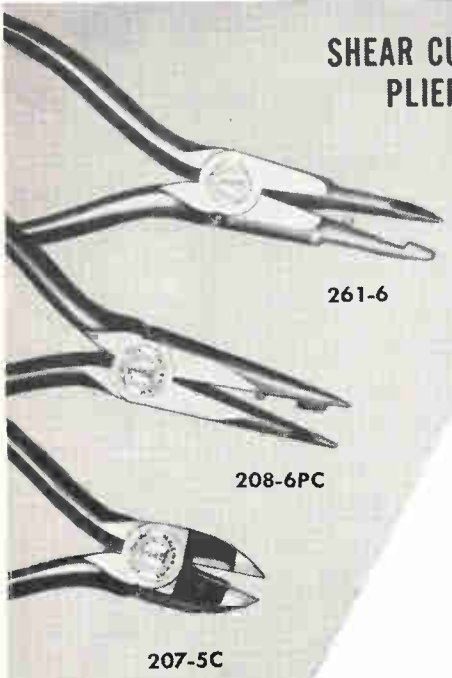

261-6

208-6PC

207-5C

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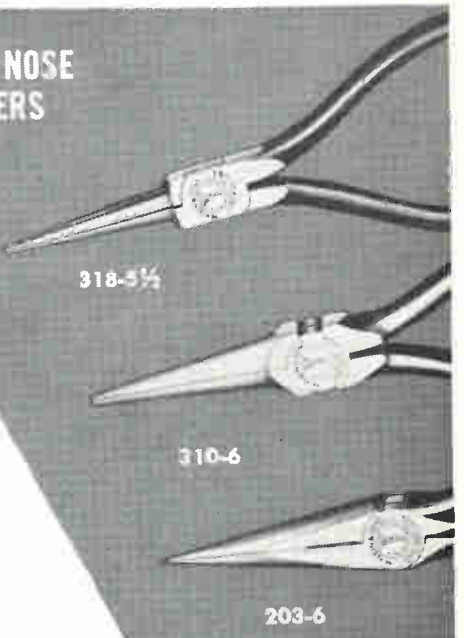

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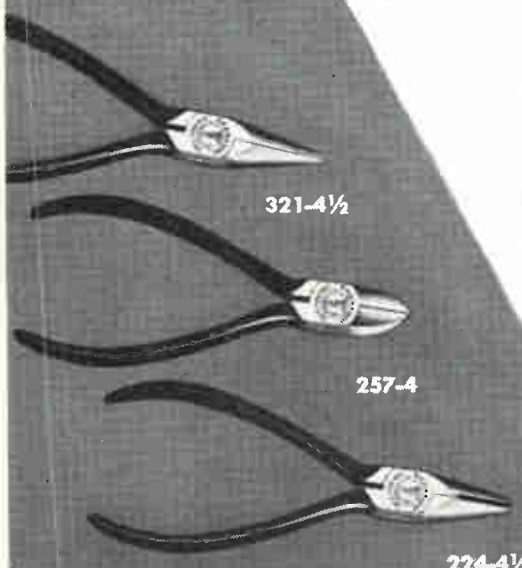
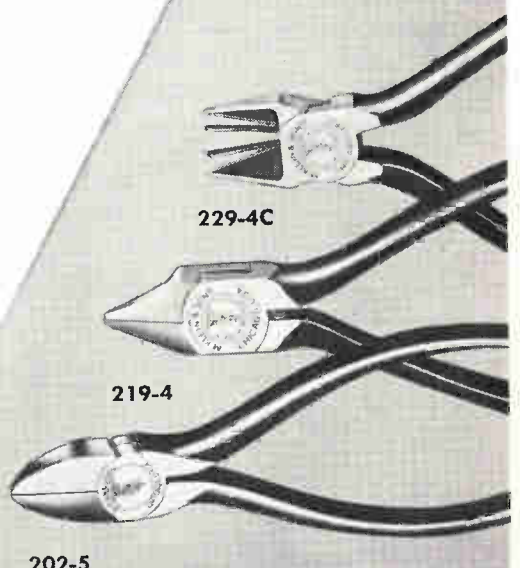


321-4½

257-4

224-4½

OBLIQUE CUTTERS



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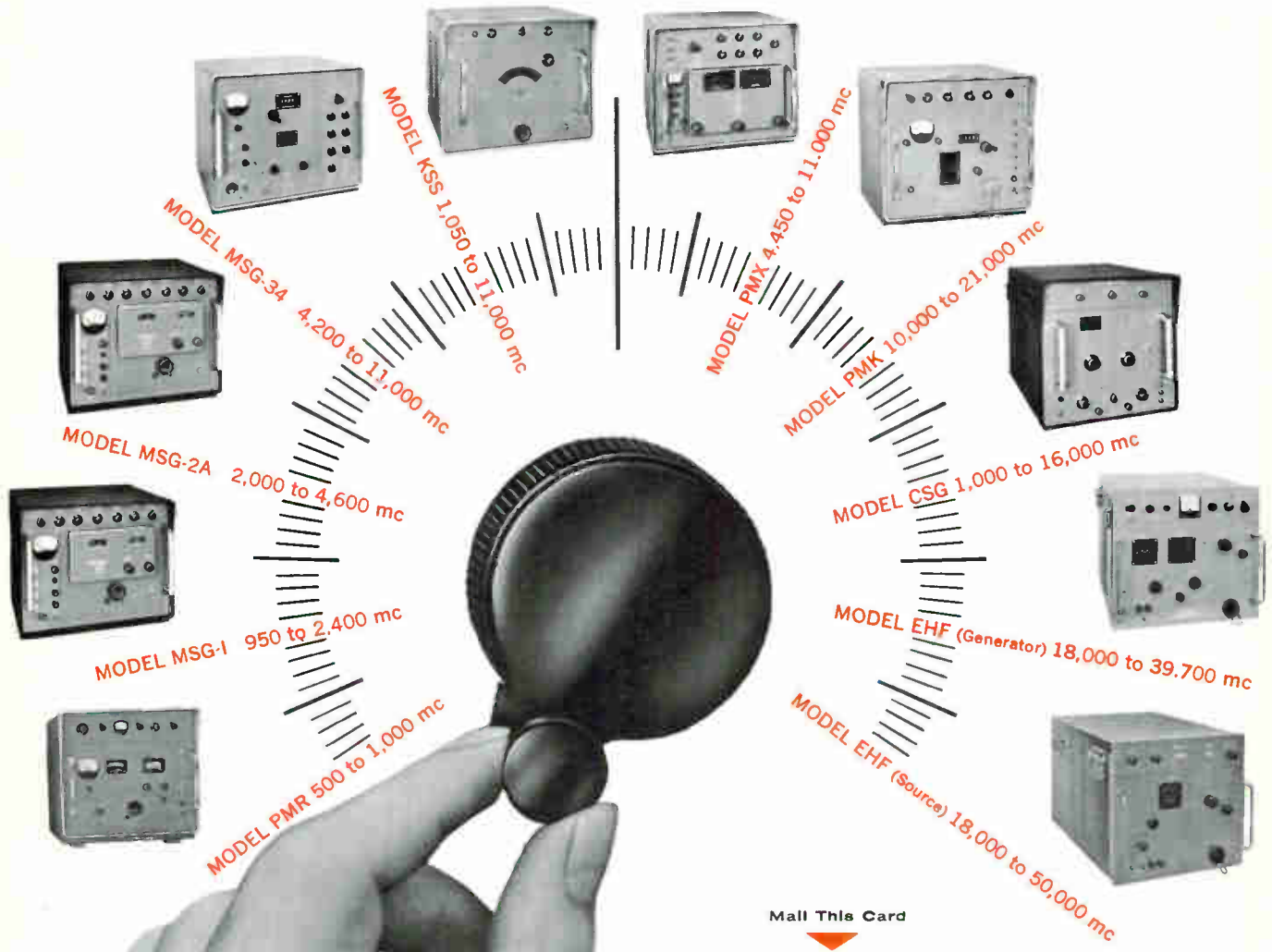

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- ☐ Model PMX
- ☐ Model CSG
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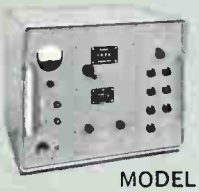

MODEL MSG-34

MODEL KSS

MODEL CSG

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MODEL EHF (Generator)

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MODEL PMR	500 to 1,000 mc	Complete modulation capabilities — internal pulse modulator or FM modulator
MODEL MSG-1	950 to 2,400 mc	Complete modulation capability including square wave modulation
MODEL MSG-2A	2,000 to 4,600 mc	Complete modulation capability including square wave modulation
MODEL MSG-34	4,200 to 11,000 mc	Widest frequency range in a single instrument
MODEL KSS	1,050 to 11,000 mc	Compact high power signal source with plug-in tuning units — internal modulation
MODEL PMX	4,450 to 11,000 mc	Calibrated 1 milliwatt signal generator with complete modulation capability
MODEL CSG	1,000 to 16,000 mc	Higher power sweep generator
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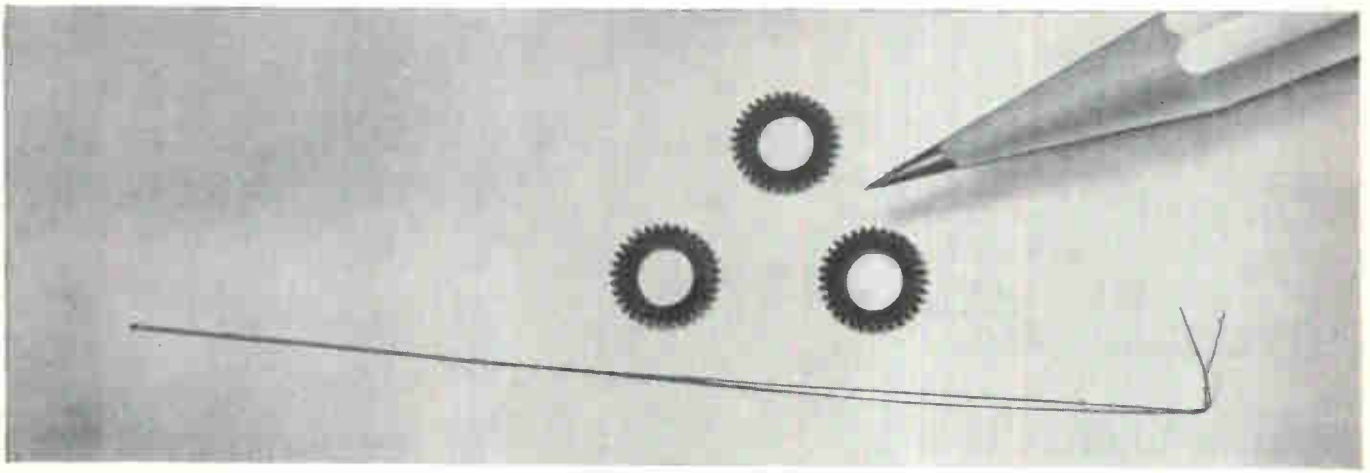
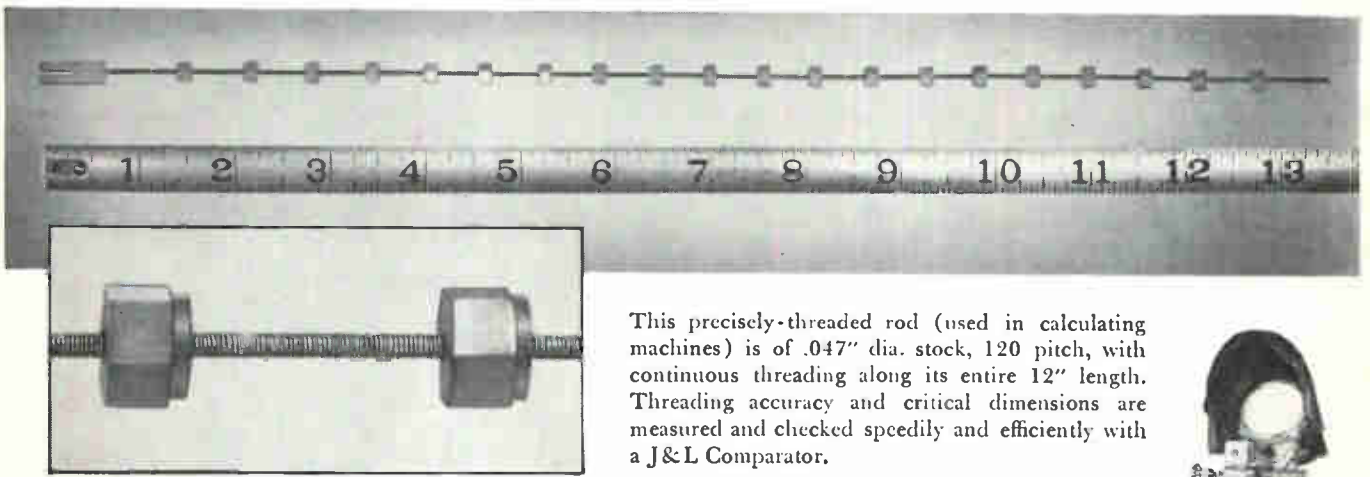
The Comparator's ability to measure and inspect, through shadow magnification, all sorts of parts and objects with extreme precision and speed makes it ideally suited for checking electronics components, especially those which are tiny or intricately contoured.

Investigate how the J&L Comparator can help you make your production operations more efficient . . . and more profitable. Write today for a free copy of our new illustrated catalog No. 5700.



For Instance — A customer writes: "One of our assemblies, containing 32 separate circuits, measures only 5/16" dia. by 1" long. The parts which go into this assembly must have perfect shape and tension, which are impossible to check by mechanical means. Two such parts are these .005" dia. gold wires, and precisely toothed brush spacers. Since using the J&L Optical Comparator in our inspection, assembly failure due to malfunction of either of these two parts has virtually disappeared."



This precisely-threaded rod (used in calculating machines) is of .047" dia. stock, 120 pitch, with continuous threading along its entire 12" length. Threading accuracy and critical dimensions are measured and checked speedily and efficiently with a J&L Comparator.

Model PC-14

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Atomic Field Sales Showing Healthy Rise

SALES of electronic instruments and controls to the atomic energy field are climbing at a healthy rate, according to information from the U. S. Dept. of Commerce's Bureau of the Census.

During 1959 total shipments of atomic energy products were $244.9 million. This figure includes shipments to U. S. Government agencies as well as exports of key atomic energy products manufactured by commercial producers. Although the major portion of the funds went for fuels, vessels, sites and related items, $16.4 million was spent on radiation counting equipment, largely electronic.

Atomic spending for accessory equipment and instrumentation for reactor control also benefited our industry. Total spent in this category for 1959 was $15,933,000. Of this sum, $11,311,000 was accounted for by U. S. government agencies. The remaining $4,622,000 was spent by other organizations and export purchasers.

In 1958, total spending for atomic energy products was $161,762,000. Of this, $15,284,000 was spent for accessory instrumentation for reactor control, with $12,326,000 being accounted for by government spending.

In 1957, $99,614,000 was spent on atomic energy products with government outlays for control instrumentation amounting to $6,771,000 and other organizations including export purchasers spending $3,182,000.

Money spent for equipment to survey, monitor and control radiation amounted to $12,547,000 in 1959 dipping from the $14,799,000 spent in 1958. In 1959, however, nongovernment spending for such gear exceeded that spent by federal agencies. Commercial and institutional spending was $6,684,000, while federal spending was $5,863,000. A year earlier in 1958, government spending for radiation survey monitoring and control devices was $8,930,000, while nongovernment was $5,896,000.

Figures for spending on radiation survey, monitoring and control devices and radiation counting equipment in 1957 are not broken down into separate categories. Combined totals for the two classes of gear in 1957 are $17,471,000 with government spending accounting for $8,422,000.

Listed as a separate expense category by the Bureau of the Census is radiation counting equipment. Spending under this heading in 1959 was $16,381,000, in 1958 it was $10,387,000. In both years, government outlay for radiation counting gear was considerably below commercial and institutional expenditures. In 1959 the ratio was: government $2,940,000; nongovernment $13,441,000. In 1958, government agencies spent $2,661,000, while their commercial and institutional counterparts spent $7,726,000.

Another separate listing in the Census report covers control and measuring devices using radioactive isotopes. In 1959 total spending in this category was $8,897,000 with $8,704,000 being spent by nongovernment groups including export buyers, and only $193,000 being spent by federal agencies. The 1958 figures stand somewhat lower for the radioactive isotope devices, amounting to $3,896,000 with $3,760,000 being spent by other than federal organizations and only $136,000 being spent by government. The total for 1957 was $6,007,000, with breakdowns not available for the government and nongovernment categories.

INSTRUMENTATION INDUSTRY in the U. S., which posted record sales during 1960, can look forward in 1961 to continuing growth, according to J. S. Locke, vice president of Minneapolis-Honeywell Regulator, in a year-end forecast.

"There are a number of favorable factors at work for the instrument industry," he said. "Capital spending plans for new plants and equipment and for modernizing existing

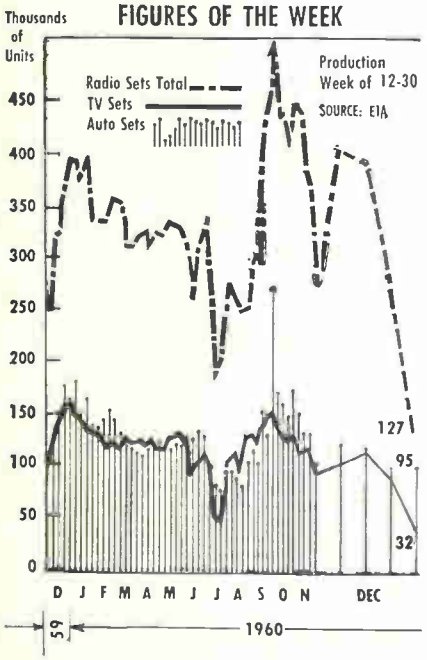
facilities are down only slightly from 1960 and may be revised upwards before the end of the year to the point where such outlays may approach record peaks."

Military expenditures may be increased substantially, according to the M-H executive. Conventional and specialized instrumentation ranging from individual devices to complex systems are required for testing and operating the intricate electronic weapons of our armed forces. Another growth factor cited was an enlargement of the instrumentation market as affected by continuing high expenditures by industry to develop new products.

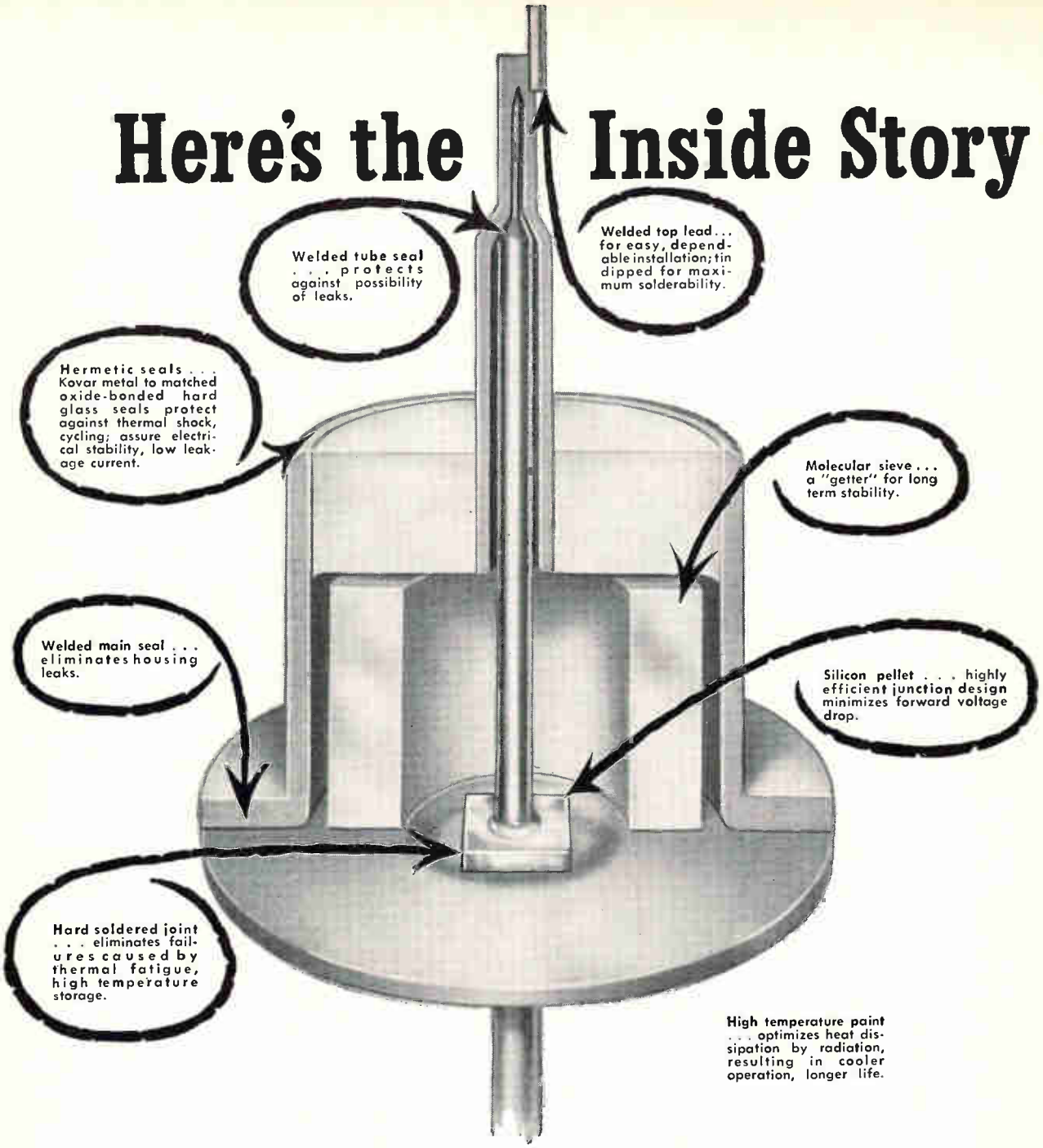
Locke estimates 1960 sales of the instrumentation industry as a whole at nearly $200 million, an increase of better than 10 percent. Sales in 1950 were approximately $50 million. He said the most significant trend in instrumentation is the heavy emphasis on engineered control systems and the insistence by many manufacturers that these be integrated by a single source which assumes responsibility for entire systems.

Among areas offering growth potential for such systems, he said, were electric and gas utilities, metals production and processing, chemicals and food processing.

FIGURES OF THE WEEK



Here's the Inside Story



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Survival Data from Operating and Elevated Storage Tests

Type of Unit	PRV	Current (ma)	Operating Temp. (ambient)	Type of Test	No. of Units	*Percent Survival
1N538 Silicon	200V	250	150°C	Operating at full load and at elevated storage temperature of 175°C ambient	83	99 @ 10,000 hrs.

*Percent survival = $\frac{\text{No. of good units} \times 100}{\text{total no. tested}}$

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Transient PRV ratings provide safer applications. You get the continuous rating you need with protection against occasional transients up to 1200 PRV . . . at no extra cost.

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Minimum forward voltage drop combined with outstanding efficiency of hermetic seal provides unsurpassed reliability.

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		@ 50°C	@ 25°C	@ 25°C	
1N440	100	300 ma	.3 µa	.65V	150°
1N441	200	300 ma	.75 µa	.65V	150°
1N442	300	300 ma	1.0 µa	.65V	150°
1N443	400	300 ma	1.5 µa	.65V	150°
1N444	500	300 ma	1.75 µa	.65V	150°
1N445	600	300 ma	2.0 µa	.65V	150°
		@ 25°C		@ 200 ma	
1N599	50	600 ma	1.0 µa	.65V	150°
1N599A	50	600 ma	1.0 µa	.65V	150°
1N600	100	600 ma	1.0 µa	.65V	150°
1N600A	100	600 ma	1.0 µa	.65V	150°
1N601	150	600 ma	1.0 µa	.65V	150°
1N601A	150	600 ma	1.0 µa	.65V	150°
1N602	200	600 ma	1.0 µa	.65V	150°
1N602A	200	600 ma	1.0 µa	.65V	150°
1N603	300	600 ma	1.0 µa	.65V	150°
1N603A	300	600 ma	1.0 µa	.65V	150°
1N604	400	600 ma	1.5 µa	.65V	150°
1N604A	400	600 ma	1.5 µa	.65V	150°
1N605	500	600 ma	2.0 µa	.65V	150°
1N605A	500	600 ma	2.0 µa	.65V	150°
1N606	600	600 ma	2.5 µa	.65V	150°
1N606A	600	600 ma	2.5 ma	.65V	150°
		@ 30°C	@ 150°C	@ 150°C	
1N560	800	600 ma	.3 ma	0.5V	150°
1N561	1000	600 ma	.3 ma	0.5V	150°
		@ 50°C	@ 100°C	@ 100°C	
1N1692	100	600 ma	.5 ma	0.6V	115°
1N1693	200	600 ma	.5 ma	0.6V	115°
1N1694	300	600 ma	.5 ma	0.6V	115°
1N1695	400	600 ma	.5 ma	0.6V	115°
1N1696	500	600 ma	.5 ma	0.6V	115°
1N1697	600	600 ma	.5 ma	0.6V	115°
			@ 25°C	@ 25°C	
1N444B	500	650 ma	1.75 ma	.65V	150°
1N445B	600	650 ma	2.0 ma	.65V	150°
1N440B	100	750 ma	0.3 ma	.65V	165°
1N441B	200	750 ma	0.75 ma	.65V	165°
1N442B	300	750 ma	1.0 ma	.65V	165°
1N443B	400	750 ma	1.5 ma	.65V	165°
			@ 150°C		
1N1100	100	750 ma	.3 ma	.65V	165°
1N1101	200	750 ma	.3 ma	.65V	165°
1N1102	300	750 ma	.3 ma	.65V	165°
1N1103	400	750 ma	.3 ma	.65V	165°
		@ 25°C	@ 125°C	@ 125°C	
1N1487	100	750 ma	.4 ma	.55V	140°
1N1488	200	750 ma	.3 ma	.55V	140°
1N1489	300	750 ma	.3 ma	.55V	140°
1N1490	400	750 ma	.3 ma	.55V	140°
1N1491	500	750 ma	.3 ma	.55V	125°
1N1492	600	750 ma	.3 ma	.55V	120°
		@ 50°C	@ 150°C	@ 150°C	
1N536	50	750 ma	.4 ma	.5V	165°
1N537	100	750 ma	.4 ma	.5V	165°
1N538	200	750 ma	.3 ma	.5V	165°
	(Meets MIL-E-1/1089 (USAF); MIL-E-1/1084A (JAN))				
1N539	300	750 ma	.3 ma	.5V	165°
1N540	400	750 ma	.3 ma	.5V	165°
	(Meets MIL-E-1/1089 (USAF); MIL-E-1/1085A (JAN))				
1N1095	500	750 ma	.3 ma	.5V	150°
1N1096	600	750 ma	.3 ma	.5V	150°
1N547	600	750 ma	.3 ma	.5V	165°
	(Meets MIL-E-1/1089 (USAF); MIL-E-1/1083A (JAN))				

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What to Expect From the New Administration

More but selective defense spending, little change in projected space outlays, more money for aviation aids, little real protection from import competition seem forthcoming

By MORT REICHEK
Washington Staff Correspondent

WASHINGTON—AS THE KENNEDY administration takes office this week, Washington becomes more than ever the news center of the electronics industry. In the months ahead a new team of leaders will be grappling with problems common to government and industry: our military and civilian agency contracting, foreign trade, commercial application of space, labor regulations, federal organization, radio-tv frequency allocations.

The outlook is for a sharply expanded federal government market for electronics industry output. The increase will come primarily from accelerated military buying, stepped-up modernization of the nation's civil airways system, a possible space program speedup, and the growing use of electronic data-processing machines by government agencies. Much of this increase in electronics spending was in the works even before Kennedy's election.

The outlook also is for more centralized management of the Defense Department and the National Aeronautics & Space Administration and for tighter coordination between both agencies in policy and plans, if not actual operations.

In response to a survey of industry problems made by the Kennedy camp before election, the Electronic Industries Association cited import competition and Walsh-Healey wage requirements as the most critical Washington issues facing the industry.

EIA proposed quota limitations on imports of foreign electronic products and repeal of the Walsh-Healey Act, which sets minimum wages on government supply contracts. Both proposals, however, run counter to Kennedy policies.

Even under the final Eisenhower budget, defense expenditures are slated to rise $1.4 billion in fiscal 1962, beginning July 1. A Kennedy revision may bring this to at least $2 billion over the current $41.5 billion annual rate of defense spending. At least half the increase will be earmarked for procurement of major weapons and equipment and for R&D. This would bring total procurement spending well over $14-billion and R&D outlays close to $4.5 billion in the new fiscal year. Of these sums, electronics will account for at least 20 percent.

Kennedy's defense advisers have placed top priority on greater production of Air Force Minuteman ICBM and the Navy's Polaris missiles and nuclear submarines, and on modernization and expansion of ground combat forces. Each of the weapons systems calls for large quantities of electronic gear.

The Army, for instance, plays up modernization requirements for mobile air defense fire-direction systems, forward-area communications apparatus, combat surveillance drones, and other advanced types of communications and electronic equipment.

On procurement policy, there will be serious attempts to spur greater competition on major prime contracts and to award increased amounts of subcontracts to small business.

There will also be greater emphasis on weeding out costly, duplicating R&D projects. The stress will be not only on elimination, say, of rival missile or rival aircraft projects, but on trimming unrelated weapons systems that have similar missions. This will mean, for example, a hard look at service re-

NEW TEAM AT THE PENTAGON

Defense Secretary Robert S. McNamara and President Kennedy

Director of Defense Research & Engineering Herbert F. York

quirements for naval, aircraft, and missile strategic weapons and a possible reassessment of priorities.

From all signs, the White House will give the new Secretary of Defense, Robert S. McNamara, former Ford Motor Co. president, a freer hand on basic policy than his predecessors enjoyed. Although a newcomer to the defense program, McNamara has the advantage of having experienced Pentagon hands in his top civilian echelons: Roswell Gilpatric, the new Deputy Secretary of Defense; Herbert York, who stays on as Director of Defense Research & Engineering; and Eugene Zuckert, the new Secretary of the Air Force.

Odds are heavily against adoption of the controversial Symington plan to bolster military unification. The plan proposes greater centralization of authority in the hands of the civilian Secretary of Defense and a single military chief of staff, downgrading the roles of the separate services, and shortening the Pentagon's complex chain of command.

For the electronics industry, the plan would probably mean considerably fewer military field agencies authorized to deal with industry; more uniform contracting policies; quicker decisions on invitations to bid and on contract awards; and simplification of the command channels dealing with plans for new weapon projects.

New administration leaders have avoided endorsement of the plan. In Congress and within the Pentagon, there's bitter opposition.

But it's likely that administrative measures will be ordered to clamp tighter controls on Pentagon planning and to centralize planning. This would bypass congressional opposition to a wide-ranging reorganization while aiming for minimized duplication of R&D and production efforts.

The military-civilian division of space projects will be continued by Kennedy. But coordination between the Pentagon and NASA will be pushed through the National Space Advisory Council to resolve competition between the two agencies.

Kennedy is expected to endorse the Eisenhower administration's decision that the government will not build an operational satellite communications system in competition with industry. NASA will limit its efforts to development of satellite hardware to provision of launching facilities.

The government will operate functional systems of military communications, weather, navigation, and military warning and surveillance satellites.

The outlook on space spending is uncertain. All through the election campaign, the Democrats charged Eisenhower with inadequate budgets on space. But Kennedy is not expected to go much beyond Eisenhower increasing NASA spending. On the military space side, however, project managers have been plumping for additional funds. Any Kennedy stepup in the space program, therefore, would emphasize military projects.

The Eisenhower administration did not act on EIA's petition for import restrictions on transistors and other semiconductors under the defense-essentiality clause of the Trade Agreements Law. But the bulk of the staff work of OCDM and other agencies has been completed. The unofficial recommendation of the bureaucrats is to reject the industry's plea. The majority view is that transistor imports are not endangering national security. There's little doubt that the Kennedy administration will approve such a ruling.

From all signs, the new administration will take an even more liberal approach on foreign trade than Eisenhower's. This is the word from Kennedy advisers who discount his campaign concessions to a "need to protect" certain domestic industries.

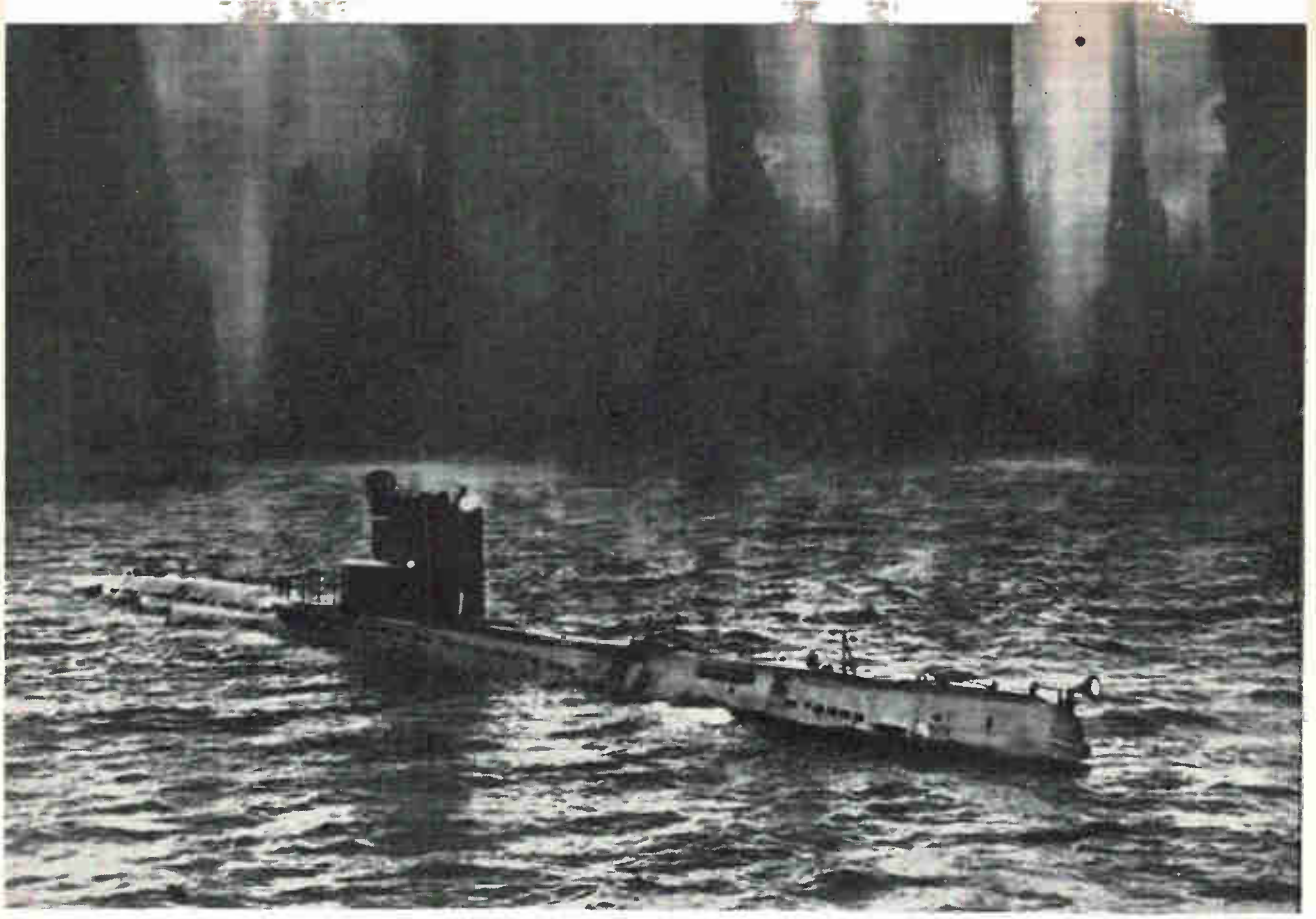
What the new President has in mind as "protection," for example, is a federal "trade adjustment" program. This would provide compensation for domestic manufacturers who could prove injury from foreign import competition through a combination of such aids as subsidies, tax relief, worker retraining and relocation. "Helping people go out of business," is the caustic comment of one Washington observer.

The first Walsh-Healey electronics wage determination has already been made on electron tubes and semiconductors. Two other cases are pending: components and end-item equipment. The industry argues that the law hurts smaller producers in traditionally low-wage areas by jacking up labor costs to national levels.

But Walsh-Healey is too firmly entrenched to offer much hope for those who want to repeal the law. With the growth of government procurement in recent years, the Walsh-Healey Act was vigorously enforced by the Eisenhower administration. Arthur Goldberg, the new Secretary of Labor and a longtime union lawyer, can be expected to continue the policy. Industry's best chance: push for more area wage determinations under Walsh-Healey.

Assistant Secretary of Air Force Roswell L. Gilpatric

Air Force Secretary Eugene Zuckert



Russian submarine carries a full complement of scientists during oceanographic expeditions

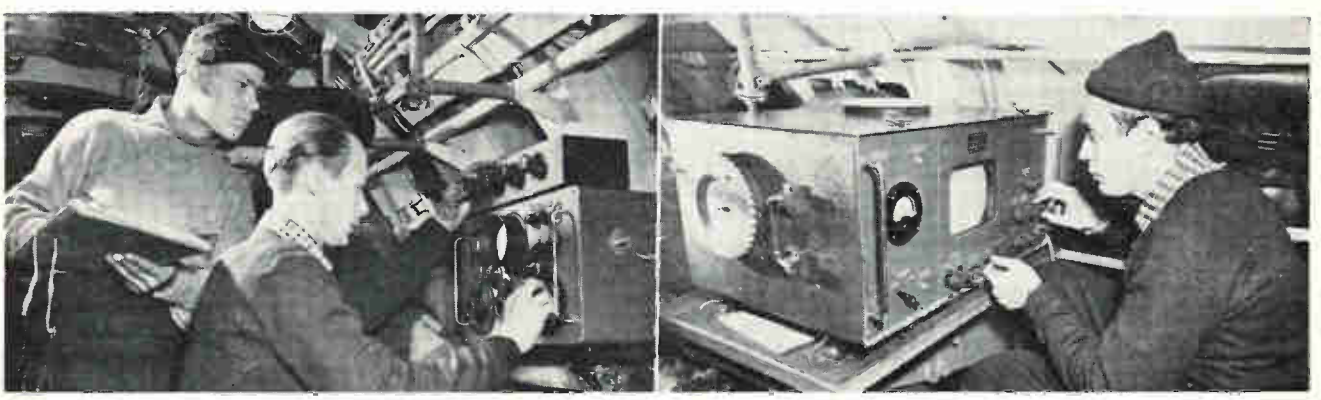
DEPTHS PROBED ELECTRONICALLY BY

SOVIET RESEARCH SUBMARINE

THE USSR IS OPERATING a converted navy submarine as an underwater oceanographic laboratory. The sub is equipped with advanced electronic aids. Undersea animal and plant life are studied in efforts to locate new fishing areas. The *Severianka*, placed in service in 1958, has multidirection sonar for detection of fish schools.

A view of waters ahead of the sub in the low ambient light encountered while submerged is obtained by a tv system. Several portholes and a battery of lights for observing and photographing undersea life are built in. Devices are carried for measuring water chemistry, ocean currents and taking bottom samples.

The United States does not operate a similar vessel having complete mobility and no need to rely on a mother ship. Our experts point out that a submarine avoids turbulence encountered on the surface and makes an ideal stable platform for sonar research, temperature profiling with thermistor chains, and similar studies.



Electronic thermosalter (left) obtains data on water temperature and salinity at various depths. Right: Sensitive underwater vision is achieved aboard submarine Severianka using tv pickup and display. (Photos by Sovfoto)

Navy Uses Computer To Forecast Weather

WEATHER-FORECASTING COMPUTER checked out on the Pacific Missile Range is soon to become part of a Navy experiment aimed at faster, more accurate forecasts for fleet activities. A thirty-man numerical weather prediction team at Monterey, Calif., can now deliver complete forecasts covering the next 24-48 hours forty minutes after observations come in on the teleprinter. Numerical prediction leaves less room for human error.

Observations come in over six teletypewriter channels from thousands of Northern Hemisphere stations. They are processed by a Control Data Corp. CDC 160 satellite computer, and edited and processed onto magnetic tape, while at the same time a printed map is produced automatically. The map reports the current weather picture in terms of atmospheric pressure at grid intersections.

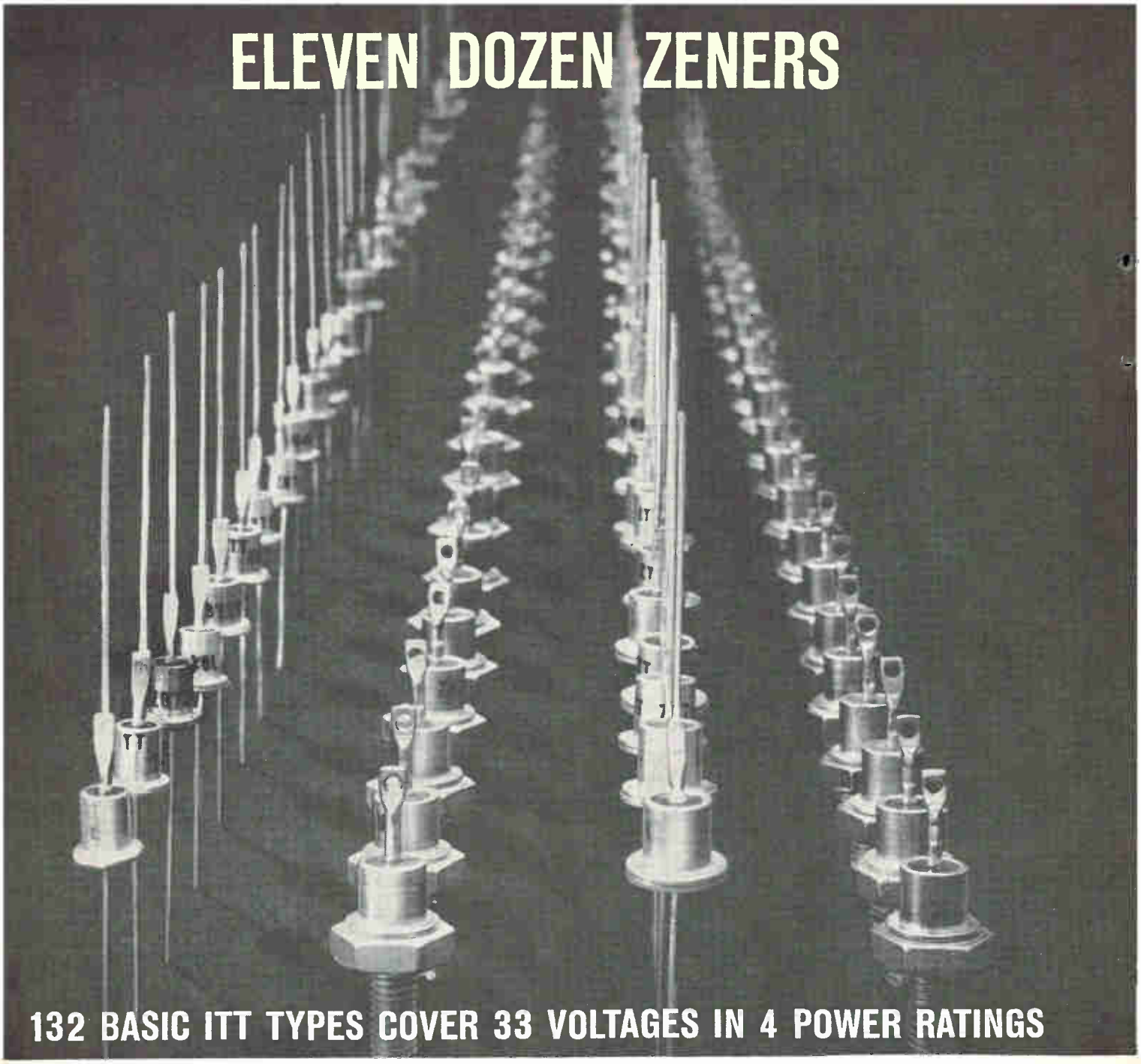
The computer extrapolates observations into next-hour predictions of changes of pressure at each grid intersection. As many as 300 million separate computations may be required to project successive series of next-hour changes for the total period of a 24-48 hour forecast.

Final map of pressure predictions permits meteorologists to figure temperature and precipitaiton predictions. Numerical methods can also predict wind direction, and velocity and height of waves, may even be used to tell whether hurricane diversion methods—now under study by both Navy and the Weather Bureau—are feasible or dangerous.

X-Ray System Inspects Steel 11 Inches Thick

POWERFUL X-ray system will be installed by High Voltage Engineering at the Milwaukee plant of A. O. Smith Corp. to check for flaws in metal components. Device is an 8-Mev linear accelerator that can put out 6,000 roentgens a minute. Machine will be able to X-ray steel 11 inches thick in one minute with the larger of two focal spot sizes; a smaller spot can see through 8 inches of steel.

ELEVEN DOZEN ZENERS



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NEW MICROWAVE LINK TO SPAN CONTINENT

Western mountains dwarf microwave relay station as one more site is added to the more than 250 that will extend across the continent by 1962

A NEW TRANSCONTINENTAL microwave network by Western Union is now in construction. Company spokesmen say it should be completed within about six months of the centennial anniversary of their first cross continent telegraph link finished in 1861.

The new system will cover more than 5,000 miles, cost about $53 million and include more than 260 relay stations.

The new link focuses attention on a number of changes in communications requirements that have quietly evolved in the past decade.

One spokesman estimates that the near future will see more data transmission channels being used than the total number now being used for voice channels. One roadblock to maximum growth in this area is the present lack of compatibility between some computer output data and transmission means.

Another growing use area is private wire leasing for industrial and commercial applications. The new microwave system will be expected to carry its share of this steadily increasing traffic which has been growing at the rate of some 10 percent a year in the recent past.

Some idea of the growth of microwave use may be had from the comment of one engineer who told ELECTRONICS, "Ten years ago, we constructed a 16-voice channel system in the northeastern part of the country and considered it more than adequate for the traffic it would have to bear. This new transcontinental system will handle 600 voice channels and may have to be expanded in the near future."

Another change the past 10 years have seen is the sharp growth of interference possibility on a nationwide scale. In planning the new link, whole regions of the country were mapped by aerial surveys to determine the best locations for relay sites. Interference studies were made involving data sifting through a computer on interference possibilities within a 250 mile radius of each station. Antenna riggers are working within tolerances of five ft. for vertical positioning, 25 ft. for lateral.

The first leg of the new system, now in operation, runs between Santa Barbara and Sunnyvale, Calif., and is carrying message and video transmission service. Microwave gear for the system was made by Radio Corp. of America under contract to Western Union. Antenna equipment was supplied by Gabriel Laboratories. The equipment, RCA MM-600-A6 provides 600 frequency division multiplex voice circuits. One r-f channel will provide up to six-mc bandwidth for high-speed data or video transmission. This leg of the system is designed to meet the entire network capability of transmitting information at a rate of 2,400,000 words per minute, and providing broadband facilities for data handling, alternate record-voice, facsimile, telegraph, tv and other communications services.

The nine-hop California section of the link will soon be keyed into 18 more locations between Berwick, Kans. and Bushnell, Nebr. For points beyond this, more than 60 sites have already been selected or optioned by Western Union. These sites will carry the link from its Northern end at Hollister, Calif. across the Sierra Nevada mountains through Nevada, Utah, and over the Rockies to Kansas. Surveys are under way in the Los Angeles and San Francisco areas to connect these cities into the system during this year.

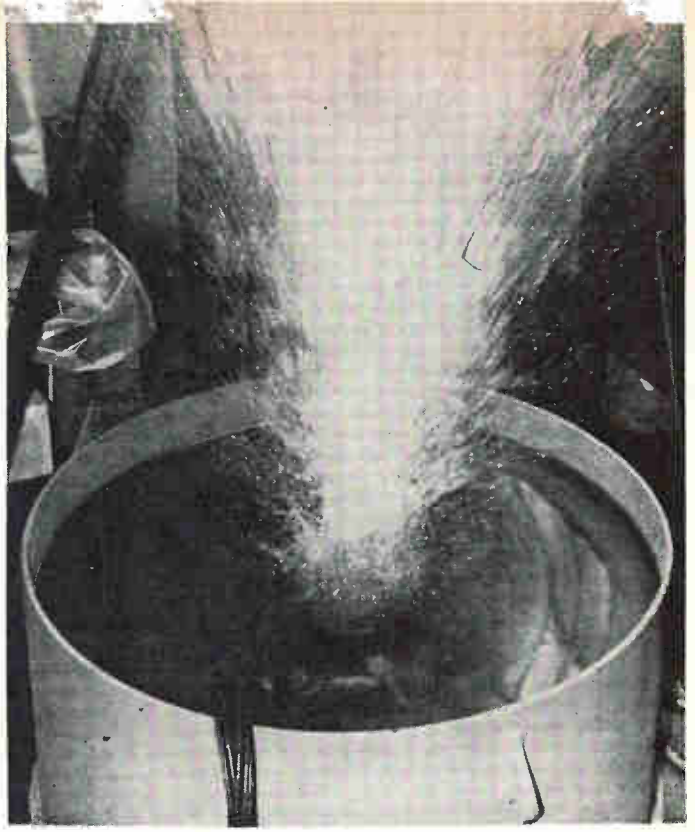
Part of the 5,000-mi route includes extensions to Dallas, Kansas City, Detroit, Chicago, Cleveland, Buffalo, New York and Washington, D. C.

Final evaluations of sites are being made in New England, upstate New York, Pennsylvania, Kentucky and West Virginia. Slated for tie-in are Boston, Syracuse, Pittsburgh, Cincinnati and St. Louis. System planners say they expect to complete the entire system by mid-1962 and have transcontinental communications some six months before then. The network will add more than 50 million channel miles to present Western Union facilities, multiplying present traffic capacity more than ten times.

Other electronics industry subcontractors for the cross-country microwave network include Raytheon which is responsible for a number of trunk routes connecting urban sites with the main beam path. Collins Radio is also providing equipment for Western Union. And General Electric is supplying much of the multiplex gear.

Capacitor Discharge Forms Metals

By ROY J. BRUUN, Assistant Editor



Water erupts from shock-wave caused by capacitor discharge

SCHENECTADY, N. Y.—Explosive shaping of hard-to-work metals such as titanium may be given a boost by a capacitor discharge electrospark technique developed by General Electric's General Engineering Laboratory. This method may be preferred to chemical explosive techniques that may not be as easy to control. Isolated structures for the process would not be required as in the chemical-explosive technique.

Conventional die-forming techniques have not been found effective with titanium and other metals used for missile and jet aircraft construction. Other possible use of the new technique is in the forming of intricate shapes of more easily shaped metals.

In the technique, water forms and transmits the shock wave that supplies the shaping force. The hydraulic shock wave is of high magnitude and exists for a very short time. It strikes a sheet of metal sealed against an evacuated die. An underwater spark gap creates the shock wave. The spark gap is within a metallic cylinder that directs the shock wave into the metal. The gap receives energy from a 27,000-joule capacitor bank. The bank is charged by a 35-kilovolt full-wave d-c power supply using high-vacuum diodes.

The metal is first sealed to the die. Die and metal are then placed under water in line with the electrode cylinder. A vacuum pump removes entrapped air and water from the die cavity—this is critical since air in the cavity may not be fully compressed by the shock wave and will contribute an unwanted configuration to the shaped metal. After charging the capacitor bank, the trigger switch is closed by the operator. This causes the main three-electrode switch to arc over, releasing the full stored energy into the spark gap. The discharge lasting a few millionths of a second sends a severe shock wave against the metal to force it into the configuration of the die.

Gyrogenics is another area being researched at the General Engineering Laboratory. Prototypes of superconductive bearings, motors and switches have been built, but they await further development before becoming practical devices. Meanwhile more research is being devoted to attaining higher critical field strengths and higher transition temperatures. The magnetic-mirror effect, which provides a cushion of magnetic flux, has been used in a model superconductive bearing. The performance of this model supposedly tops that of conventional magnetic and electrostatic devices. It consists of a superconductive coil of niobium wire above which a superconductive disk is mounted so that it can move vertically but not laterally. The magnetic flux created by the coil repels the disk pushing it upward with a force of 300 grams per square centimeter. This development should lead to magnetic bearings for supporting a rotating shaft and to three-dimensional bearing arrangements for gyroscopes. Superconductive bearings say GE people will eliminate friction in special electric motors so that an efficiency of nearly 100 percent is attainable. A model superconductive motor has been built and has been driven up to 20,000 rpm. It was limited to this speed because the rotor was not built to withstand higher centrifugal forces. Necessity for low temperatures restricts applications.

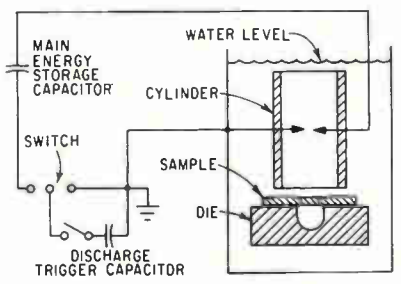
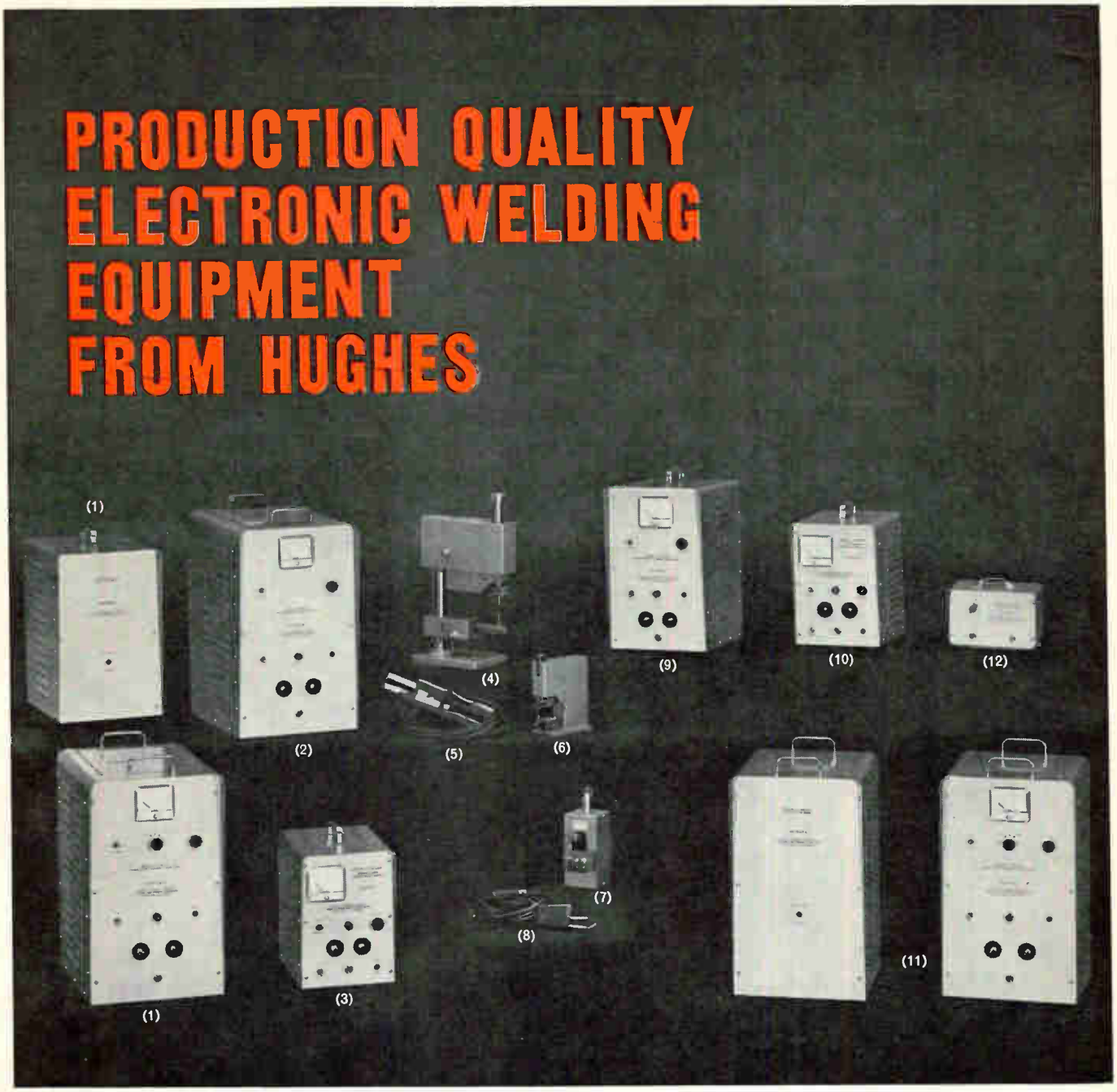


Diagram of capacitor discharge electrospark system

PRODUCTION QUALITY ELECTRONIC WELDING EQUIPMENT FROM HUGHES



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Weld speed control

Small-Company Problems Aired

SMALL COMPANY management in the electronics industry faces some knotty problems, but thoughtful management planning can arrive at definite solutions.

This was the advice given recently to the Long Island section of the Professional Group on Engineering Management of the Institute of Radio Engineers during a panel discussion at Garden City, N. Y.

Panelists included Arthur Dorne of Dorne & Margolin; Sol Dubin of Telechrome Manufacturing, and R. S. Marston of Crosby Teletronics. F. K. Ballaine of Adelphi Research Center was panel moderator.

All three panelists agreed that growth—preferably rapid growth—is vital to survival of small companies. Only by growing can a young firm support the research and development needed to maintain a competitive position.

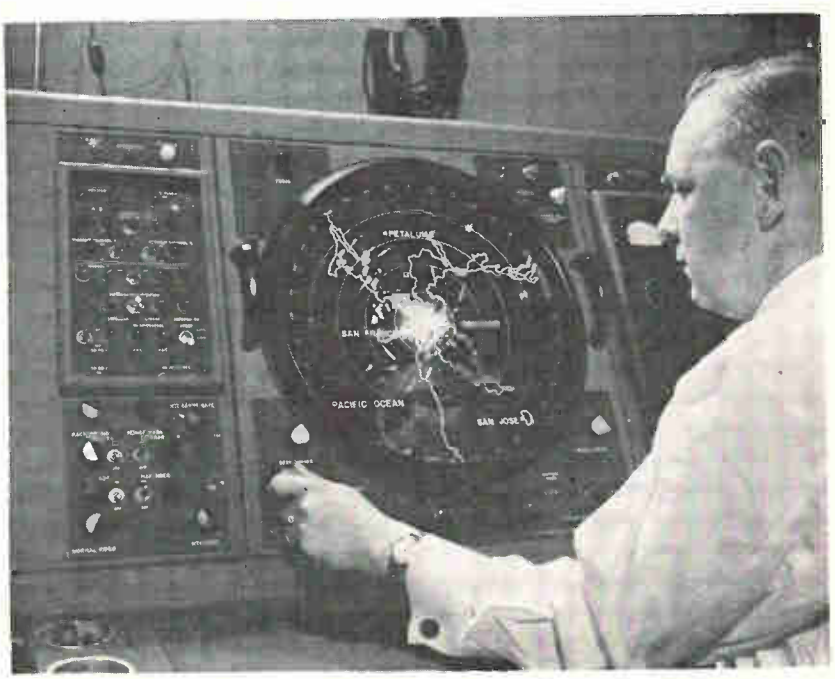
It was also agreed that the consumer, commercial, and industrial markets offer more advantages than military products; in these areas, a young company can write its own specs and make its own prices. Merger was unanimously preferred as a method of growth despite its many frustrations, because internal growth generally takes too long.

Moderator Ballaine quoted a Dun & Bradstreet statistic indicating that 79 percent of electronic companies that failed in 1959 did so because of managerial inexperience.

Dubin outlined the techniques that a small company should follow in attaining an efficient growth pattern. He pointed out that few companies plan for growth, adding that the problem of growth is not largely one of financing, but rather revolves around technical competence and knowledge of the market. He described three developmental phases of planned growth: (1) initial planning and merger operations, (2) reevaluation phase, and (3) maintenance of momentum.

During the first phase, a planning group is formed and headed by an executive with fiscal training whose main responsibility is to supervise growth efforts. At this time, merger activity is pursued, with the sole consideration being company competence and its relationship to market potential.

Aircraft Plotting System



Raytheon-developed bright display system uses radar signals to show continuous progress of all aircraft within 60 miles of San Francisco

Reevaluation phase corrects and improves the fiscal program. In the third phase, the company maintains its economic momentum by being alert to the contributions of new techniques and new individuals.

Dorne said that his company has taken four steps to avoid becoming ingrown: adding outside membership to the board of directors including two electronic company presidents, a university scientist, and an attorney; using consultants whenever possible to get a broad point of view; hiring senior people to maintain a 30 percent level of new staff; encouraging employees to engage in outside work-related activities.

Dorne feels that wide participation in planning by management people means fewer bugs and broader training of future top management. He considers once-a-month meetings to be valuable for keeping management thinking in focus.

Marston emphasized that the present-day business environment for starting a small company is much different from that of 1947 when his company was established. He and his partner had little concept of the business world and got away with it. But today, he said, the engineer starting a company should have financial corporate experience and should have a supporting team consisting of a good corporate attorney and a good salesman.

If the engineer cannot afford payment to the team, said Marston, he should give them an interest in the business. Significance of product-line marketability, and where to get financing, are business aspects that must be kept constantly in mind. Product-testing for all possible operating contingencies is of particular importance.

(He and his partner experienced unexpected trouble with their first marketed product, a ground-loop antenna garage door operator system: the system would operate the door when nearby street lights were illuminated and also during electrical storms.)

Stay within known capabilities, he added; be sure to have an adequate technical distribution setup with knowledgable people, and never over-engineer.

Electronics' editor W. W. MacDonald (second, left), now touring Europe, chats at Marconi's Wireless Telegraph, Chelmsford, England, with (left to right): G. N. MacLarty, engineer-in-chief, Marconi's; R. P. Raikes and E. R. Burrough, both of Marconi's; and Derek Barlow, McGraw-Hill World News, London

Birds Causing "Ring Angels"?

CHELMSFORD, ENGLAND—"Ring Angels" resembling the constantly widening concentric circles caused by pitching a pebble in a pond when seen on a radar screen are birds leaving their roost at sunup.

At least so it appears to Eric Eastwood, chief of research for Marconi's Wireless Telegraph, who disclosed this belief here a few days ago to ELECTRONICS' visiting chief editor, W. W. MacDonald.

In a film Dr. Eastwood will show before a meeting of ornithologists next spring, this hitherto puzzling type of "Angel" (see ELECTRONICS, p 140, March 14, 1958) frequently appears in the northwest and southeast corners of the British Isles when scanning the area using power up to 70 megawatts and wavelengths around 23 centimeters.

Investigation on the ground indicator shows that more than a million starlings seeking their morning meal are involved.

So sensitive and long-ranged is the equipment used to make these observations that noise generated by the rising sun can be clearly seen on the display.

Aurora streamers are also visible and this may not only throw new light upon the nature of magneto fields surrounding the earth at such times but also show more precisely the time relationship between flares on the sun and the resulting electrical phenomena in space immediately surrounding the earth.

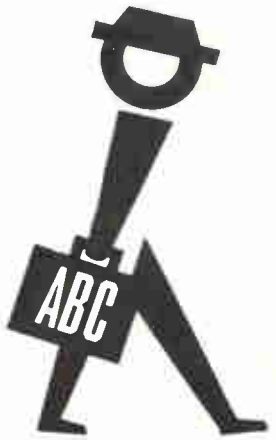
Proposal to Merge Military Buying Hung Up

DON'T LOOK for quick action on the proposal to consolidate military electronic procurement in a single agency, now being studied by the Armed Forces Supply Support Center.

The study covers common-use communications equipment, electronic components, and electrical gear. Procurement of the items under study runs to about $1.5 billion annually.

Officials making the study say it won't be ready until February. Chances are it will limit its recommendations to revamping of supply management — requisitioning procedures, questions of storage and distribution, and so forth—and will leave the hot issue of centralized procurement alone.

Even if AFSSC proposes consolidation, it'll still be subject to Pentagon review. Navy, for one, is arguing against the idea, claiming that electronics requirements differ so much that single-agency procurement is impractical.



here, there . . . almost everywhere

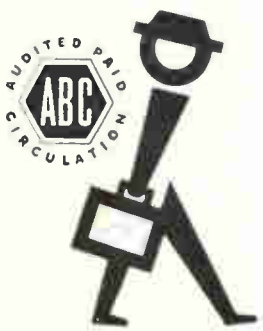
Members of the specially trained, 70-man field auditing staff of the Audit Bureau of Circulations* make regular calls on 2,900 publications . . . ours included . . . located in almost as many places.

The ABC auditor's call might last a day, a week, or even several months . . . just as long as it takes him to make a complete audit of our circulation records and obtain the information about our circulation audience that ABC will later publish.

Actually, he is working for you — our readers and our advertisers. Knowing full well that we will stay in business only so long as our publication continues to serve the interests of our readers, this audit of our *paid* circulation provides us with a regular and objective review of how well you think we are doing.

Knowing full well that sales messages must reach a responsive audience in order to be effective, our advertisers are also interested in the ABC auditor's call. The hard, and sometimes cold, facts he reports about our circulation provide you with an informed basis for investing your advertising money.

Yes, the ABC auditor has been here . . . and he will be here again, calling to check on how well we are doing our job and to provide the facts to help us *and our advertisers* do even better.



electronics

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Lawyers Explore Uses of Computers

NATIONAL CONFERENCE on law and electronics recently held by the UCLA School of Law and University Extension explored the uses of computers and machine language in judicial procedures. This includes the organizing and indexing of laws, judicial decisions and legislative acts. This was the first meeting of the group made up of 100 leading judges, lawyers, professors, philosophers, engineeers, linguists, businessmen, scientists, and computer experts. They decided to undertake a study of the Los Angeles Municipal and Superior Court System, compilation of a legal dictionary and legislative index, electronic analysis of legal problems, machine translation of foreign legal writings, and immediate improvements in research tecniques through electronic data processing. A future UCLA Institute for Interdisciplinary Studies of Law and the Administration of justice will coordinate these and other projects, says Edgar L. Jones, Jr., UCLA law professor. He hopes to eventually see a nationwide network of regional computer centers, each a storehouse and distributing center for legal information serving lawyers, judges and legislators as well as social scientists, businessmen.

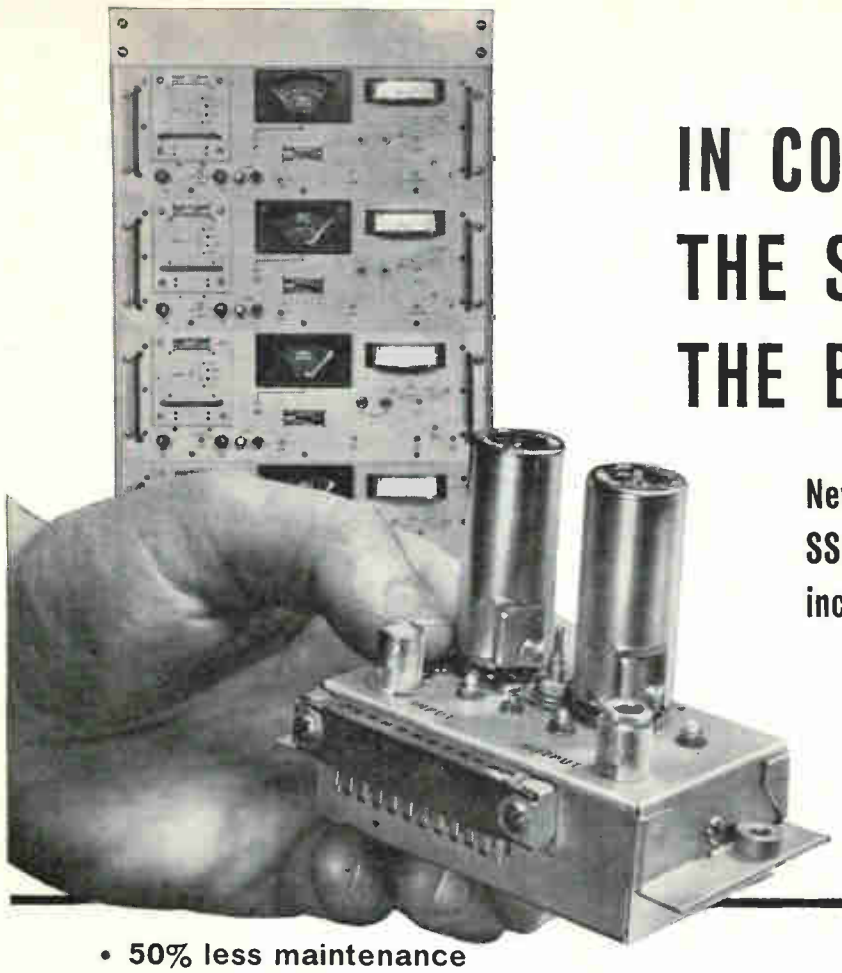
Polarized Antenna

Single antenna developed by Chance Vought provides vertical, horizontal and circular polarization

SOUTHWESTERN INDUSTRY NEED of a regional scientific and technical information center is being studied by Southern Methodist University under a grant by the National Science Foundation. This function would be served by the Science Information Center at SMU. The center would also service higher education in the southwest. The study is scheduled for completion in May, and it will be based to a large extent on personal interviews and questionnaires aimed at scientists and engineers doing research in this geographical area, asking them what kind of information they need in what subjects. Involved in the study are visits to and detailed studies of existing scientific information centers by business economists who will also make an area economic study. Due for completion next August, the SMU information center is the gift of local industrialists.

AVAILABLE ENGINEERING TALENT not already being used by industry was the reason Ann Arbor, Michigan was chosen by the Electronic Assistance Corporation (Red Bank, New Jersey) as the site of its new Systems Engineering Division. According to company president Robert Edwards, most areas with so much engineering ability have already attracted a concentration of industry. He believes that not only will the University of Michigan supply engineering graduates for staff work but will also have available engineering faculty members as consultants. A University of Michigan alumnus, William A. Wheatly, will be vice-president of the division and will head an accompanying long-range research center.

DEGREE OF NUCLEAR ENGINEER is being offered for the first time by Columbia University. The degree is designed for persons who plan to carry their course work one year past the master's degree but who have no need to carry out an intensive doctorate research to complete their educational program.



IN COMMUNICATIONS... THE SIMPLER THE BETTER

New Hallicrafters <u>all-modular</u> SSB strip receiver cuts costs, increases reliability.

- **50% less maintenance**
- **Far greater stability and reliability**
- **Down time almost entirely eliminated**
- **Lower initial cost**

Hallicrafters' new SX-116 SSB Receiver is the essence of simplicity—key to reliability in the Hallicrafters Series 116 communication system.

The SX-116 is entirely modular in construction, *virtually eliminating "down time" and cutting maintenance cost by over 50%.* The unit is quickly and easily adaptable to existing systems, entirely compatible with future requirements.

It is extremely stable—1 part in 10^6 per month (standard) or 1 part in 10^8 per month (special) . . . it permits, for the first time, continuous, unattended operation with *maximum reliability.*

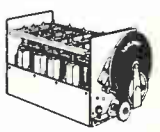
The SX-116 weighs in at just 36 lbs.—equally practical for fixed, mobile, air or seaborne installations. *And its initial cost is very substantially lower.*

Finding a better and simpler solution to complex communications problems has been a Hallicrafters habit for over a quarter-century.

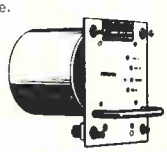
hallicrafters

Military Electronics Division, Chicago 24, Illinois

100% modular construction— only seven basic components

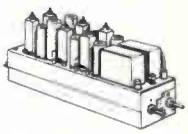


RF Module. Image and IF rejection maintained at better than 70 db. Single tuned circuit between antenna and RF grid. Four-channel, continuous tuning—2.0 mc. to 30 mc. range.



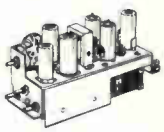
HF Crystal Oscillator Module. Stability: 1 in 10^6 per month. Capacity is four crystals; designed for HC-6/U metal or glass crystal holders. Oven temp. varies less than ±0.01°C.

Injection Amplifier Module. AGC-controlled wide-band video amplifier provides constant injection level.

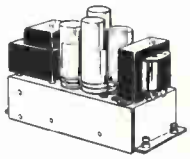


IF Module. Allows simultaneous reception of upper and lower sideband, independent AGC control of upper and lower sideband.

BFO Module. Operates at 1650.000 kc. Oscillator frequency stabilized in separate oven. Plate and filament voltages regulated.



Audio Amplifier Module. Features duel, independent 100-milliwatt line amplifiers. Hum level is 80 db. below 100 milliwatts. Harmonic dist. less than 0.5%.



Power Supply Module. Separate transformers provided for regulated and non-regulated voltages. Local oscillator and BFO filament supply are regulated for ±10% line voltage variations!

Write for complete specifications on the SX-116.

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ORchard 2-6861

H. Kenneth Hudson
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CLearbrook 6-4978

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(Red Bank, N.J.)

LOOKING FOR A CHALLENGING OPPORTUNITY? We have openings for communications systems and equipment design engineers at all levels. Please write to William F. Frankart, Director of Engineering.

MEETINGS AHEAD

Jan. 24-27: Society of Plastic Engineers, Annual; Shoreham and Sheraton-Park Hotels, Washington, D. C.

Jan. 29-Feb. 2: Electrical Engineers Exposition, AIEE; Coliseum, New York City.

Jan. 29-Feb. 3: Super Power Tubes, AIEE, Statler-Hilton Hotel, New York City.

Jan. 31-Feb. 2: Cleveland Electronics Conf.; Engineering & Scientific Center, Cleveland.

Feb. 1-3: Military Electronics, PGMIL of IRE; Biltmore Hotel; Los Angeles.

Feb. 1-3: Solid Propellant & Rocket Conf., ARS; Hotel Utah, Salt Lake City, Utah.

Feb. 3-4: Industrial Engineering Inst., Annual, Latest Developments in R&D; Univ. of Calif., Berkeley, Calif.

Feb. 1-4: Electronic Representatives Assoc., Annual Convention; Ambassador Hotel, Los Angeles.

Feb. 7-9: Electrical Manufacturers Assoc.; Veteran's Memorial, Columbus, O.

Feb. 13-16: Information Storage and Retrieval, Machine Indexing; American Univ., Washington, D. C.

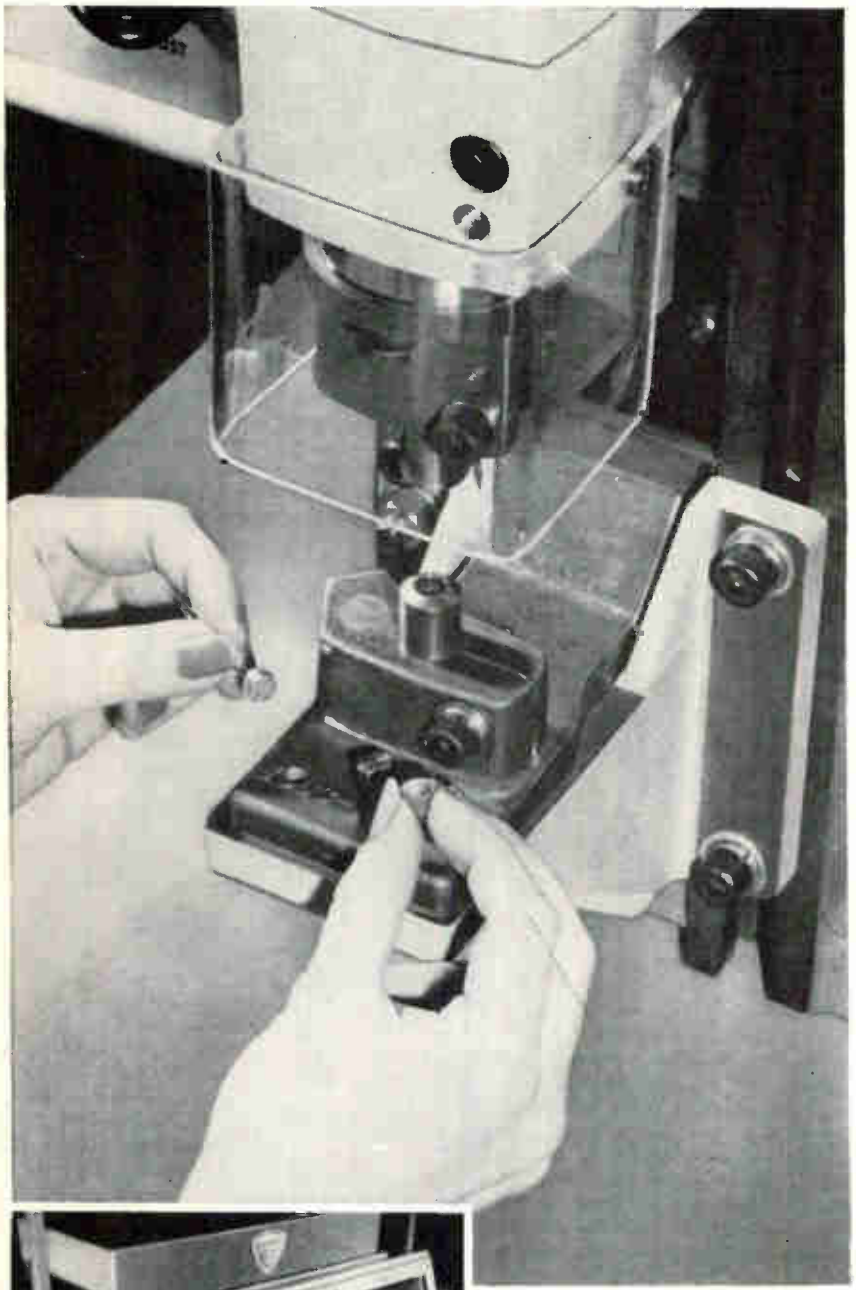
Feb. 14-16: Nondestructive Testing of Aircraft & Missile Components, Southwest Research Inst., South Texas Sec. of the Soc. for Nondestructive Testing Inc.; Gunter Hotel, San Antonio, Tex.

Feb. 15-17: Solid State Circuit Conf., International, PGCT of IRE, AIEE; Univ. of Penn. & Sheraton Hotel, Phila.

Feb. 26-Mar. 1: Pacific Electronic Trade Show; Great Western Exhibit Center, Los Angeles.

Mar. 20-23: Institute of Radio Engineers, International Convention, All PG's; Coliseum & Waldorf Astoria Hotel, New York City.

FOR PRECISION WELDING OF TRANSISTORS AND COMPONENTS



RAYTHEON'S MODEL "M" WELDING HEAD

Newest development in precision welding of miniature parts.

The "M" head—Raytheon's completely new precision welding device—assures consistent welding performance even when joining miniature parts. The secret is the advanced design that achieves relatively low welding currents and electrode pressures.

The new head has extremely fast action and a new low-impact anti-hammer arrangement that extends electrode life many times. It has an air chamber that provides for a deflection of less than .003 inch under full pressure.

The "M" head—thoroughly tested in transistor production—can be mounted horizontally or vertically and is adaptable to dial feed or in-line feed for automated production.

THE UNIQUE ADVANTAGES of an "M" head installation will be obvious to you after reading the latest technical bulletins. Write for them today to Raytheon Company, Commercial Apparatus & Systems Division, Production Equipment Department, 1415 Boston-Providence Turnpike, Norwood, Massachusetts. In Canada, Raytheon Canada, Waterloo, Ontario.

FEATURES

- Can be used with any welder
- Horizontal or vertical operation
- Adaptable to dry box installations
- Quick, easy servicing, electrode changing
- Adjustable linear bushing and electrode alignment
- Long electrode life
- Minimum deflection

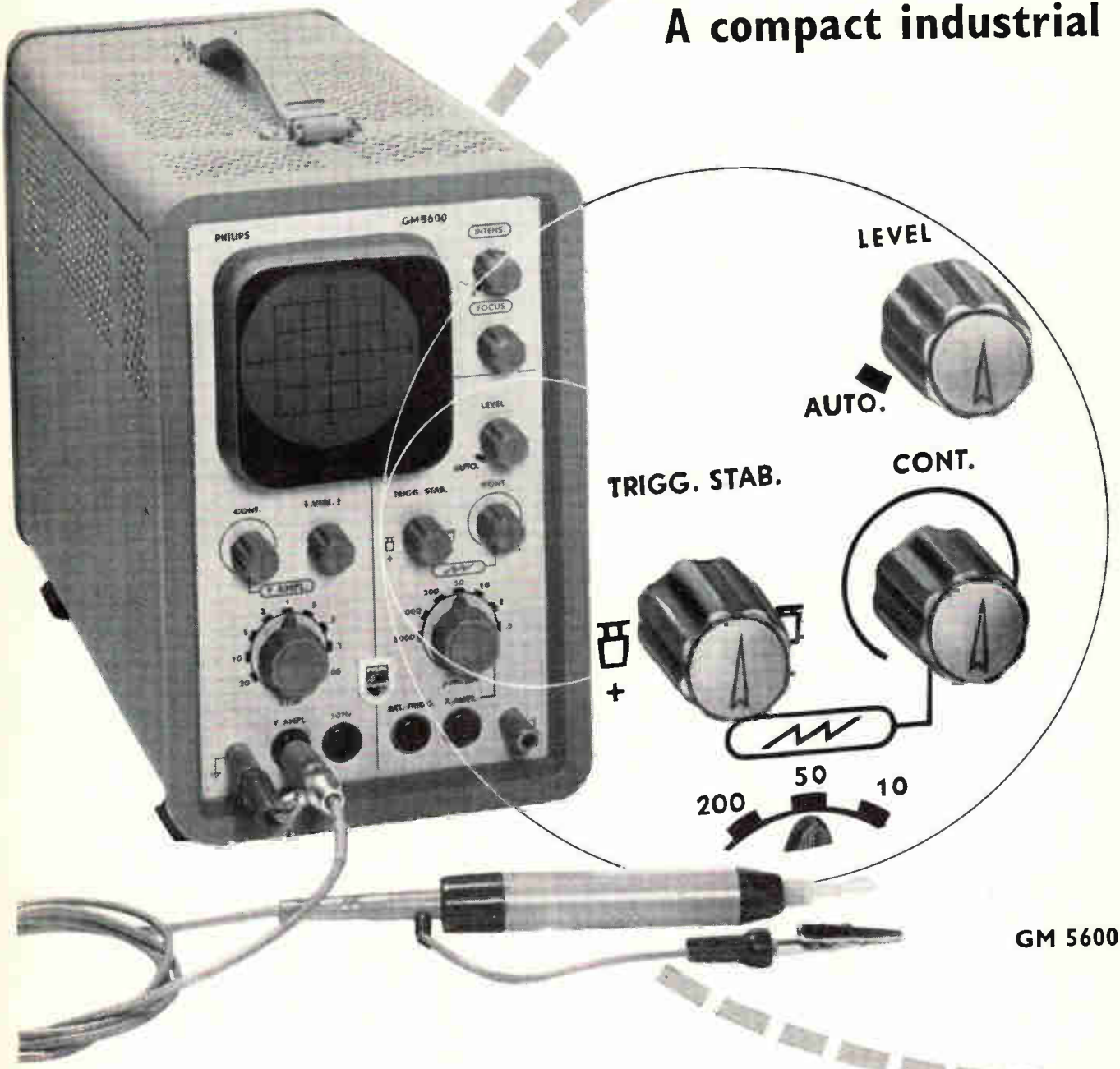
RAYTHEON

RAYTHEON COMPANY

COMMERCIAL APPARATUS & SYSTEMS DIVISION

A complete line of precision welding equipment for the electronics industry

A compact industrial



GM 5600

PHILIPS *electronic measuring*

Sold and serviced by Philips Organizations all over the world

Further information will gladly be supplied by:

N.V. Philips' Gloeilampenfabrieken, EMA-Department, Eindhoven, the Netherlands

For Canada: Philips Electronics Ind. Ltd., 116 Vanderhoof Ave., Toronto 17, Ont.

oscilloscope

with all facilities

Important characteristics:

4% calibrated vertical deflection (maximum sensitivity: 50 mV cm, bandwidth: 0—5 Mc s)

Optimum trigger stability with manual and automatic level control at repetition frequencies between 10 c s and 1 Mc s

Dimensions: 16 x 25 x 34 cm (6.5" x 10" x 13.5")

These three main characteristics make this oscilloscope the standard instrument for service and monitoring applications in industry. It gives just those features you are looking for and which up till now were not available in instruments of this price-class.

Some other data

Vertical amplifier

Bandwidth: 0—5 Mc s (—3 dB), risetime 70 mμsec
Sensitivity: 50 mV/cm—20 V cm in 9 calibrated steps (accuracy ± 4%)
Continuous control: 1 : 2.5

Time base

Sweepspeeds: 0.5 μsec cm—30 msec cm in 7 steps and continuously adjustable

Trigger-possibilities

Internal or from an external source both with pulse repetition frequencies from 10 c s to 1 Mc s, as well as from the mains frequency. Stability control and manual or automatic level control.

Horizontal input

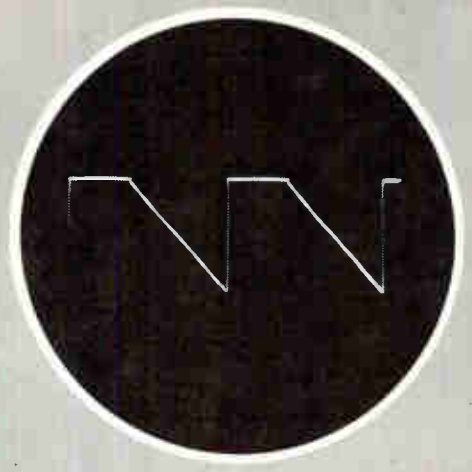
Bandwidth: 5 c s—2 Mc s
Sensitivity: 3—50 $V_{p\text{-}p}$ cm (continuously adjustable)

C.R.T.

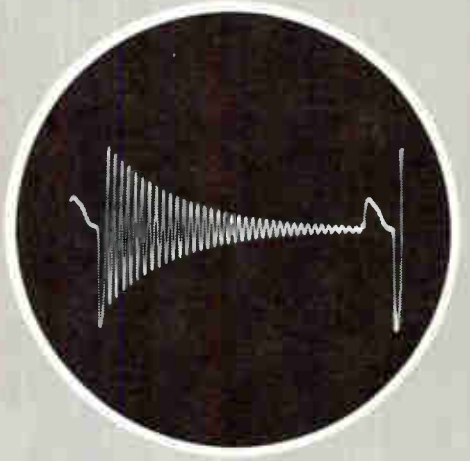
7 cm flat-faced with 1.4 kV accelerating voltage

Probe

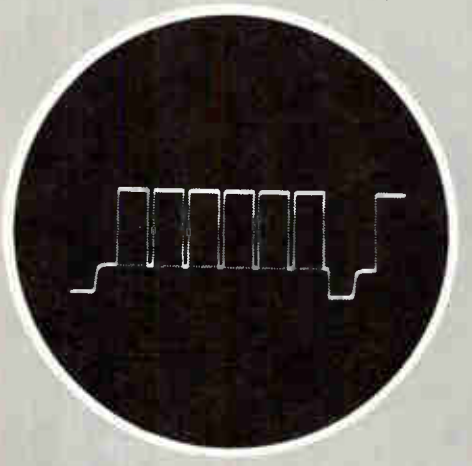
Attenuator probe (10 : 1) available



timebase voltage of GM 5600 (triggered position)



1 Mc s damped sine-wave on GM 5600



one line of a TV pattern with vertical bars

instruments: **quality *tools* for industry and research**

PHILIPS

CIRCULATORS*

Coaxial isolators and circulators with no external magnets...

Miniaturized by SPERRY

MODEL NO.	FREQ. (MC)	AVE. PWR. (WATTS)	MAX. INS. LOSS (db)	MIN. ISOLATION (db)	MAX. INPUT VSWR	DIMENSIONS (INCHES)	WEIGHT LBS.	OZ.
D44J7-5	225-300	5	5.0	18	1.30	3x1½x7⅞	3	4
D44J7-6	300-400	5	3.6	18	1.20	3x1½x7⅞	3	4
D44J7	400-450	5	1.0	12	1.20	3x1½x7⅞	3	4
D44P1-7	450-550	5	1.0	15	1.20	3x1½x7⅞	3	4
D44P1-3	700-900	5	1.2	20	1.25	3x1½x7⅞	3	4
D44P1-5	870-990	5	1.2	20	1.20	3x1½x7⅞	3	4

ISOLATORS — UHF STRIP TRANSMISSION LINE

SPERRY MICROWAVE ELECTRONICS COMPANY, *CLEARWATER, FLORIDA • DIVISION OF SPERRY RAND CORPORATION*

Microline Instruments | *Radar Test Sets* | *Systems Instrumentation* | ***Solid State Devices and Materials*** | *Microwave Components and Antennas*

MODEL NO.	FREQ. (KMC)	AVE. PWR. (WATTS)	MAX. INS. LOSS (db)	MIN. ISOLATION (db)	MAX. INPUT VSWR	DIMENSIONS (INCHES) DIA.	HEIGHT	WEIGHT LBS. OZ.
D52J1	.40- .45	25	.7	17	1.30	5 7/16	7/8	3
D52P1	.90- .96	15	0.7	20	1.30	2 1/2	3 11/16	3 10
D52L1	1.25- 1.35	10	0.7	20	1.30	2 1/2	3 11/16	3 10
D52S1	2.7 - 2.9	10	0.5	20	1.30	1 5/8	2 1/16	12
D52C1	5.4 - 5.9	15	0.5	20-30	1.30	1 2/5	1 2/5	6
D52C1-2	5.4 - 5.9	15	0.5	20-30	1.30	1 1/2	3/4	4

* Physical dimensions on the D52D1, L1 and S1 subject to change in the near future. This change, if made, will be aimed at improving manufacture of the units plus improving reproducibility.

Sperry's constant effort to reduce the size and weight of its devices without sacrificing any of their desirable features or performance characteristics has resulted in a complete line of coaxial and strip transmission line isolators and circulators miniaturized to a degree that only Sperry research could have made possible.

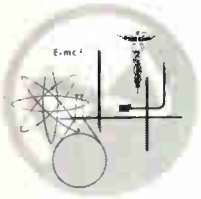
These isolators and circulators have no external permanent magnets, possess excellent electrical performance and almost perfect magnetic shielding. Designed for operation from 225 mc to 6000 mc with 10 percent bandwidths. Miniaturized units with wider bandwidths and stable operation under rigid environmental conditions are available on special order.

Sample units available from stock. We will welcome your inquiries for more complete information.

MODEL NO.	FREQ. (KMC)	AVE. PWR. (WATTS)	MAX. INS. LOSS (db)	MIN. ISOLATION (db)	MAX. INPUT VSWR	LENGTH* (INCHES)	WEIGHT (OZ.)
D44L7	1.25 - 1.35	5	0.9	15	1.20	6 39/64	6¼
D44L7-7	1.24 - 1.40	5	0.8	12	1.20	6 39/64	6¼
D44L7-6	1.435- 1.535	5	0.6	16	1.15	6 39/64	6¼
D44L11-2	.96 - 1.215	10	0.8	10	1.20	11 11/16	10
D44L33-25	1.7 - 2.3	10	1.0	13	1.20	10	8
D44L33-5	2.0 - 2.7	10	2.0	40	1.20	11 55/64	14
D44S7	2.7 - 3.1	5	0.9	15	1.20	4 11/32	5
D44C7	5.4 - 5.9	5	0.9	15	1.20	4 11/32	5

*All units have a maximum diameter of 25/32 inch.

ISOLATORS – COAX INTERNAL MAGNET



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For precise quantitative analysis of:

- Dielectric properties of solids and liquids
- Ferromagnetic effects
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- Absorption spectra of gases
- Molecular beam resonance
- Superconductivity phenomena
- Microwave accelerated particles
- Radiometry
- Velocity and phase by interferometry
- Transmission and absorption spectrometry
- Plasma diagnostics

UNIQUE FERRITE ISOLATORS

We use a special ferromagnetic compound in these units. Result: improved unidirectivity.

Typical Specifications

Frequency range:	full waveguide bandwidth
Insertion loss:	1.0 db max.
Isolation:	30 db min.
VSWR:	1.15 max.
Overall length:	5⅞"

CIRCLE 252 ON READER SERVICE CARD

NEW FERRITE-LOADED CRYSTAL MULTIPLIER

You have long wanted more power at Ultra-microwave® frequencies. These ferrite-loaded harmonic generators deliver 10 db more power at the second harmonic.

Units are available with outputs to 200 KMC sec.

CIRCLE 251 ON READER SERVICE CARD

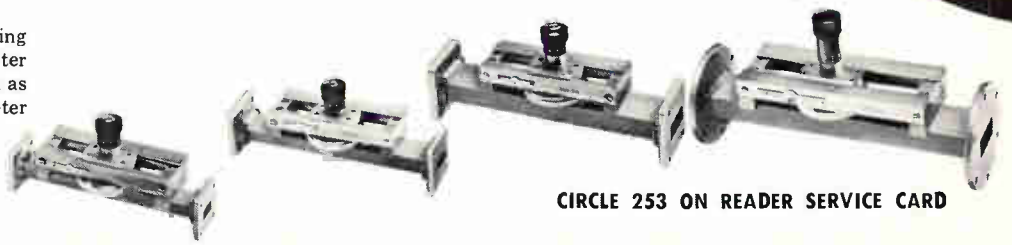
CLICHE' DEPT.

We not only claim "the most complete line" —we have it!

DE MORNAY

STUB TUNERS

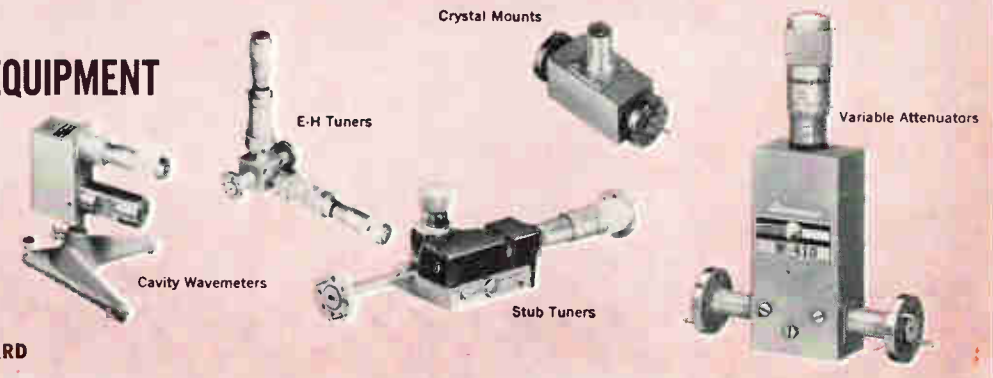
—the finest money can buy, offering precise resettability . . . micrometer depth control . . . VSWR as high as 20/1, as low as 1.02 . . . micrometer readout to .0001".



CIRCLE 253 ON READER SERVICE CARD

ULTRAMICROWAVE® EQUIPMENT

This line—the most widely used in America today — has opened new horizons in microwave applications. If you are interested in higher and higher frequencies, get in touch with us—we're now working with frequencies up to 300 KMC/sec.



CIRCLE 254 ON READER SERVICE CARD

WHAT IS THE FREQUENCY STANDARD FOR THE U.S.A.?

ANSWER: By act of congress, the U.S. Bureau of Standards determines the primary standard, based on the revolution of the earth. Our unique design, methods, and environmentally controlled calibration procedures enable us to deliver production cavity wavemeters calibrated to an accuracy of 1 x 10^{4}. Transfer of frequency calibration from U.S. Bureau of Standards data is accomplished well within the limits defined.

Exclusive features:

- Hermetically sealed
- Temp. comp. 10^{-5} fMc/°C, −30 to +70°C
- Covers full waveguide bandwidth
- High Q values
- .0001 micrometer resolution

CIRCLE 255 ON READER SERVICE CARD

A CHALLENGE TO YOU!

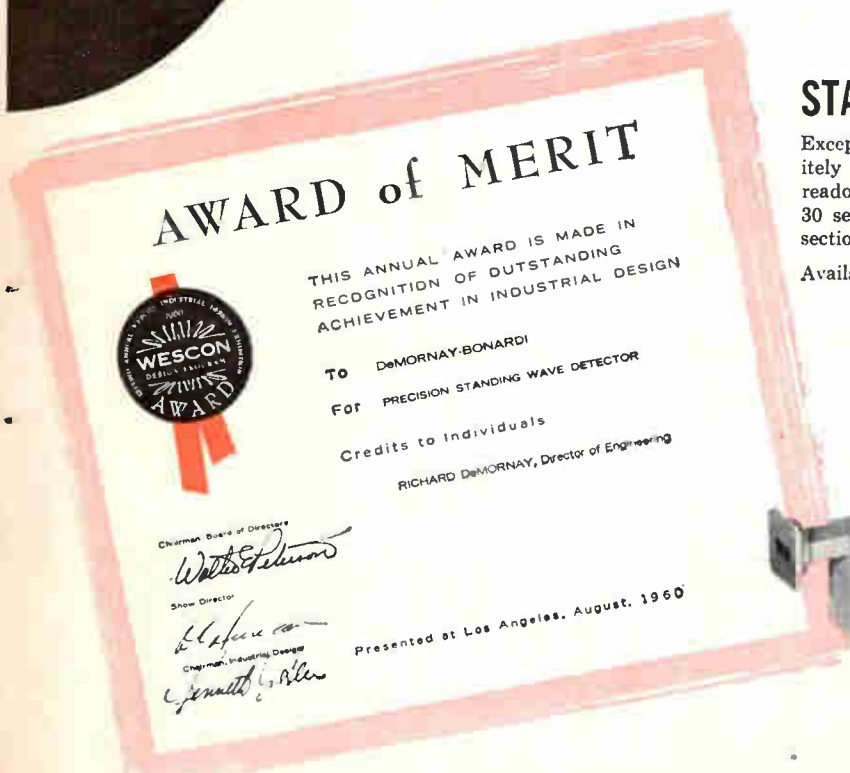
Buy any one of our 1500 stock items. Try it. If it doesn't meet our specifications, the person who verifies this and notifies us will receive a reward of $50.00.

This offer holds good for orders placed until the end of the month following publication of this issue.

BONARDI

OLD! OLD! OLD!

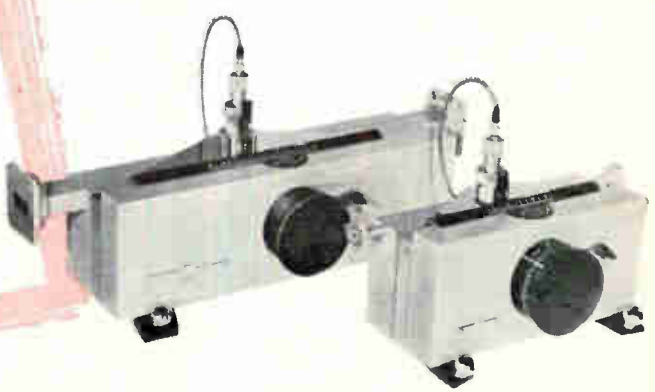
—yes, we're proud to have the oldest name in the business.



STANDING WAVE DETECTORS

Exceptionally accurate . . . patented, gearless, infinitely variable speed drive . . . linear displacement readout to .01 mm . . . direct phase readout . . . only 30 seconds to change to any of 10 other waveguide sections, with perfect alignment.

Available from 5.8 KMC to 300 KMC.



CIRCLE 256 ON READER SERVICE CARD

NEW FROM NARDA

Wide Range

KLYSTRON POWER SUPPLY— $495.00

Model 438

Operates more Klystrons than any comparable unit!

This new Narda Wide Range Klystron Power Supply operates virtually all medium and low voltage Klystrons, as well as some high voltage tubes (at reduced power output). It literally operates more Klystrons, including Sperry and Varian tubes, than any other unit in its price range!

What's more, all components, including tube sockets, are operated within manufacturers' ratings. (Many other supplies exceed plate-cathode, cathode-filament or socket-ground voltage ratings.)

Want more information about this new Power Supply that gives you greater versatility and longer trouble-free service at lower cost? Then write us for complete spec sheets. Ask, too, for your free copy of our complete catalog. Address: Dept. E-6.

FEATURES

- **250-700 volt Beam Supply, 0-65 ma.**
- **0-1000 volt Reflector Supply**
- **Accurate Ten-Turn Dial Calibration**
- **5 mv max. Reflector Ripple**
- **Diode Protection Circuit**
- **Oil Filled Capacitors in High Voltage Filters**
- **Square Wave Modulation 0-150 Volts, 300 to 3000 cps.**
- **Saw Tooth Modulation 0-150 Volts, 30 to 180 cps.**
- **Sine Wave Modulation 0-150 Volts, 60 cps.**

the narda microwave corporation

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HOW TO AVOID DEVELOPING A COMPULSIVE DESIRE FOR A DIGITAL COMPUTER

The computer we're warning you about is called Recomp. It looks innocent enough at first. Yet one glance can be enough to arouse your acquisitive instincts. Recomp is a handsome piece of equipment. Like fine architecture or jet plane design, it looks right because it is right; form fits function.

Something else that will appeal to your practical sense is the compact size of Recomp. It's solid state, of course; in fact, it was the first fully transistorized computer on the market. There are no voluminous rows of vacuum tubes; no ventilating problems. Yet many times Recomp can match the performance of computers that literally fill rooms.

Now, to indulge your natural desire to find out more about the finest computer in its class, just imagine you have a Recomp handy. First, plug it in; any wall socket will do, and it takes no more electricity than an ordinary electric toaster. After an appreciative look at that distinctive keyboard, try a few sample problems. You will have a full scale compiler named SALT (that's Recomp's own Symbolic Algebraic Language Translator) to help you, or you can use Recomp machine language which is the simplest of any computer on the market today. If you do not know how to operate the keyboard, never mind; in a few hours you can become an expert at programming Recomp. It doesn't even demand specialized talents; anyone with computer problems can be taught to do it.

While you're enjoying yourself at the keyboard, why not try a problem using floating point arithmetic? Of course, Recomp has it built-in; in fact Recomp is the only compact computer on the market today in which this is a standard feature. It is rather astonishing how much greater capacity this gives you to handle a wide range of problems. Cuts down on that frustrated feeling.

If, at this stage, you can already feel the first stirrings of an irresistible urge to possess Recomp for your very own, let us counsel you: this is just a premature impulse. First you should read this unembellished list of facts:

1] Exclusive built-in floating point arithmetic.

2] Easy to program.

3] Efficient programming; 49 basic instructions expandable to 72.

4] Fast access time due to high-speed loops.

5] Magnetic disk memory with large capacity—up to 8192 instructions.

6] Large word length of 40 binary bits.

7] Each word contains two instructions.

8] Solid-state reliability.

9] Built-in square root command.

10] Large sub-routine and program library.

11] Active users group.

12] Built-in automatic conversion from decimal to binary.

13] Visual display of any word in memory.

14] Simple correction of errors.

15] Easily installed anywhere.

16] Can use conventional teletype equipment.

17] Low cost per computation.

18] High-speed input and output.

19] Programming training provided.

20] Large program exchange.

21] Coast-to-coast sales & service.

No doubt you have read of other computers that claim many of these advantages, but you see, Recomp is the only one that can claim them all. This can be very disquieting when you think about it.

Now, as to how you can avoid developing a compulsive desire for a digital computer: don't see Recomp in action. For on seeing the performance of Recomp, it is quite likely you will insist on owning one. However, if you find that the insidious Recomp has made an ineradicable impression on you, it would be as well to face facts. The truth is, you need Recomp. We'll be glad to help. Our address is AUTONETICS INDUSTRIAL PRODUCTS, Dept. 015, 3400 E. 70th St., Long Beach, California. The Autonetics Division of North American Aviation, Inc.

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electronics
January 20, 1961

MEDICAL ELECTRONICS

Part I: DIAGNOSTIC MEASUREMENTS

Instruments and techniques used to translate physiological parameters into diagnostically significant form are outlined

By WILLIAM E. BUSHOR,
Associate Editor

MEDICAL DIAGNOSIS can be defined as the technique of determining the distinctive nature of a disease. Since the diagnostic judgment of a physician is based in part on physiological measurements, electronics can lend a hand by providing more accurate data or by extending the sensibilities of the investigator.

Electrocardiographs—An electrocardiograph (ecg or ekg) detects and measures electrical potentials generated during contraction and relaxation of the heart muscle and makes a paper record of the events in time sequence. Waveforms and amplitudes have been correlated with heart action—abnormalities showing up as variants from empirically established norms.

Recent trends are to use transistor amplifiers and to provide greater amplification without seriously increasing signal-to-noise ratio. Also, portable ecg units are being made lighter, smaller and more rugged through use of transistors, ruggedized tubes and printed circuits. Areas receiving most attention are instrumentation of active subjects and vector ecg.

Instrumenting ambulatory or exercising patients is important in discovering abnormalities which are only revealed under stress.

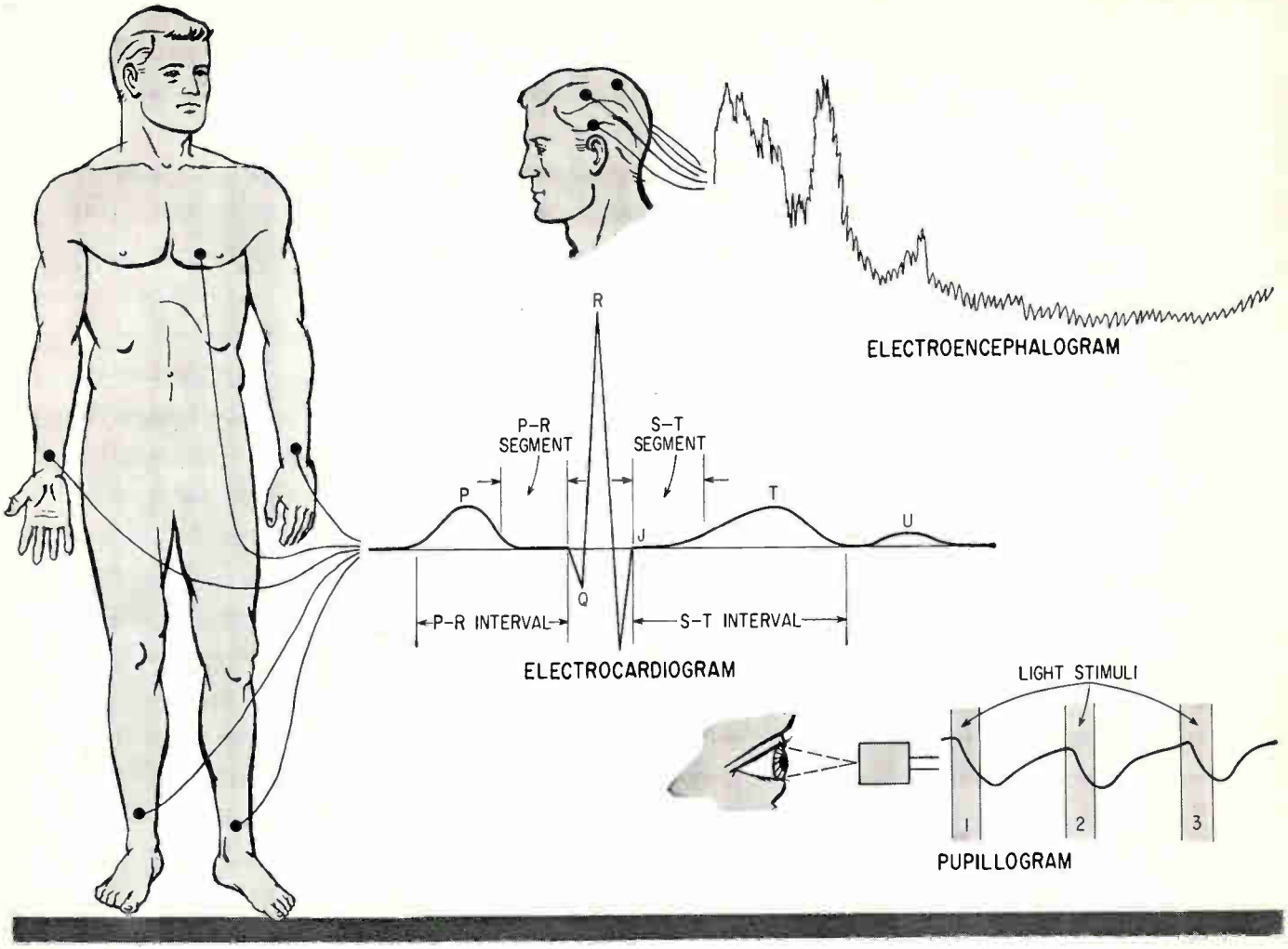
An ecg system for use during exercise has been proposed by researchers at Memorial and James Ewing Hospital, Sloan-Kettering Institute for Cancer Research, Cornell U. Medical College and Airborne Instruments Lab.[1] Pliable stainless steel mesh electrodes are applied to the skin so that the lead wire is immobilized to prevent traction on the electrode during body movements. Recordings from subjects performing a variety of movements are played through filters with corner frequencies ranging from 10 to 100 cps to minimize muscle potentials and interference. Alteration in original tracing resulting from filtering is then evaluated to determine the effect of stress on the heart.

Lockheed's Missile and Space div. and the Heart Research Foundation have developed a three-ounce transistorized transmitter which is worn around the neck or carried in the pocket. Signals picked up from body electrodes are broadcast to a remote f-m tuner that drives a conventional ecg. By connecting the tuner output to a phone line, ecg signals can be transmitted almost anywhere in the world.

An adjunct to the conventional ecg is the vector-ecg. Since the electrical potential produced by contracting muscle is equivalent to that of a dipole, this voltage can be represented as a vector. Visualization of the three vector components is possible using a crt display technique introduced by Phillips of Eindhoven.[2] Potentials of various parts of the body with reference to the right arm are amplified separately. A mixing circuit computes three signals proportional to the X, Y and Z components of the heart vector. After further amplification, combinations of two of the signals are successively applied to the vertical and horizontal deflection plates of a crt which displays horizontal (X, Z), frontal (X, Y) and sagittal (Y, Z) projections of the vector. Also, a device known as a vector-electrocardioscope is being used in Russia to investigate visually functional indices of heart action and circulation.[3]

ON THE COVER—*Physician uses obstetric stethoscope to position microphone of Airborne Instrument Lab's phonocardiotachometer (Medical Tribune Photo—Richard Saunders)*

Ballistocardiographs—A ballistocardiograph (bcg) detects and measures the small movements produced in the human body under influence of displacements of heart and blood occurring in connection with cardiac activity. With the aid of different types of transducers and electronic differentiators and integrators, it is possible to study



the basic parameters of these movements—displacement, rate and acceleration.

A prototype bcg has been developed by Astro-Space Labs. This system uses a sensitive accelerometer mounted on the patient's bed so that it is responsive only to lateral vibrations. Air bearing mountings isolate the bed from external vibrations. Output of the accelerometer is detected and fed to a strip chart recorder.

Phonocardiographs—Although the ear-stethoscope combination demonstrates a sensitivity and versatility difficult to match, many electronic devices and techniques have been investigated to facilitate or enhance listening.

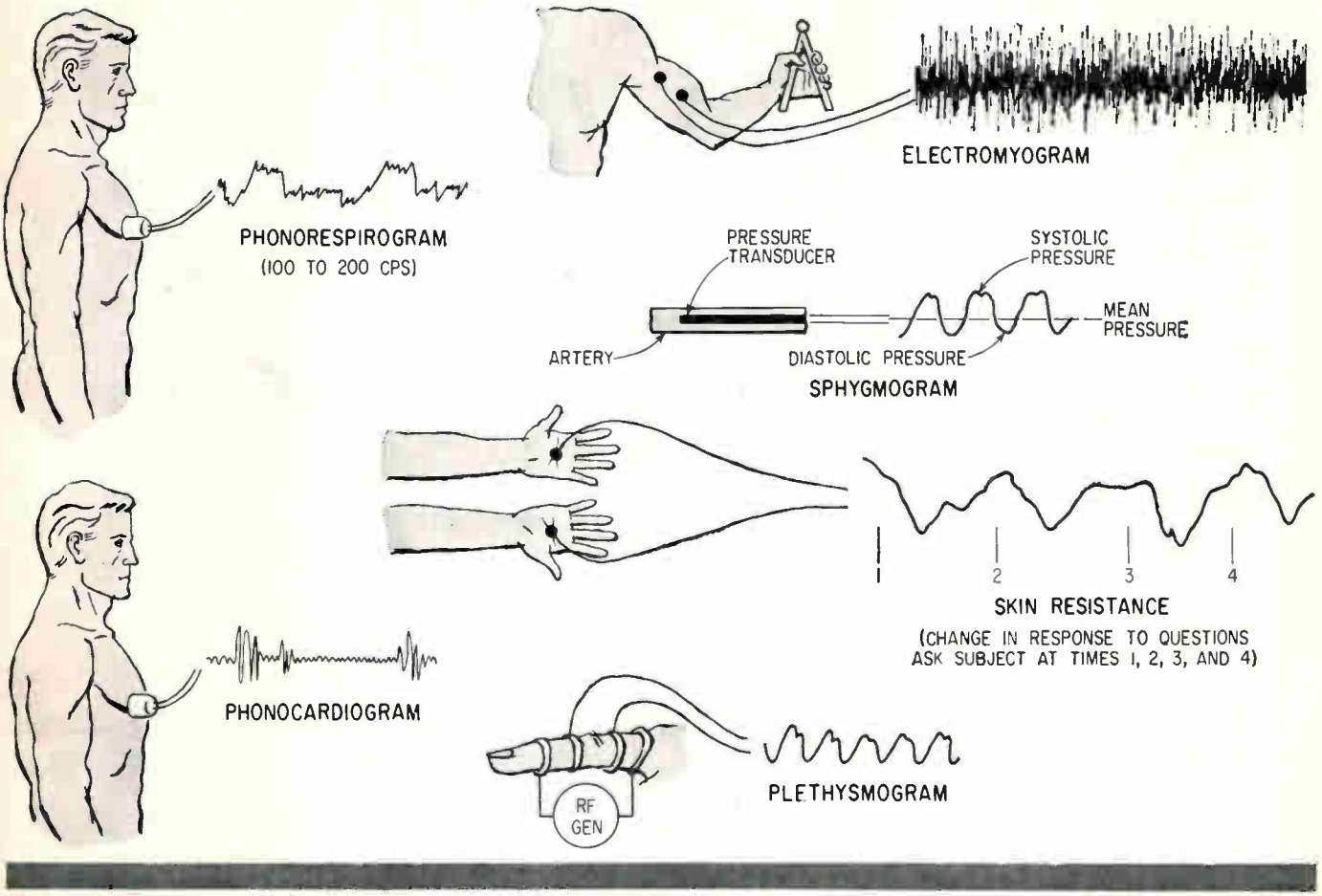
Phonocardiographic equipment that provides continuous, instantaneous recording of beat-to-beat changes in fetal heart rate during the last stages of pregnancy has been built by Airborne Instrument Lab and NYU's Downstate Medical Center.[4] A wide-frequency range microphone is held to the abdomen by a metal holder and elastic band. The fetal heart sounds are amplified, filtered and sent to a heartbeat detector that uses a technique adopted from track-while-scan radar systems. A tracking gate in the detector automatically adjusts to track either the first or second heart sound. Whenever a heartbeat occurs, the detector transmits a pulse to a tachometer where it is converted into a heart rate signal that is then fed to a graphic recorder.

An ultrasonic phonocardiograph has been built by Swedish physicians I. Edler and A. Gustafson. A sliver of quartz crystal generates 2½ Mc ultrasound that impinges on the heart. The reflected sound is detected by the crystal and electrical signals representing the generated and echoed ultrasound are displayed on a crt. By positioning the crystal opposite various sections of the heart, abnormal murmers and flutters can be registered with a sensitivity previously obtained only by surgical means.

A Doppler-type ultrasonic device for investigating movements of the heart chambers and valves through analysis of the particular shift signals produced from the motion of the respective part has been constructed in Japan.[5] The technique consists of radiating a continuous ultrasonic wave towards the heart from the surface of the chest wall and detecting the Doppler effect in the partial wave reflected from the moving heart. By recording these Doppler signals simultaneously with an ecg and phonocardiograph, it is possible to obtain direct information on valve movement timing that could not be obtained in other ways.

Sanborn and Ampex have jointly developed a heart sound recording and playback system consisting of a tape transport, recording and playback amplifiers, contact microphone and audiophone. In addition to recording and playback functions, the recorder can be used as an amplifying stethoscope. A plug-

WAVEFORMS FOR PHYSIOLOGICAL MEASUREMENTS



in attachment reproduces heart sounds with a high-pitched bleat, indicating any change in heart rhythm.

Gulton Industries has mounted a tiny microphone in a catheter (hollow tube) that permits pickup of sounds from within the heart. The technique circumvents the distortion introduced by body tissue lying between the heart and the outside, or by breathing sounds. The microphone is arranged as shown in the figure on page 52. The ceramic element consists of two thin outer layers of piezoelectric ceramic and a thin layer of metal. Heart pulsations are picked up by a window diaphragm whose vibrations activate the pointer causing the ceramic element to bend or vibrate. This produces an electrical impulse that is fed into a cathode follower and amplifier for presentation on an oscilloscope or direct-writing recorder.

The Russians have built a transistor phonocardiograph that can be attached directly to an ecg. This device uses a series of filters to distinguish between various frequencies produced by heart movements, blood flow and breathing.[5]

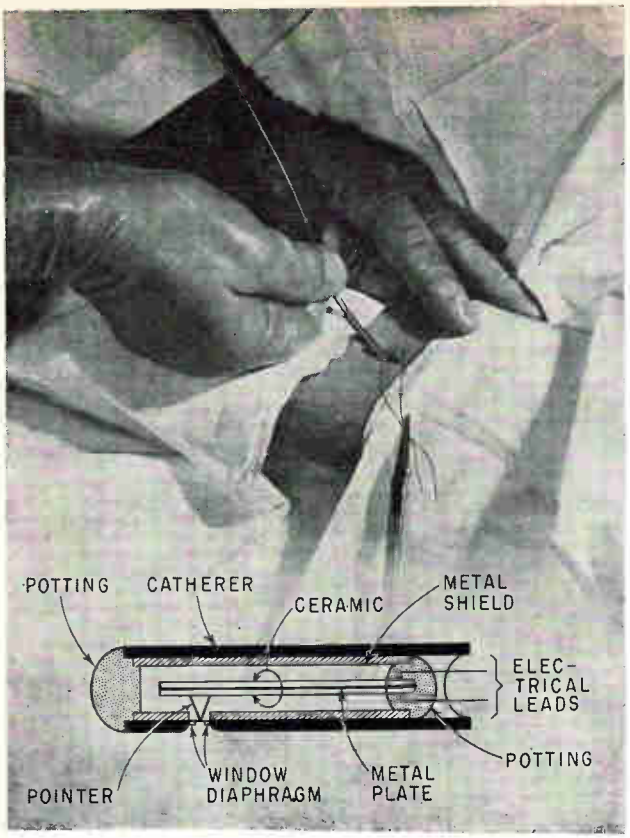
A new area of phonography consists of studying the sounds connected with pulse changes in the brain. Over the area of a brain tumor, blood clot, hemorrhage and the like, the intensity of the sounds is markedly altered. By recording these sounds using a microphone placed on the head, topical diagnosis of brain injuries is possible. A graphic recording of sounds in the head has been obtained using a portable electronic stethoscope to detect and localize sounds, and a lightweight pocket tape recorder to make a permanent record of the waveform.[6]

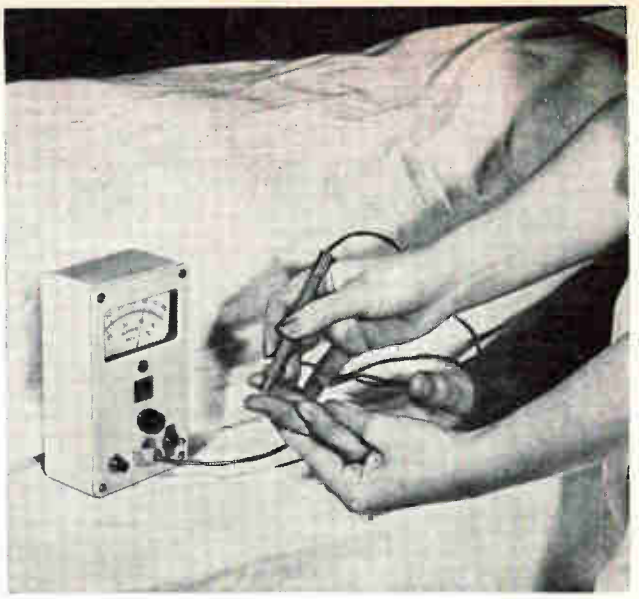
Cardiotachometers—Energy consumption of the human body can be approximated by measuring pulse rate. Light or sedentary work requires 70 to 80 beats per minute; moderately heavy work, 80 to 100; and very heavy work, 100 to 130.

Illinois Bell Telephone and the University of Chicago have developed a self-contained, cumulative heart beat counter. The instrument is connected by a flexible cable to electrodes on the subject's chest over the heart. The R-wave of the ecg complex (see typical waveform) is selectively amplified by five R-C coupled transistor stages. Every pulse of output current activates an electromechanical arrangement that drives a spring-wound watch movement. Thus, each R-wave is recorded on watch as 1/5 second.

Also, a technique of measuring fetal heart rate by using the fetal ecg as a trigger source for a cardiotachometer and display system has been developed by Epsco's Medical Div.[7]

Sphygmotonometers — A direct method of measuring blood pressure is to insert a catheter into a blood vessel or chambers of the heart and measure pressures through the fluid column of the catheter. A less accurate but com-





Instantaneous measurement of skin temperature can be made with Gulton Industries' electronic thermometer

Catheter used in Gulton Industries' intracardiac phonocardiograph is inserted into an artery (photo) and threaded through the vessel until microphone in tip (diagram) enters the heart

monly used indirect method is to use a pressurized cuff to collapse the artery. The systolic and diastolic phase can then be detected with a stethoscope or finger when the pressure is released and correlated with readings on a manometer connected to the cuff.

A blood pressure transducer developed by the Franklin Institute and the Decker Corp. measures pressure of the radial artery that runs just under the skin of the wrist. This artery expands and contracts in a linear fashion with blood pressure. By strapping a transducer over the artery, the arterial pulse waves can be detected. Since artery expansion has low driving power behind it and the area of action is small, a capacitive transducer is used to gain the advantage of the low coercive force associated with capacitive measurements. The transducer also functions as a phase-sensitive rectifier or detector by providing a phase-sensitive, d-c voltage proportional to the capacitance change.

Brain blood pressure and pulse shape can be measured by a simple and safe device, called a pulsensor, developed by the Franklin Institute and the University of Pa. Hospital.[8] The instrument makes use of the fact that the ophthalmic artery is a branch of the principal large arteries on each side of the neck. An air chamber with rigid walls is created in front of the eye's orbit. Amplification of the signals from a sensitive pressure transducer in the chamber yields a plethysmogram from each eye. Both systolic and diastolic pressure can be recorded. Knowledge is used to diagnose cerebral arterial disease.

Blood Flowmeters—Measurement of blood flow rate is important in diagnosing circulatory ailments and to detect changes in internal resistance of blood vessels.

Probably the most widely used electronic technique is to measure the voltage developed by the velocity of the blood (considered a conductor) when an exposed vessel is in a magnetic field. Voltage obtained is proportional to magnetic field, diameter of the vessel and blood velocity.

A square-wave electromagnetic flowmeter developed by Western Electric and the Bowman Gray School of Medicine uses an electromagnetically energized probe.[9] The vessel rests in an opening at the end of the probe. Voltage induced by blood flow is sensed by two electrodes connected to a high-gain low-level amplifier, fed to a mixer and then amplified again. The flow portion of the signal is converted to a d-c voltage, amplified and recorded.

Variations of the square-wave system have been experimented with extensively. Cardiac output (less coronary flow) has been measured at the University of Kansas using a gating technique to eliminate large cardiac action potentials.[10] Measurement of blood flow in a dynamic human is done at Ohio State University Research Foundation using a tiny transducer implanted about the vessel, the leads passing through the skin to an amplifier which drives a monitoring device.[11] Low blood flow rates in unopened vessels have been measured using a high-sensitivity square-wave electromagnetic flowmeter developed jointly by the Buffalo School of Medicine, the Veterans Administration and Cornell Aeronautical Labs.[12] A trapezoidal-wave electromagnetic flowmeter introduced last month by the Michael Reese Hospital overcomes fluctuating action of conventional electromagnetic flowmeters by making the measurement only when the fluctuating magnetic component is zero.

Tracerlab recently announced a nuclear technique for detecting blockage in vessels supplying blood to the heart muscle. A harmless quantity of radioactive tracer is thoroughly mixed in the blood stream. Detectors are then used to measure emitted radioactivity which is proportional to blood flow.

Isothermal flowmeters using a heated thermistor head in the flow-

ing blood stream have been investigated at the University of Washington.[13] The thermistor is connected to a catheter threaded into the vessel and is used as one arm of a balanced a-c bridge. Thus, the cooling effect of the blood causes an unbalance in the bridge. Error signal required to maintain the thermistor temperature and retain bridge balance is proportional to flow.

Nuclear magnetic resonance (NMR) techniques of measuring blood flow have been experimented with in recent years. Part of the body to be tested is placed between the poles of a large electromagnet. Hydrogen protons contained in the blood are normally oriented at random, but in the presence of a magnetic field they align themselves in the same direction. When a low-power burst of r-f energy is sent through the tissue, part of the energy is absorbed by the protons, resonating and flipping them over. The energy required to do this is a measure of the number of protons passing per unit time. AN NMR flowmeter has been built at the National Institutes of Health which permits measurement of mass flow in an intact limb.[14]

Ultrasonic flow measuring techniques do not require the opening of arteries or veins, are fast, are not bothered by naturally occurring signals and have an output which bears a linear relation to blood flow. The Mayo Clinic's ultrasonic flowmeter detects the small phase difference of signals traveling upstream and downstream between two transducers.[15] The University of Washington uses a pulse technique to detect differences in transit times directly, thus eliminating the difficult problem of measuring small phase shifts.[16] Bursts of 3-Mc sonic waves are passed diagonally through the stream of flowing blood by barium titanate crystals. Difference in transit times upstream and downstream is proportional to the mean velocity of blood flow; also, volume flow per unit time is proportional to the mean velocity if the vessel diameter remains constant. During transit time of the bursts, the capacitor is charged at a constant rate. When a crystal receives the ultrasonic waves, the capacitor is discharged. Maximum ramp voltage attained by the capacitor before discharge is a measure of transit time. Difference in transit time is measured by switching the sonic bursts alternately upstream and downstream by mechanical choppers.

The Japanese have succeeded in measuring blood flow by transmitting ultrasonic waves to the blood vessel from the surface of the skin. By demodulating and amplifying the reflected wave produced by the turbulent flow within the blood stream, noise that changes its intensity in proportion to the velocity of blood flow can be obtained.[17]

Plethysmographs — These devices measure the change in volume of tissue resulting from an increase in quantity of blood contained. Rhythmic fluctuations of blood content cause body tissue to expand or contract during the cardiac cycle with a consequent change in tissue impedance. A transistor device that will detect these changes using electrode pickups, resistance bridge and phase-sensitive detector has been designed by the Walter Kidde Co. and NYU. A photocell-type finger plethysmograph that is relatively insensitive to minor muscular movements has been built by the University of Washington.

Electroencephalography—An electroencephalograph (eeg) detects the rhythmically varying potentials produced by the brain using 15 to 24 pairs of electrodes placed at various postions on the scalp. After amplification, the signals from pairs of electrodes are simultaneously recorded. By examining these records, it is possible to diagnose a variety of neurological disorders and to measure the state of consciousness of an individual. In the latter application, eeg is now frequently used as a sensitive measure of the depth of anaesthesia.[18]

Until the advent of transistors, eeg equipment was used almost exclusively in the laboratories of larger hospitals. Greater simplicity and reliability provided by transistor circuits have made eeg a practical tool for smaller hospitals, clinics and portable applications.

Navy Medical Corps researchers report that they can determine by using eeg how many children an expectant mother will bear. Electrodes are applied to the mother and a systematic search made for heartbeats. Electrical impulses from the heartbeats of the expectant mother and the fetus or fetuses are detected and recorded on a graph. The number of fetuses is determined by their slightly different heartbeats.

The Russians M. N. Levanov and V. M. Anan'yev have built what they term an electroencephaloscope.[3] This device amplifies biological currents detected at 50 to 100 different sections of the human brain. An electronic commutator sequentially connects each of these channels to a common amplifier. When the signals are fed to an oscilloscope, a measure of the brain pattern is obtained on the screen. By the brightness of undivided sections of the image, those sections of the brain which are in an excited state can be determined.

Voltages picked up by electrodes directly on or within the brain are 10 to 100 times greater than those taken at the scalp surface and the responses are much faster. Originally these electrodes were massive, picking up impulses from hundreds or thousands of cells. In recent years microelectrodes capable of detecting the activity of a single nerve cell have been developed.[18]

Electromyography — Action potentials generated by muscles are measured on electromyographs (emg). Surface electrode recordings indicate the presence of activity and help in investigating the time relationship of the activity in different muscle groups. Because rapid or distortion-free recording is not necessary, the eeg amplifiers and ink writers can be used.[19]

Needle electrode recordings are used to determine the synchronization and relative timing of muscles and the relative amount of work done by the muscle. An amplifier and oscilloscope system is needed which is capable of recording muscle potentials without substantial distortion over a frequency range of 2 to 1,000 cps.

An ultraquiet transistor amplifier developed by Milivac Instruments and St. Claire Hospital has detected a new range of extremely weak high-frequency electrical signals from muscular tissue. Abnormalities in muscular structure were found to affect the frequency pat-

tern of the voltages generated by the muscle, thus providing important clues in diagnosis of muscular diseases. This equipment can detect weak signals occurring at frequencies up to 50 Kc.

Skin Resistance Measurement — Galvanic skin response and skin resistance are used as reliable indexes of a number of psychological states—degree of alertness, apprehension, fear, panic and placidity. Tissue capacitance has not been measured dynamically, but might be an additional important index.

Airborne Instruments Laboratory has designed a portable transistorized tissue resistance monitoring instrument capable of distinguishing between the potential and the resistance of skin.[20] The device uses a low-frequency, alternating sensing current. Amplitude of the current is a direct measure of the tissue resistance permitting the simultaneous monitoring of tissue potential. Since it is a d-c measurement, the tissue potential can be separated from the tissue resistance by using external filters.

Yellow Springs Instrument Co. is marketing a skin resistance measuring instrument for advanced studies of the self-governing nervous systems. A specially designed nonpolarized zinc disk and plastic holder combination allows placement on most parts of the body. Also, Gulton Industries has developed a device for measuring galvanic skin response. Electrodes placed at the insteps measure skin resistance, indicating psychological reactions of subjects in plight.

Temperature Measurement—Body, blood and skin surface temperatures are most commonly measured. Both thermocouples and thermistors have generally proven satisfactory as temperature sensors. Recent research indicates that semiconducting diamonds, whose electrical resistance varies with slight changes in temperature, might make excellent sensing elements.

An electronic thermometer developed by Gulton Industries will measure skin, rectal and oral temperatures instantaneously. A thermistor is used in an a-c bridge circuit whose output is amplified, rectified and filtered to yield a d-c output which is displayed on a meter.

Respiration Measurement — Respiratory measurements are useful in determining the amount of oxygen consumed by an individual and any changes in the rate and depth of respiration. Both Offner Electronics and Gulton Industries have constructed strain gage transducers mounted on an elastic band for measuring chest expansion. Recordings made from the strain gage signals give an approximation of respiratory volume and rate.

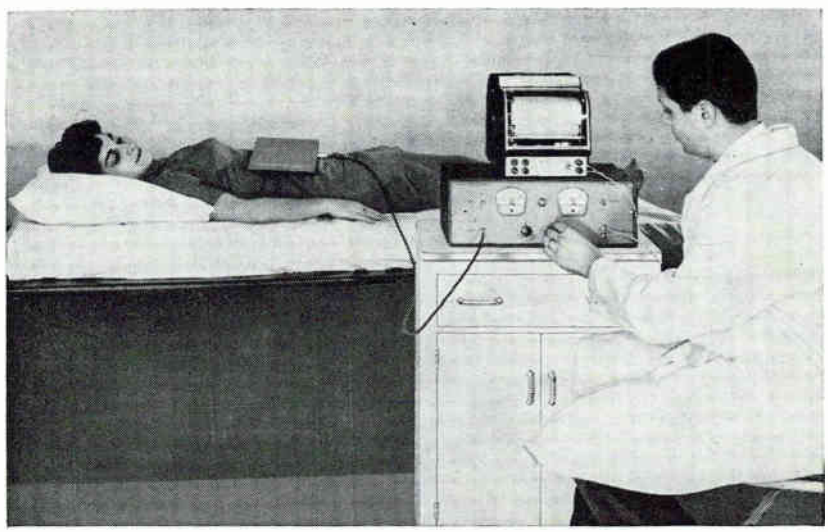
More accurate volume data can be obtained by using a flowmeter into which the subject breaths. One type employs a slightly resistant diaphragm through which the air passes. Pressure developed across the diaphragm is measured by a sensitive differential pressure transducer. Gulton Industries has developed a face-type transducer which detects the flow of air, rather than the volume, directly. It gives a written record in the form of a curved wave, the area above a base line drawn through the curve being a measure of instantaneous flow on the inhalation and the area below a measure of exhalation flow. The transducer consists of eight cantilevered stainless steel arms with wires cemented to their surface. When the arms flex in and out, a strain is imposed on the wires changing their resistance. Electrical signals generated by these changes are used as a measure of the flow of air.

Electronic devices have been built that give a direct physical and chemical analysis of respired air. Carbon dioxide is usually detected by its thermal conductivity, oxygen by its characteristic paramagnetic properties. Also, microrespirometers capable of measuring quick changes in the volume of oxygen in an isolated nerve have been developed.[18] This technique involves electrometric determination of oxygen tension at the surface of a nerve enclosed within a chamber of small volume.

A study made by the Avco Corp. for the U. S. Army Chemical Corps indicates that respiratory sounds can be correlated with pathological changes in the lungs.[21] The technique consists of making a magnetic tape recording of breath sounds produced during relaxed respiration. By playing the tape back through bandpass filters, amplitudes in decibels at various frequency bands as a function of time are recorded. Maximum amplitude of these frequency bands is determined and then plotted against mid-frequencies for both inspiration and expiration. Analysis of the recordings indicate that healthy human subjects have a maximum amplitude of about 250 cps while subjects possessing diseased lungs show a frequency shift or flattening of the amplitude peak.

Eye Measurements — Pupillary reactions are indicators of automatic nervous activity.

A device which will rapidly and



Gastrointestinal pressure is detected by Airborne Instrument Lab's Transensor endoradiosonde. Signal picked up by antenna on patient's stomach is demodulated by the f-m receiver and plotted on the strip recorder

continually measure the pupil diameter change in response to given spectral stimuli of known intensity and duration has been developed by Airborne Instrument Lab. To keep visual perception from interfering with test control, an infrared illumination and scanning system is used to measure and record pupil dilation and contraction. The infrared beam, a rapidly moving pin point of light, scans the eye similar to the way a tv tube projects an image on its screen. The beam's small size and great velocity eliminate danger of injury to eye tissue.

Electrical response of the human retina to light stimulation can be measured on an electroretinograph (erg). Recently a technique for measuring eye flicker caused by light stimuli was devised by using a contact lens electrode.[22] The response signal is fed to a resonance amplifier to preserve a high signal-to-noise ratio. Amplitude is read off a dial of a resonance meter tuned to the rate of stimulation.

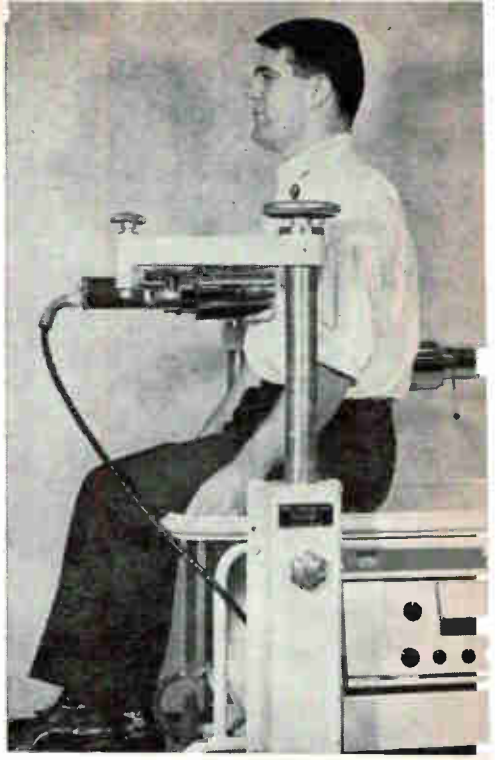
Gastrointestinal Measurements—Endoradiosondes (radio pills) detect and transmit physiological data from the gastrointestinal tract or other inaccessible body cavities. Pressure and temperature are most often measured, although pH values are occasionally required.

A number of radio pills have been developed both in the U. S. and abroad during the last six years and are capable of being used routinely by technicians. A pressure sensitive radio pill, called the Transensor, is now being manufactured for sale by Airborne Instrument Lab. AIL is experimenting with a Transensor capable of measuring temperature, monitoring acidity and detecting the presence of blood in the gastrointestinal tract. Dr. Noller of Germany is manufacturing a radio pill on an industrial scale which can be treated as expendable item.

Researchers in England have developed pressure and temperature sensitive radio pills, using only commercially available components, that are now in limited production.[23] The pressure sensitive pill uses an internal oscillator frequency modulated by the movement of a diaphragm-mounted ferrite disk that is part of a magnetic circuit containing the tuning inductance. Two types of temperature sensitive pills have been built. The first uses temperature-sensitive capacitors in the tuning circuit and is intended for temperature ranges of more than a few degrees. The second is a modified pressure-sensitive pill on which a small chamber has been sealed over a diaphragm containing a low-boiling point liquid (pentane or hexane). Temperature variations are thus transformed into pressure changes.

An externally energized radio pill has been developed by RCA.[24] It is smaller and less dense than conventional battery-operated pills. Also, the energy source gives a relatively unlimited effective operating life.

Satisfactory operation of radio pills for wide-range pressure fluctuations has been achieved at the U. of California.[25] This is done by supplying the restoring force to a core using the compressibility of a trapped pocket of air rather than by using the resiliency of a rubber diaphragm. Other physiological variables can be monitored similarly. A recent consideration involves a blood detector for localizing internal bleeding. The U. of California has also developed an omnidirectional antenna-receiver system that allows reception of a signal at constant intensity independent of the orientation of the pill. This device uses nonlinear elements, connected as full-wave rectifiers, to generate second or other even harmonics of the signal from each of three perpendicular receiving coils. The variation in frequency of the sum of these three signals is the useful signal and does not vanish for any orientation.



Coronary occlusion using Tracerlab's radioactive heart blood flow measuring system

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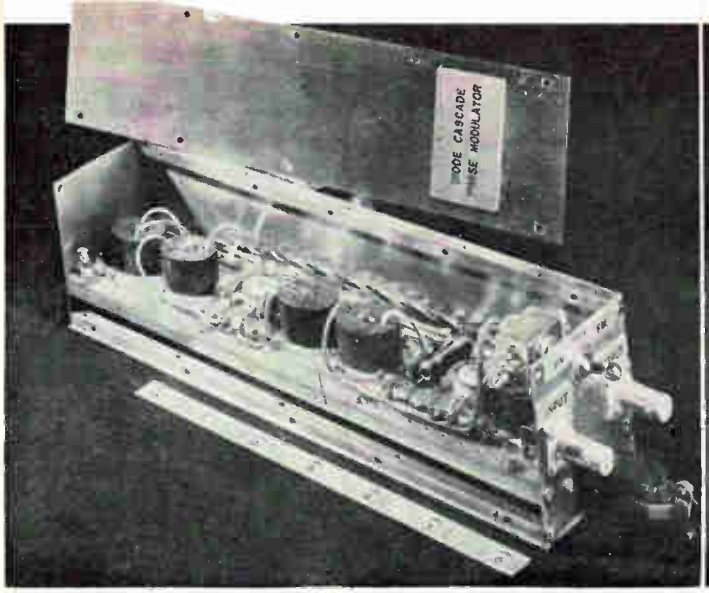
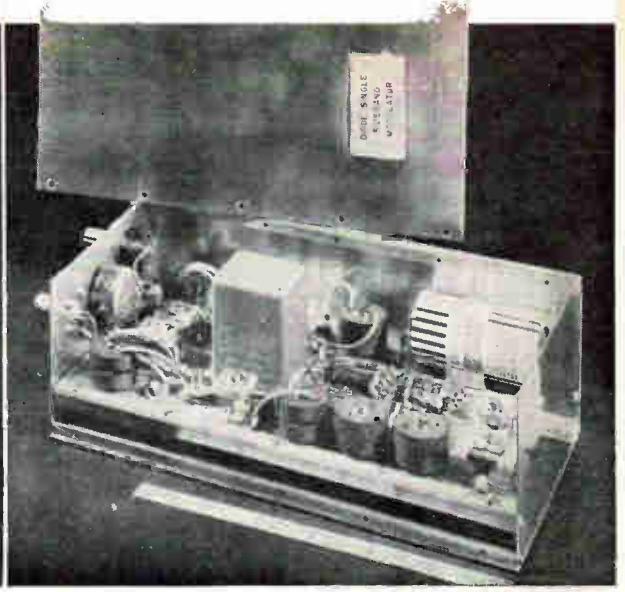


Package for the cascade modulator of Fig. 2A



Single-sideband modulator of Fig. 4A

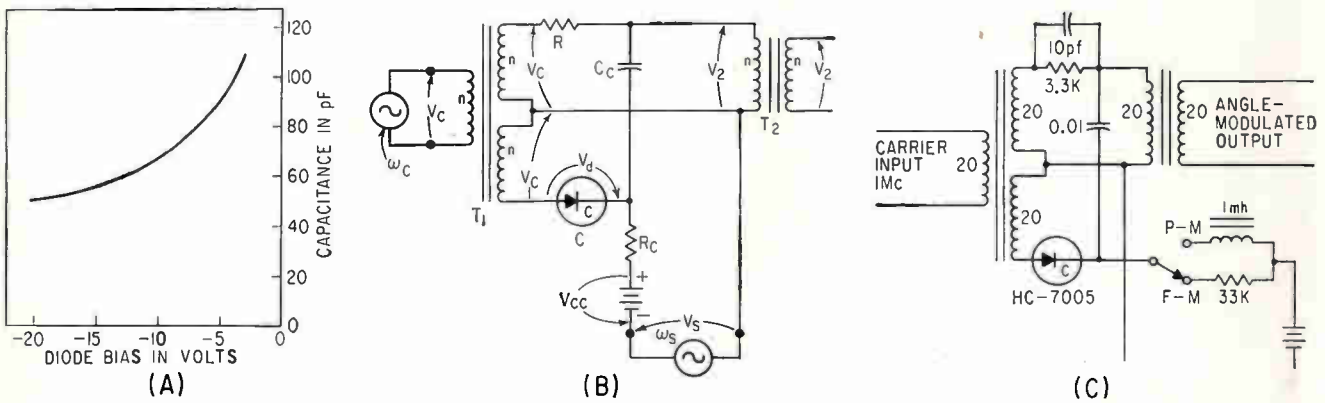


FIG. 1—Capacitance of voltage-variable diode HC-7005 (A), angle modulator (B) and f-m/p-m modulator (C)

Using Voltage-Variable Capacitors in

Single and cascade phase modulators have deviation angles of ± 25 degree per section at 1-Mc carrier frequency. Design equations treat phase and frequency modulators and ssb amplitude modulators

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VOLTAGE-VARIABLE capacitors can be used in cascade phase modulators and in single-sideband amplitude modulators. Using only linear elements, except for the capacitor, the phase modulator has acceptable linearity over a deviation angle of ±25 degrees per section. The single-sideband amplitude modulator has good linearity and acceptable suppression of the carrier and unwanted sidebands. The circuits are simple, compact and rugged.

The capacitance across a reverse-biased *p-n* junction diode varies with the magnitude of bias applied to the diode; such a bias forms a depletion layer at the junction whose width is a function of the applied voltage. Capacitance variation with applied voltage is

$$C = C_o / V_d^n \qquad (1)$$

where V_d is the total voltage across the junction, including the internal contact potential, C_o is a constant and n is about 0.5 for the step junction and about 0.3 for the graded junction.

Characteristics of a typical voltage-variable capacitor are given in Fig. 1A.

An angle modulator can be formed with a voltage-variable capacitor or diode in the usual *R-C* phase-shift circuit, as shown in Fig. 1B. For circuit analysis, a number of assumptions are made.

Transformers T_1 and T_2 are perfect transformers at carrier angular frequency ω_c, but appear as short

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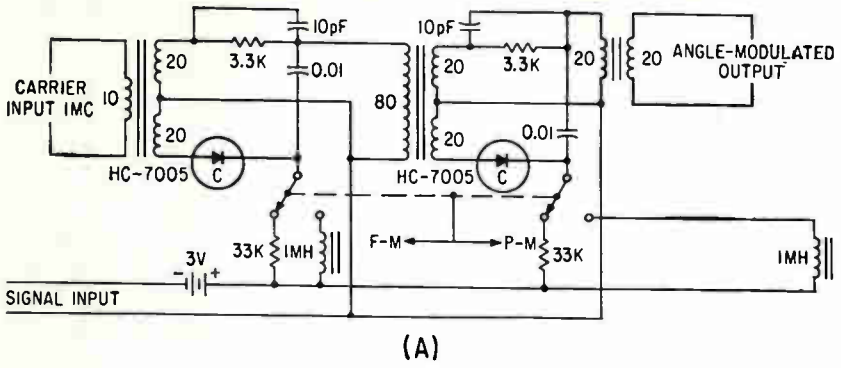
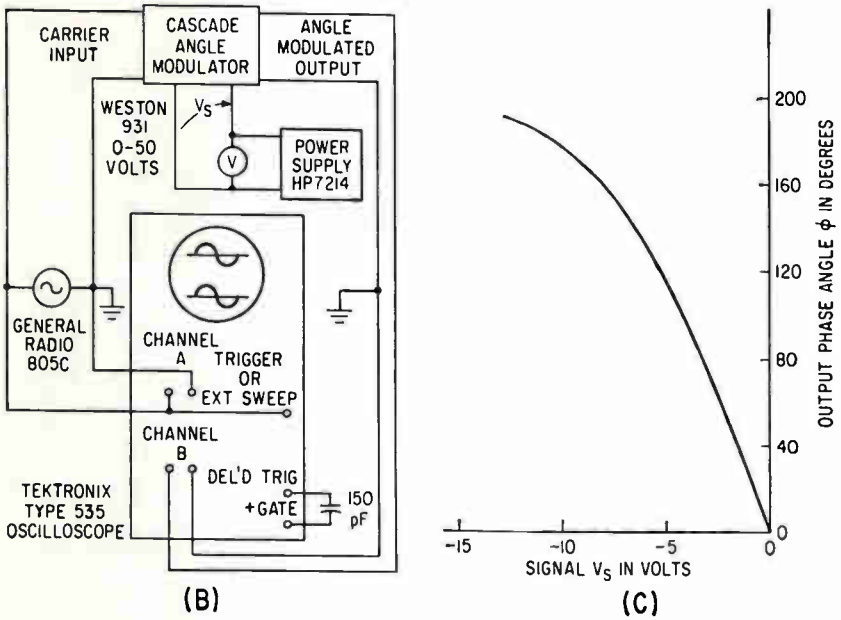


(A)



(B) (C)

FIG. 2—Cascade angular modulator (A) has deviation of ± 25 degrees per section. Test setup (B) for measuring performance (C)

Modulator Design

circuits at signal frequency ω_s. Capacitor C_c has negligible reactance at ω_c and C_c is much greater than the capacitance C of the voltage-variable diode. Resistor R and voltage-variable capacitor C form a signal-controlled phase-shift network; R is made equal to three times the reactance, at ω_c, of the quiescent capacitance of the voltage-variable capacitor. Resistor R_c is made equal to $10R$, and therefore may be neglected when the approximate behavior of the circuit at carrier frequency is considered. For frequency modulation, C_c and R_c are selected to give the integral of the signal voltage v_s across diode C. An r-f choke is substituted for R_c if phase modulation is desired.

Assume that signal voltage V_s is much larger than the carrier voltage, v_c and that both are sine waves.

$$v_c = V_c \sin \omega_c t \quad (2)$$

$$v_s = V_s \sin \omega_s t \quad (3)$$

Under these conditions, voltage v_d across the diode will be due almost entirely to the sum of signal voltage, bias voltage V_{cc} and diode contact potential V_{cp}.

At a particular value of diode voltage, $v_d = v_{d1}$, diode capacitance will be $C = C_1$. Assuming C_1 is constant over the carrier frequency cycle, $v_2 = v_1 - v_c$, where v_1 is the carrier frequency component of the voltage across the diode capacitor, and v_2 is the output voltage of the angle modulator.

In phasor form (let $|V| = V/\sqrt{2}$)

$$V_2 = V_1 - V_c \quad (4)$$

From the circuit of **Fig. 1B.**

$$v_1 = (2V_c/j\omega_c C_1)/[R + 1/(j\omega_c C_1)] \quad (5)$$

which may be written

$$V_2 = -V_c[1 - (1/j\omega_c C_1 R)]/[1 + (1/j\omega_c C_1 R)] \quad (6)$$

In polar form

$$V_2 = -V_c \angle -2 \arctan (1/\omega_c C_1 R) \quad (7)$$

Expressing v_2 as a function of time

$$v_2 \doteq -V_c \sin [\omega_c t - 2 \arctan (1/\omega_c C_1 R)] \quad (8)$$

If the deviation of voltage across the diode capacitor from the quiescent value is sufficiently restricted, Eq. 1 reduces to

$$C \doteq C_{o1}/v_d \quad (9)$$

and the angular modulator output for any diode voltage becomes

$$v_2 \doteq -V_c \sin \{\omega_c t - 2 v_d/\omega_c C_{o1} R\} \quad (10)$$

If the signal is applied through an r-f choke instead of R_c, the voltage across the diode (neglecting the small carrier-frequency region components) is

$$v_d \doteq V_s \sin \omega_s t - V_{cc} - V_{cp} \quad (11)$$

and the output becomes

$$v_2 \doteq -V_c \sin \left\{\omega_c t - \frac{2V_s \sin \omega_s t - 2V_{cc} - 2V_{cp}}{\omega_c R C_{o1}}\right\} \quad (12)$$

Equation 12 is for a phase-modulated wave with modulation index $m_p = 2V_s/\omega_c R C_{o1}$.

If a frequency-modulated wave is desired, the circuit of Fig. 1B is used and the audio signal is integrated by network $R_c C_c$ before it is applied to the diode capacitor. The signal voltage component across the diode capacitor will be

$$V_{ds} = (V_s/j\omega_s C_c R_c)/(1 + 1/j\omega_s C_c R_c) \quad (13)$$

If, over the signal-frequency range $\omega_s C_c R_c < 10$, then $V_{ds} = V_s/j\omega s C_c R_c$. Neglecting components near carrier frequency, the voltage across the diode capacitor becomes

$$v_d = (-V_s/\omega_s C_c R_c) \cos \omega_s t - V_{cc} - V_{cp} \quad (14)$$

Hence, if the variation of v_d from quiescent is sufficiently restricted, the output of the angle modulator becomes

$$v_2' = -V_c \sin \left[\omega_c t + \frac{2V_s \cos \omega_s t}{\omega_s C_c R_c \omega_c R C_{o1}} + \frac{2(V_{cc} + V_{cp})}{\omega_c C_{o1} R}\right] \quad (15)$$

Equation 15 is for a frequency-modulated wave with a modulation index $m_f = 2V_s/\omega_s C_c R_c \omega_c R C_{o1}$.

The deviation angle for a given signal voltage may be increased n

times by operating n angle-modulator sections in cascade. In cascade, the output of each modulator stage provides excitation for the succeeding stage, while the signal terminals are connected in parallel. If stage interaction is neglected, a cascade system will give an output voltage of

$$v_{2n} = -V_c \sin \left\{ \omega_c t + \frac{2n(V_s \sin \omega_s t - V_{cc} - V_{cp})}{\omega_c R C_{01}} \right\} \quad (16)$$

The phase modulation index is $m_{pn} = n(m_p) = 2n\ V_s/\omega_c R C_{01}$.

A cascade system of n frequency modulator sections will give an output voltage of

$$V'_{2n} = -C_c \sin \left\{ \omega_c t + \frac{2n V_s \cos \omega_s t}{\omega_s C_c R_c \omega_c C_{01}} + \frac{2n(V_{cc} + V_{cp})}{\omega_c C_{01} R} \right\} \quad (17)$$

Frequency modulation index is $m_{fn} = n\ (m_f) = 2n\ V_s/\omega_c C_c R_c \omega_c R C_{01}$.

The circuit diagram of an angle modulator for a carrier frequency of one Mc is shown in Fig. 1C. For frequency modulation, the R_cC_c product gives a signal frequency break point of about 500 cps; hence, in the f-m position, the system gives the usual hybrid behavior—phase modulation below 500 cps and frequency modulation above. A small capacitance across R (Fig. 1B) provides compensation for dissipation in the diode and tends to make the output voltage independent of the degree of modulation.

If two angle modulators are connected in cascade, as in Fig. 2A, the modulation index is doubled for a particular signal value. An experimental modulator tested as a phase modulator in the system of Fig. 2B gave the results shown in Fig. 2C. For $V_{cc} = -2.5$ volts, a signal of 2 volts gives a deviation of plus and minus 50 degrees with good linearity.

The voltage-variable capacitor can be used in a phasing single-sideband modulator,[1] as shown in Fig. 3A. The multiplying operation may be performed as shown in Fig. 3B. Assumptions are similar to the first case presented.

Transformers T_1 and T_2 are perfect transformers at carrier angular frequency ω_c but appear as short circuits at signal frequency ω_s. Capacitor C_c has negligible reactance at ω_c, but is an open circuit at ω_s. Inductor L is an open circuit at ω_c but is a short at ω_s. Capacitors C_1 and C are open circuits at ω_s.

Again, signal voltage is much greater than carrier voltage and both are sine waves (Eq. 2 and 3 apply). Thus the voltage across the diode, as far as capacitance variation is concerned, will be due almost entirely to signal and bias voltage, and diode contact potential.

$$V_d' = V_{cc} + V_{cp} + V_s \sin \omega_s t \quad (18)$$

If constant C_0 (from Eq. 1) is defined as diode capacitanec when V_s is zero, then for any diode voltage value, v_d'

$$C = C_0/\{1 + [V_s \sin \omega_s t]/(V_{cc} + V_{cp})\}^n \quad (19)$$

If $V_s << V_{cc} + V_{cp}$

$$C \doteq C_0/\{1 + [nV_s \sin \omega_s t]/(C_{cc} + V_{cp})\} \quad (20)$$

Balancing the bridge at bias voltage V_{cc} to make $V_2 = 0$, $C_1 = C_0$.

With signal v_s applied, the capacitance of the diode will vary according to Eq. 20 and

$$v_2 = -v_c(1 - C_1/C)/(1 + C_1/C) \quad (21)$$

where C is the instantaneous diode capacitance. The variation in diode capacitance from the balance value will be small; hence $C_1/C \doteq 1$. Therefore

$$v_2 \doteq -v_c(1 - C_1/C)/2 \quad (22)$$

Thus the output can be written

$$v_2 \doteq v_c n V_s \sin \omega_s t/2(V_{cc} + V_{cp}) \quad (23)$$

$$v_2 \doteq n V_c V_s \sin \omega_c t \sin \omega_s t/2(V_{cc} + V_{cp}) \quad (24)$$

It has been found desirable to add a small variable resistance in series with capacitor C_1 (Fig. 3A). The resistor compensates for the dissipation of the voltage-variable capacitor, and permits the bridge to be balanced for complete carrier suppression.

Capacitor balanced modulators are used in the experimental single-sideband generator given in Fig. 4A. The R-C networks provide the phase shift at the carrier and signal frequencies. Forty-five degree lead and lag networks are used at the carrier frequency, and an m-derived R-C network, providing two equal output signals differing in phase by ninety degrees from 300 to 3,000 cps, is used at signal frequency. If the phase-shift networks behave as intended, and no additional phase shift is introduced by the modulators or the summing network, the block diagram of Fig. 3A will apply to the system of Fig. 4A.

If carrier and signal are sine waves, then $e_c = E_c \sin \omega_c t$ and $e_s = E_s \sin \omega_s t$. At the output of the phase-difference networks, the carrier and signal voltages will be

$$e_{c1} = E_c \sin (\omega_c t + 45) \quad (25)$$

$$e_{c2} = E_c \sin (\omega_c t - 45) \quad (26)$$

$$e_{s1} = E_s \sin (\omega_s t + 45 + \theta) \quad (27)$$

$$e_{s2} = E_s \sin (\omega_s t - 45 + \theta) \quad (28)$$

If carrier and signal are applied to the capacitor modulators, output voltages of the modulators will be

$$e_{c1}e_{s1} = \frac{nE_cE_s}{2(E_{cc}+E_{cp})} \sin (\omega_c t+45) \sin (\omega_s t+45+\theta) \quad (29)$$

$$e_{s2}e_{s2} = \frac{nE_cE_s}{2(V_{cc}+V_{cp})} \sin (\omega_c t-45) \sin (\omega_s t-45+\theta) \quad (30)$$

Substituting trigonometric identities, Eq. 29 and 30 become

$$e_{c1}e_{s1} = \{nE_cE_s/4(V_{cc}+V_{cp})\} \{\cos [(\omega_c-\omega_s)t-\theta] + \sin [(\omega_c+\omega_s)t+\theta]\} \quad (31)$$

$$e_{c2}e_{s2} = \{nE_cE_s/4(V_{cc}+V_{cp})\} \{\cos [(\omega_c-\omega_s)t-\theta] - \sin [(\omega_c+\omega_s)t+\theta]\} \quad (32)$$

After the voltages produced by the modulators are added, the output occupies the position of the lower sideband of the normal amplitude modulator.

$$e_o^+ = e_{c1}e_{s1} + e_{c2}e_{s2} \quad (33)$$

$$e_o^+ = [nE_cE_s/2(V_{cc} + V_{cp})] \cos [(\omega_c - \omega_s)t - \theta] \quad (34)$$

If the voltages had been substracted, the upper sideband would have been produced.

$$e_o^- = e_{c1}e_{s1} - e_{c2}e_{s2} \quad (35)$$

$$e_o^- = [nE_cE_s/2(V_{cc} + V_{cp})] \sin [(\omega_c + \omega_s)t + \theta] \quad (36)$$

If the modulating signal contains n sine-wave components, the sum and difference voltages would be

$$e_o^+ = \frac{nE_c}{2(V_{cc} + V_{cp})} \sum_{k=1}^{n} E_{sk} \cos [(\omega_c - \omega_{sk})t - \theta_k - \beta] \quad (37)$$

$$e_o^- = \frac{nE_c}{2(V_{cc} + V_{cp})} \sum_{k=1}^{n} E_{sk} \sin [(\omega_c + \omega_{sk})t + \theta_k + \beta_k] \quad (38)$$

The ideal behavior depicted in Eq. 37 and 38 is difficult to realize, as this performance requires perfect phase-shift networks and ideal modulators. If phase and magnitude relationships for the system voltages are not maintained, suppression of the unwanted sideband will be incomplete. If the capacitor modulators are not balanced, the carrier suppression also will be incomplete. Expressions have been obtained by Norgaard[4] for the

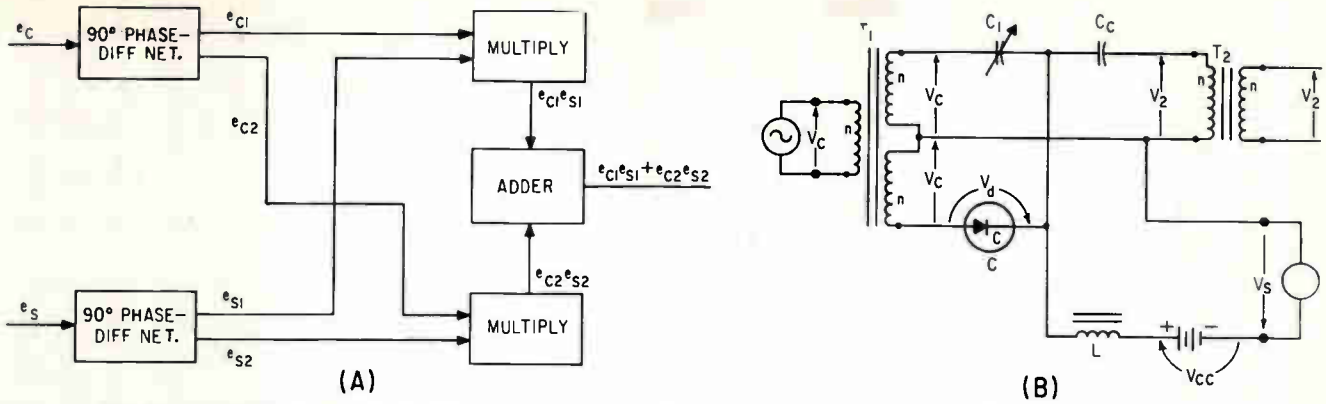


FIG. 3—Phasing method of ssb generation (A), and capacitance balanced modulator (B)

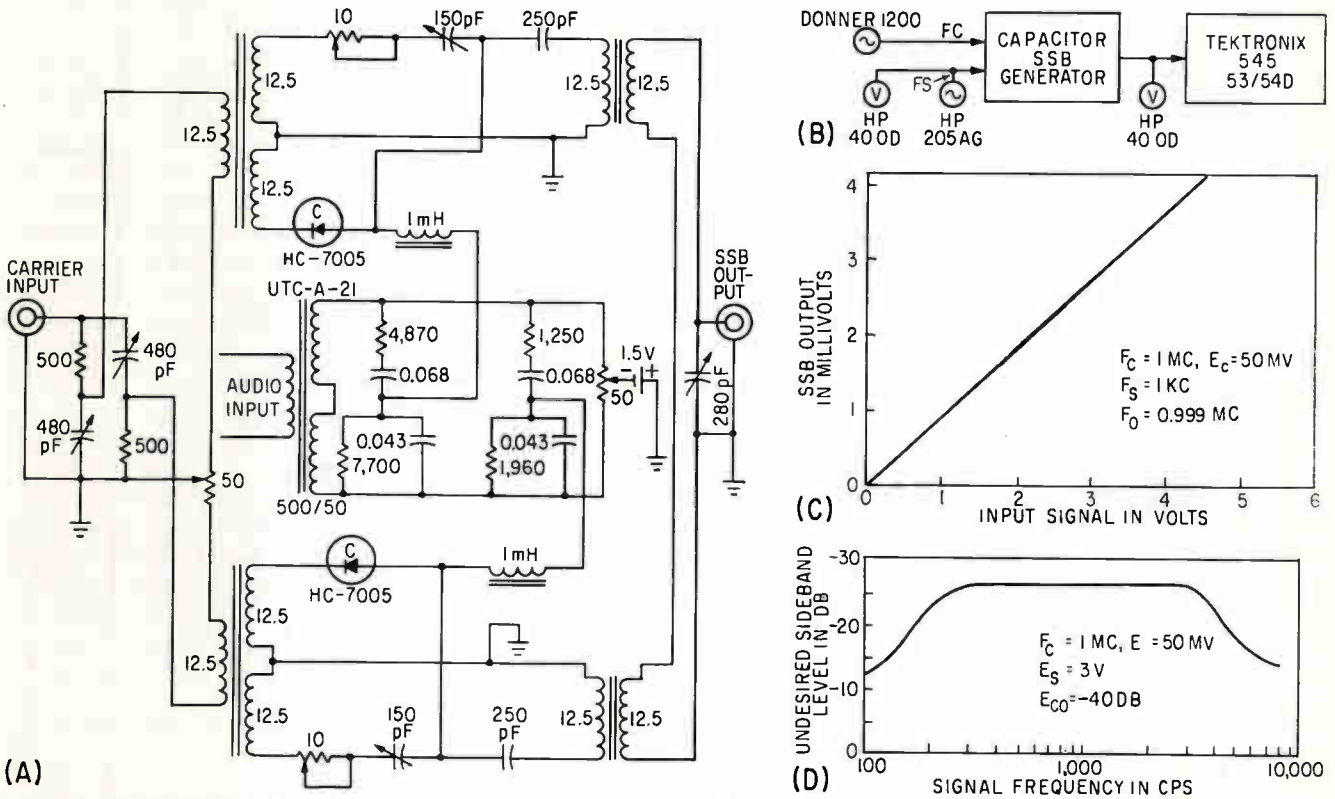


FIG. 4—Single-sideband modulator (A), when tested in circuit shown in (B), has performance (C); ssb generator has 26-db suppression of unwanted sidebands over most of range (D)

suppression in the presence of deviations from the ideal case.

The experimental behavior of the voltage-variable capacitor single-sideband generator was determined using the test arrangement shown in Fig. 4B. The one megacycle carrier drive was maintained constant at 50 millivolts throughout the experiment. It was easy to adjust the balanced modulator pair to give a carrier suppression of at least 40 db, with reference to the desired sideband magnitude for an input signal level of three volts at one Kc. The ssb generator was linear over a signal range of zero to 4.5 volts as shown in Fig. 4C. It was difficult to adjust the carrier and audio phase-shift networks to give maximum suppression of the undesired sideband. A 40 db suppression of the undesired sideband was encountered; however, the 26 db suppression shown in Fig. 4D was typical when care was exercised in adjusting the phase-shift networks.

The cascade phase modulator had an acceptable linearity over a deviation angle of plus and minus 25 degrees per section at a center frequency of one Mc. Any reasonable number of modulator sections can be connected in cascade, with a corresponding increase in the overall deviation angle.

The single-sideband generator had good linearity and acceptable suppression of the carrier and unwanted sideband components. In both cases, operation at a higher frequency may be achieved by heterodyne techniques.

The work was performed as part of a program sponsored by the United States Army Signal Research and Development Agency under contract No. DA 36-039, SC-78269. The experimental models were constructed and tested by R. H. Fors and A. J. Rubas.

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DESIGNING LOW-NOISE

By R. CALDECOTT, and W. H. PEAKE, Antenna Laboratory, Ohio State University, Columbus, Ohio

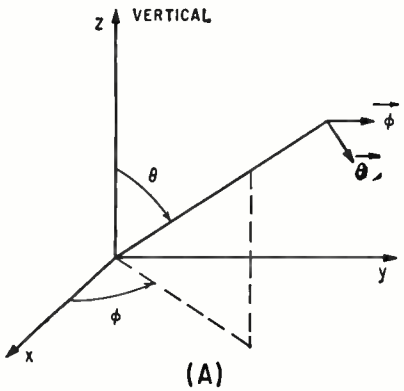


FIG. 1—Antenna temperature is defined in terms of coordinate system (A); several sources of noise radiation are indicated in (B)

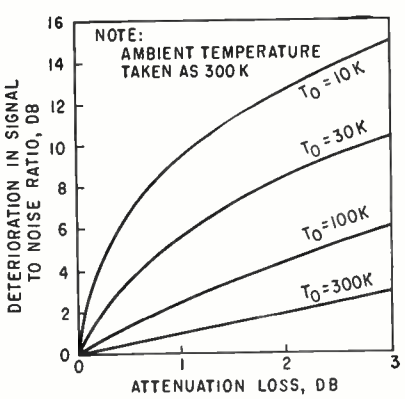


FIG. 2—Graph showing the effect of attenuation loss on the signal-to-noise ratio of a low-noise antenna in terms of the noise temperature TO of the equivalent lossless antenna

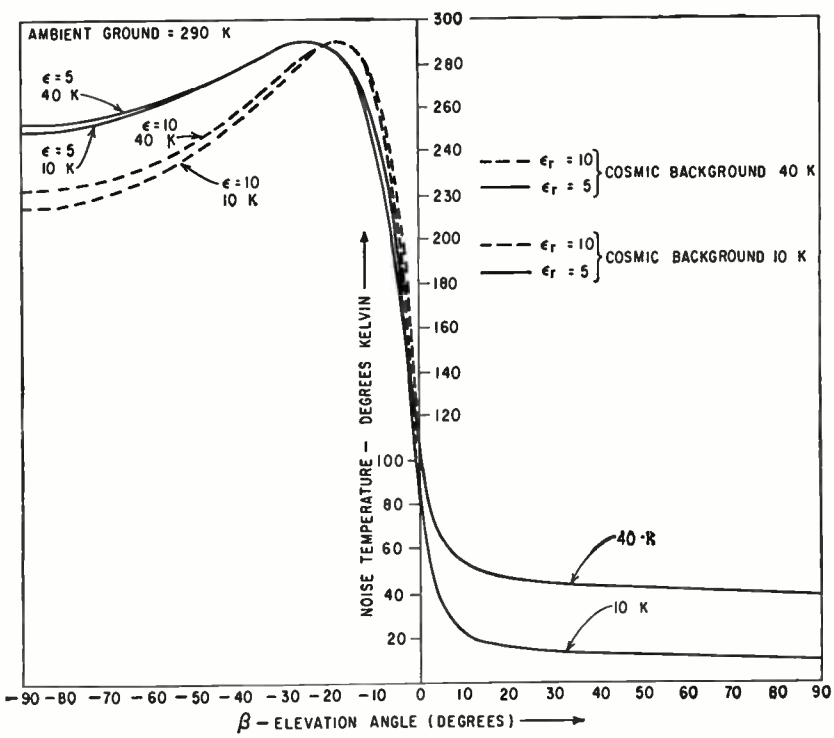
FIG. 3—Graph shows ray temperature as a function of elevation angle of antenna

AMPLIFIER AND MIXER STAGES have traditionally been considered the major sources of receiver noise. However, with the advent of masers and parametric amplifiers, the noise emphasis has shifted from these sources to the receiver antenna. Antenna noise stems from several causes, and all these must be considered in design.

The ultimate measure of receiver performance is the signal-to-noise ratio at the output. When a low-noise receiver is used, this depends mainly on the signal-to-noise ratio of the antenna output. Since any change in the antenna design will, in general, affect both the signal and the noise levels, it is important to use the signal-to-noise ratio, rather than the antenna noise itself, as the design criterion.

A useful design concept is the antenna temperature. It is defined as the physical temperature, in degrees Kelvin, of the matched load which, if substituted for the antenna, would produce the same noise output from the receiver. The matched load referred to is equivalent to the black body of thermodynamics; thus, antenna noise is thermal in origin.

Antenna temperature can be calculated in terms of the radiation temperature of the incoming thermal radiation. No account is taken of attenuation in feed lines and such whose contributions to the effective antenna temperature at the antenna input terminals must be calculated separately. Furthermore, a convenient but special set of polarization states is used so that the formulas given do not necessarily hold for radiation of arbitrary polarization. Consider an antenna at the center of a polar coordinate system (Fig. 1A). In a direction specified by the angles θ,ϕ let the power pattern of the antenna for radiation with θ polarization be $f_\theta(\theta,\phi)$ and let the corresponding power pattern for ϕ polarization be $f_\phi(\theta,\phi)$. Let noise radiation impinging on the antenna from the



ANTENNAS

With low-noise receivers for tropospheric scatter and space communication, a new approach is needed to reduce antenna noise

direction θ,ϕ have radiation temperature $T_\theta(\theta,\phi)$ for the θ-polarized component, and $T_\phi(\theta,\phi)$ for the ϕ-polarized component. That is, $T_\theta(\theta,\phi)$ is the temperature that would be measured by an ideal antenna with θ-polarization and narrow beam-width, pointing in the θ,ϕ direction. Then the antenna temperature due to this noise radiation is

$$T_O = \frac{\int [T_\theta(\theta,\phi) f_\theta(\theta,\phi) + T_\phi(\theta,\phi) f_\phi(\theta,\phi)] d\Omega}{\int [f_\theta(\theta,\phi) + f_\phi(\theta,\phi)] d\Omega} \quad (1)$$

The integration is over the entire sphere. A formula of this type is correct only if the θ and ϕ components of the incoming noise radiation are uncorrelated. That is, the third and fourth Stokes' parameters of the incoming radiation (U and V) must both be zero when the θ and ϕ vectors are used as references.

Equation 1 gives the noise temperature of a lossless antenna. In practice, however, there will generally be some loss in an antenna system due to attenuation in feed lines and other components and also to mismatch. Mismatch loss may be treated in the same manner as attenuation if it is assumed that some isolation device, such as a circulator, is placed between the antenna and the receiver. Resistive components in the antenna system will normally be at the ambient temperature T_G unless special measures are taken to cool them. Then, if a fraction α of the radiation entering the antenna reaches the receiver terminals, the antenna temperature will be modified as indicated by

$$T_A = \alpha T_O + (1 - \alpha) T_G \quad (2)$$

Attenuation loss has a double effect on the signal-to-noise ratio, since it both increases the noise and decreases the signal. The importance of this will be appreciated from Fig. 2. Temperature T_o is the noise temperature of a lossless antenna operating under the same conditions as the practical antenna. At a frequency of 1,000 Mc, for example, typical values of T_o would be 100 K for an antenna pointing at the horizon or 10 K for one pointing 20 deg or more above the horizon. It is apparent from Fig. 2 that even a few tenths of a decibel attenuation loss may have a drastic effect on the signal-to-noise ratio.

For an antenna operating at a few hundred megacycles or higher, the principal sources of noise radiation are the cosmic noise, and thermal radiation from the atmosphere and the ground (see Fig. 1B). The cosmic noise is a function of the direction of the antenna beam with respect to the galactic center.[1] At 1,000 Mc, for example, a conservative estimate of the cosmic radiation is 40 K (corresponding to the direction of the center of the galaxy) and a typical value is 10 K. These two values will be used in later calculations. It will be assumed that the radiation is unpolarized and is attenuated in passing through the atmosphere.

The effect of the atmosphere may be represented by a model in which the actual atmosphere is replaced by an equivalent uniform atmosphere, at normal pressure, 8 Km thick, and refraction effects are accounted for by assuming that the effective radius of the earth is 4/3 the actual radius. The attenuation through this atmosphere is then taken as 0.004 db per Km at 1,000 Mc due to water vapor and oxygen absorption.[2] The attenuation of a ray passing through the atmosphere will thus be a function of elevation angle and may be readily calculated from the geometry. The effect of this attenuation on the ray temperature is then calculated in a similar manner to that used for treating

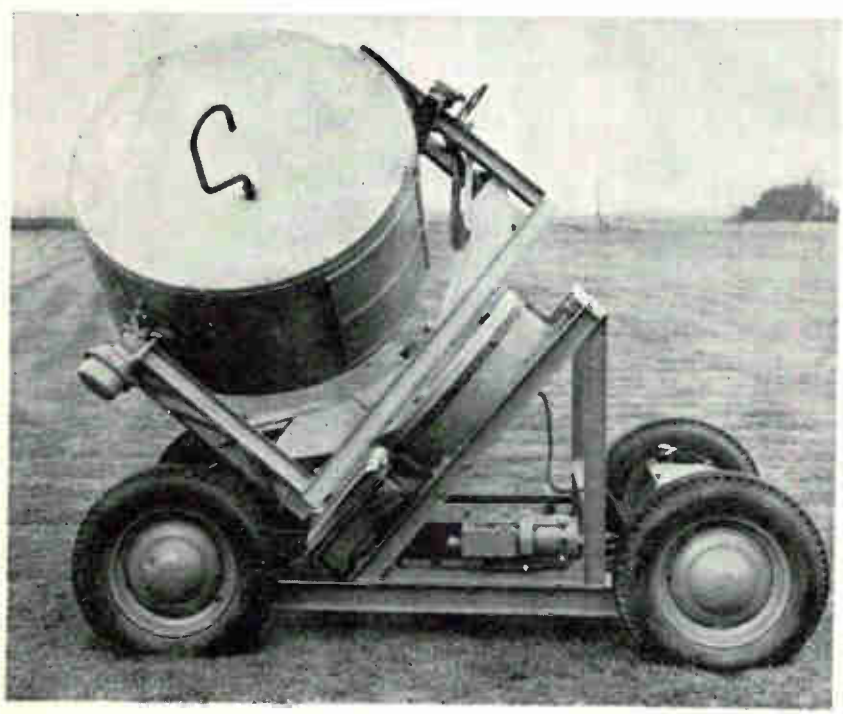


FIG. 4—An X-band radiometer for noise temperature measurement

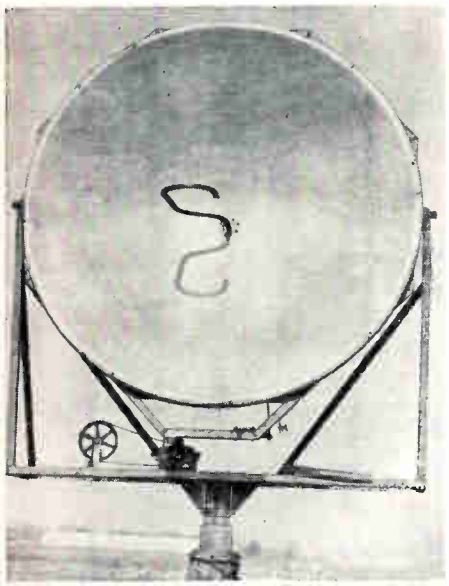


FIG. 5—Scale model of a tropospheric scatter receiving antenna

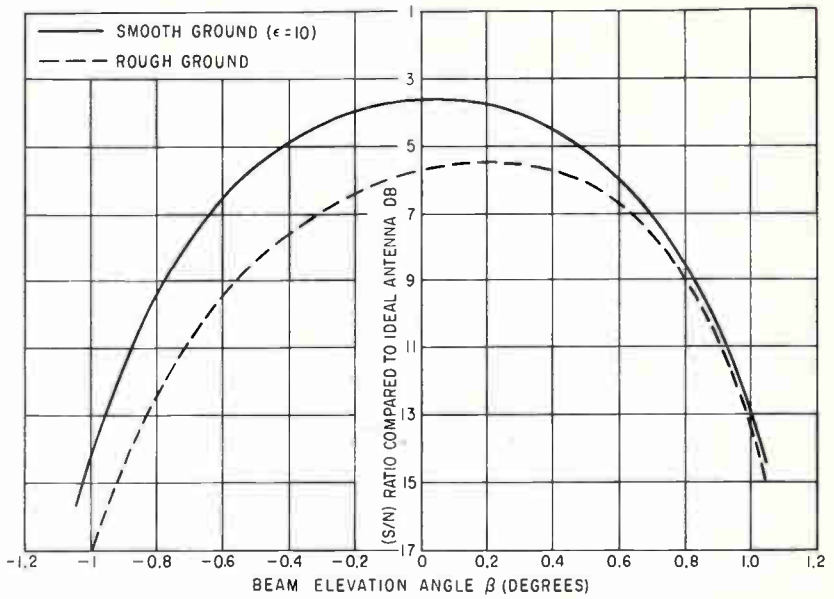


FIG. 6—Signal-to-noise ratio for a practical antenna, plotted against an ideal antenna, for different types of ground

attenuation loss within the antenna.

The final contribution to noise radiation near the antenna is that of the thermal radiation emitted by the ground.[3, 4] In general this requires a more complex treatment. Some surfaces, such as a rough sea or dense vegetation, rough in terms of a wavelength, absorb almost all incident radiation and must be treated as black bodies. Other surfaces, such as concrete or short grass, which are smooth in terms of a wavelength, behave as dielectric interfaces and reflect a greater or lesser portion of the incident radiation, depending on the incident angle, dielectric constant and plane of polarization. Equation 2 may again be used to determine the ray temperature. The power reflection coefficient of the ground is now represented by α. Figure 3 shows ray temperature as a function of elevation angle. The curves were calculated as described for vertical polarization and for two different values of dielectric constant ϵ for the ground. These values were obtained experimentally and are typical for smooth surfaces. Notice the sharp rise in antenna temperature near the horizon, rising to ambient at the Brewster angle. Noise temperature curves of this type may be verified by a radiometer such as the X-band model shown in Fig. 4.

In considering practical antennas it is necessary to have some performance criterion. It has been found convenient to define a hypothetical ideal antenna as follows:

The ideal antenna is a lossless antenna having the gain of a uniformly illuminated aperture, equal in area to that of the antenna with which it is compared, and a noise temperature equal to the ray temperature in the direction of the signal source.

This ideal antenna has the maximum possible gain and also the minimum possible noise temperature for a given situation, since in effect the definition assumes that the antenna radiation pattern is confined to a single narrow beam and hence has no side or back lobes to pick up stray thermal radiation. The ideal antenna thus gives the maximum possible signal-to-noise ratio in any given situation, and the performance of any practical antenna may be described in terms of the amount by which its signal-to-noise ratio falls below that of the ideal. In the cases to be described antenna performance is measured in decibels below the performance of the ideal antenna.

The first case is a 40-foot diameter paraboloid, to be used as a tropospheric scatter receiving antenna at L-band. A scale model of this antenna is shown in Fig. 5. The feed is a small horn and the measured gain of this antenna was 3 db down from the theoretical figure for the same aperture uniformly illuminated; it was also found that 65 percent of the power in the antenna radiation pattern was contained in the main beam. The remainder of the power is contained in the minor lobes and so far as noise pickup is concerned will be assumed to be evenly distributed around the sphere, an assumption valid in this case in view of the symmetry about the horizon. The main beam will be assumed to be cosine squared and hence the received signal power is a simple function of the beam elevation angle. Referring again to Fig. 3, the antenna noise temperature was calculated for a value of $\epsilon = 10$ and a cosmic temperature of 10 K. The contribution from the minor lobes was taken as being an average figure for the whole sphere and that from the main beam was taken as a linear function of elevation angle in the region plus or minus two degrees from the horizon. The calculation was then repeated for a rough ground. That is, the ray temperature below the horizon was then assumed to be a constant 290 K. The two results are shown in Fig. 6.

A 3-db loss in performance is due to the amount by which the antenna gain falls short of the uniform illumination case. Noise produces a further reduction of 0.6 db in the smooth ground case and 2.6 db in the rough ground case when the an-

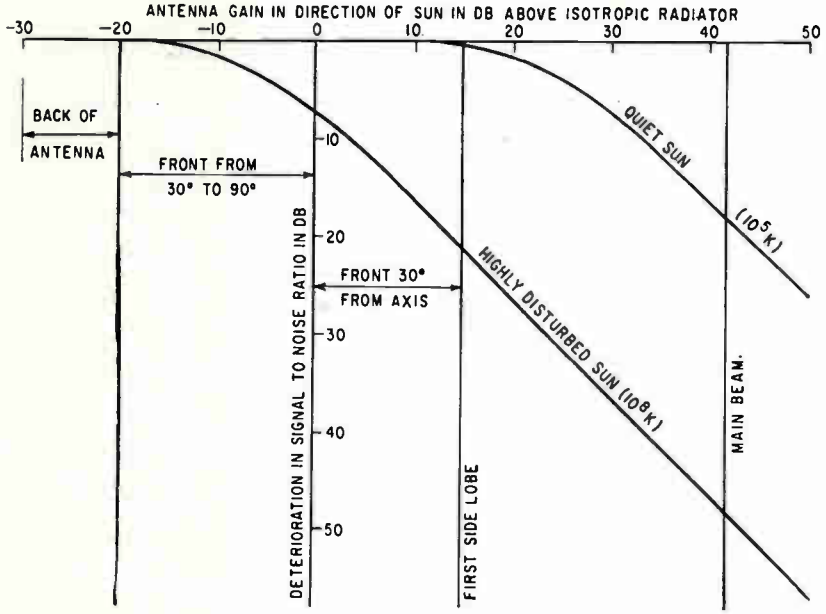


FIG. 7—Effect of the sun on antenna signal-to-noise ratio

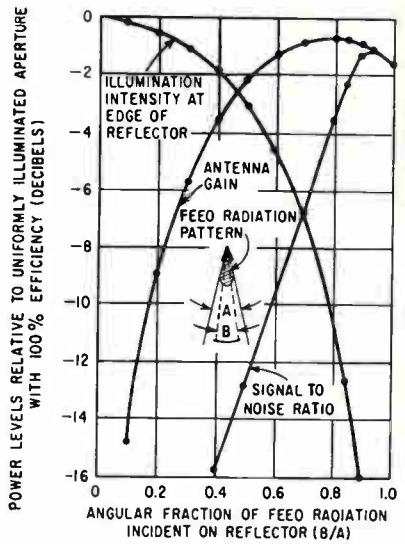


FIG. 8—The optimum illumination for a long local length paraboloid used as a low-noise antenna and looking vertically upwards

tenna beam is directed at the horizon. In the latter case, however, an improvement of about 0.3 db may be obtained by tilting the antenna up slightly. The choice of antenna site and beam elevation angle are important if maximum performance is to be obtained.

A source of noise that has not been mentioned so far is discrete, intense sources of small angular extent, such as radio stars and the sun. These will each contribute to the antenna noise in direct proportion to their noise temperature, their angular area and the gain of the antenna in the direction of the source. For the antenna described the only discrete source that might produce a detrimental effect is the sun. The effect of the sun on the signal-to-noise ratio of this antenna is shown in Fig. 7 as a function of antenna gain in the sun's direction. The regions of the antenna pattern are shown for reference. A quiet sun has no detrimental effect provided it is not within the main beam of the antenna. A highly disturbed sun, however, could increase the antenna noise almost anywhere within the front hemisphere of the antenna pattern.

The second case is a paraboloid with a large focal length to diameter ratio, looking vertically upwards, and used as a receiving antenna for signals from an artificial satellite or space probe. The conditions of a large f/d ratio and vertical beam only simplify the geometry. The basic approach would apply equally to other configurations where the antenna beam is pointed twenty degrees, or more, above the horizon. It is assumed that the main beam is looking at a sky temperature of 10 K and that the antenna is on rough ground (temperature 300 K). The radiation pattern of the feed is assumed to consist of a single lobe of cosine squared form with no side or back lobes. In normal practice the feed beamwidth is designed to make a compromise between illumination efficiency and spill-over. Thus only a fraction of the total feed beam, between the first nulls, is contained within the reflector. The effect of varying this fraction is shown on the gain curve of Fig. 8. Maximum gain occurs when eight-tenths of the feed beam is contained within the reflector. Another curve on the figure shows that this corresponds to an illumination taper of 10 db at the edge of the reflector. However, in a low-noise application the spill-over is a source of thermal radiation from the ground at a temperature of 300 K whereas thermal radiation incident first on the reflector will be at a sky temperature of 10 K. If signal-to-noise ratio, instead of gain, is now calculated as a function of feed beamwidth a different situation results as shown in the third curve of Fig. 8. Maximum signal-to-noise ratio is obtained when a little over nine-tenths of the feed beamwidth is contained within the reflector. The illumination taper is now in excess of 16 db instead of the previous 10 db. The gain is down by about 0.5 db in this case. However, if a maximum gain antenna had been used the resulting loss in signal to noise ratio would have been almost 3 db. An alternative approach in this case might be the use of a deep reflector; however, deep reflectors suffer from problems of reduced illumination efficiency.

Thus when designing antennas for low-noise rather than conventional receivers, the design criterion becomes signal-to-noise ratio rather than antenna gain.

This work was sponsored in part by contracts between the U. S. Army Signal Corps and the Air Research and Development Command, United States Air Force and The Ohio State University Research Foundation.

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Flying-Spot Integrating Densitometer

By E. M. DEELEY, Electrical Engineering Dept., University of London, King's College, London, England

A MEASUREMENT of the total amount of light-absorbing material within a defined area of a plane object is frequently required in certain fields of research. In X-ray diffraction studies using photographic film, this quantity is of fundamental importance, as it is directly proportional to the amount of radiation reaching the film within that area. Furthermore, measurements are usually required for a large number of different areas on one object, such as an X-ray diffraction photograph which may contain some hundreds of spots. It therefore becomes desirable to perform measurements rapidly and with the minimum of labor.

These measurements involve the integration of point-by-point values of optical extinction over the whole of the required area. Existing methods using recording densitometers incorporating electromechanical components have proved laborious and time consuming. The present instrument makes use of the flying-spot scanning technique[1] and electronic circuits to perform the measuring and integrating operations simultaneously, and presents the output in the form of a meter reading. The required measure of the total amount of absorbing substance present is obtained as the difference between two such readings, one with and one without the object in position. Each reading takes about two seconds. There is little advantage in reducing the measuring time below this value, as the time needed to select and position the required part of the object becomes the deciding factor in the rate with which large numbers of objects can be measured.

A block diagram of the densitometer is shown in Fig. 1. To focus the optical system, light from auxiliary source A is introduced through removable prism P to illuminate the object. The image of the object formed by lens L is positioned and focussed on the screen of the scanner cathode-ray tube, which ensures that light passing in the opposite direction from the spot of the scanner tube must be in focus at the object. Stop S is used to define the area of the object to be measured. Deflecting voltages generated by the scanning circuits cause the light from the spot to scan an area somewhat larger than stop S, thus ensuring that the whole required area is measured.

The multiplied phototube is in a circuit that gives an output voltage varying linearly with the logarithm of the light intensity at the photocathode, which according to the Beer-Lambert law is proportional to the density of light-absorbing material present, and is known as the optical extinction. A diode switch presents the output of this circuit to a voltage integrator only when the optical extinction is less than a preset value. In this manner difficulties are avoided that would otherwise arise when the scanning spot is outside the field of view, since the optical extinction measured in this region approaches infinity. A monitor tube gives a visual indication of the operation of the diode switch to ensure that the whole of the object within stop S is being measured.

The scanning process is initiated by a pushbutton switch under control of the operator. Operation of this switch also restores the integrator to its initial state, ready for the next reading. The output of the integrator is displayed on a meter.

The method of obtaining a voltage proportional to the logarithm of the light intensity on the photocathode depends on a property of multiplier phototubes utilized by Sweet.[2] Over the voltage range used in the present instrument, the secondary emission curve for each stage of multiplication follows a $V^{\frac{1}{2}}$ law, so that the anode current i in a multiplier phototube having $2n$ stages of multiplication is $i = aIv^n$, where I is the light intensity, a is a constant, and v is the voltage between successive dynodes. The dynodes are supplied from a series chain of resistors so that the voltage on successive dynodes will be proportional to v_o, the overall voltage across the chain. If v_o is continuously regulated so that the current i is kept constant at all light intensities, it follows from the above equation that $dv_o/d\log I = -v_o/n$. The smaller the variation in v_o, the more linear is the relationship between v_o and $\log I$, thus n should be as large as possible. For this reason a 13-stage multiplier phototube is used.

The multiplier phototube and the associated circuits of V_1 and V_2 (Fig. 2A) comprise a negative feedback circuit that acts to keep the voltage across R_5, and hence the current i, almost constant. The cathode of the multiplier phototube is connected to −1.5 Kv supplied from a stabilized power pack. Voltage v_o therefore depends on the cathode voltage of V_2, which in practice varies between about −50

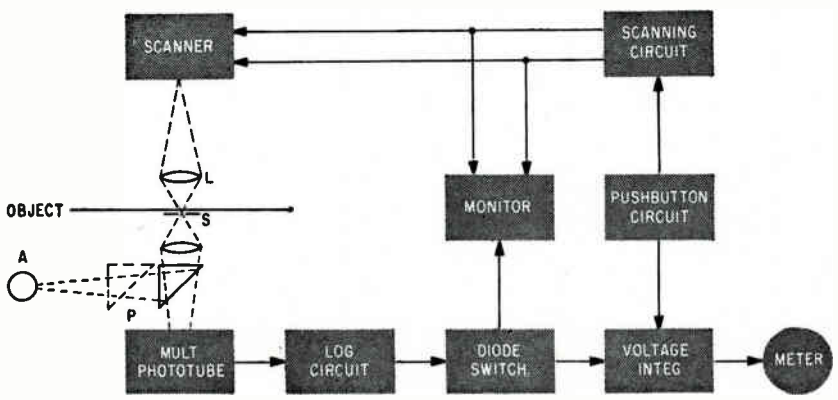


Fig. 1—Block diagram of densitometer shows optical system

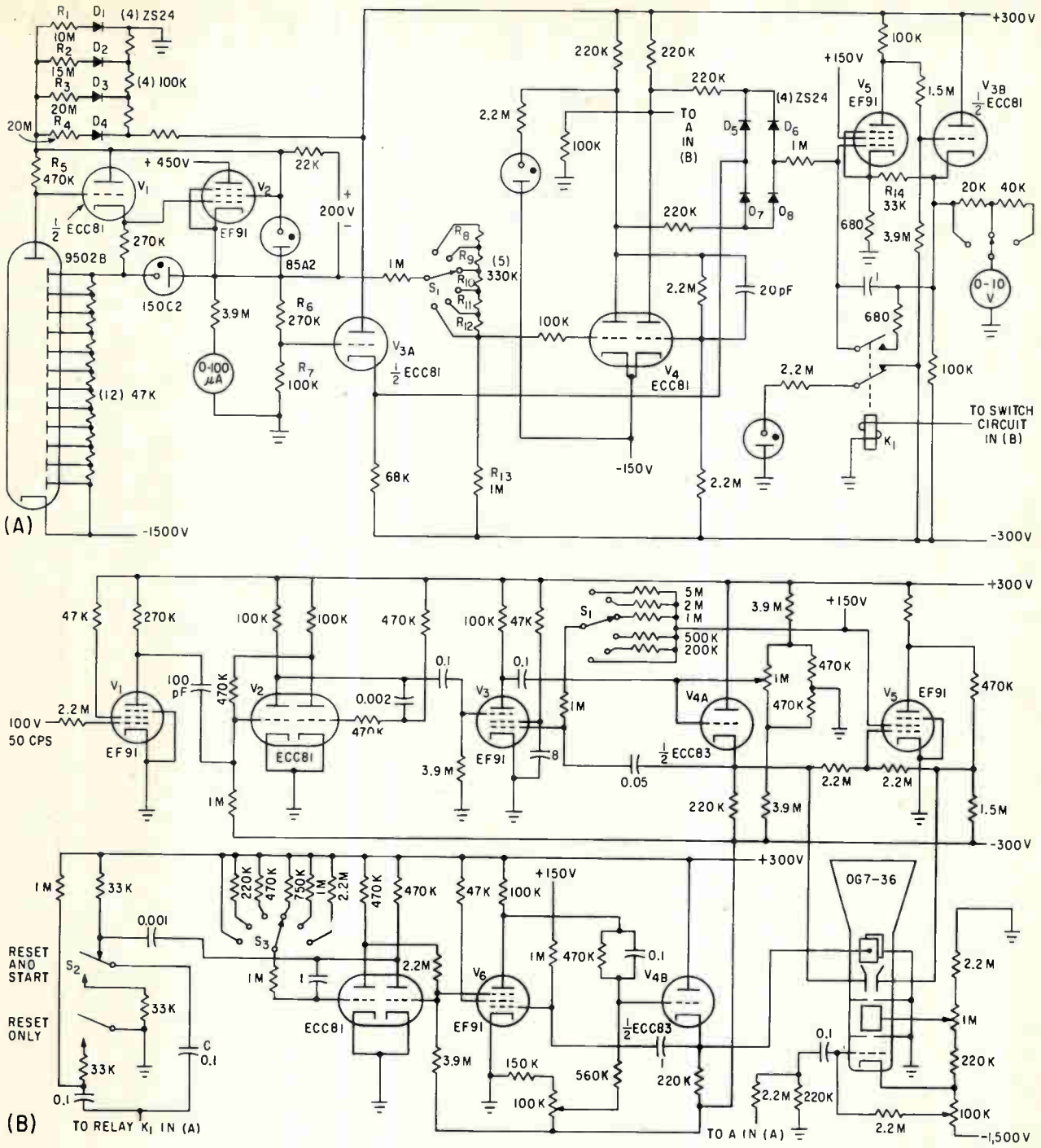
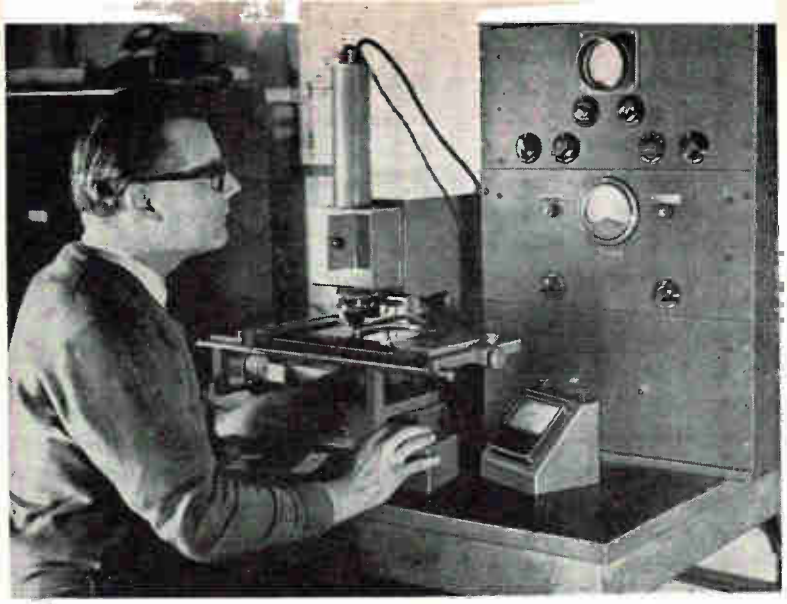


Fig. 2—Schematics of measuring circuits (A), and scanning circuits and monitor crt (B)

and 300 v according to the light intensity on the photocathode. Silicon junction diodes D_1 through D_4 have the effect of progressively reducing the voltage across R_5 as v_o increases, to correct the nonlinearity due to the term v_o in the expression for $dv_o/d \log I$. By the adjusting resistors R_1 through R_4, v_o can be made to vary linearly with extinction over the range of 0 to 1.5 density units to an accuracy of approximately 1 percent. The values of resistance required depend on the characteristic of the particular multiplier phototube used, however, and the best values must be determined by experiment.

The potentiometer formed by R_6, R_7 and cathode follower V_{3A} provides an output of suitable amplitude for input to the diode switch.

The five similar resistances R_8 through R_{12} and resistance R_{13} are so chosen that the left-hand triode of V_4 conducts when v_o is greater than a value depending on the setting of the 6-position switch S. The six positions correspond to extinctions of between 0.25 and 1.5 units. The anode voltage of this triode then falls from a large positive value to about −140 v, while that of the right-hand triode simultaneously rises from a negative to a positive voltage. These voltages control the current in a conventional four-diode switch comprising diodes D_5 through D_8, which will therefore isolate the voltage integrator from the logarithmic circuit when the extinction is greater than



Optical unit (left) and densitometer electronic unit (right)

the value selected by switch S.

The switching voltages on the anodes of V_4 and the maximum voltage excursion at the cathode of V_{3A} are such that the peak inverse voltage of the diodes comprising the switch is never exceeded.

The integrating circuit consists of a direct-coupled amplifier with resistive input and capacitive feedback.[3] The amplifier uses a single amplifying pentode V_5 and a cathode-follower output tube V_{6B}. Positive feedback to the cathode of V_5 through R_{11} provides a gain in excess of 500, and an integrating time constant of one second is used. For periods of integration of two seconds or less the integration error is therefore about 0.2 percent.

The integrating capacitor is discharged by an effective short circuit when a switching impulse is applied to the two-side stable polarized relay K_1 from the pushbutton circuit. This short circuit is removed when an impulse of opposite polarity is applied.

The scanning, pushbutton and monitor tube circuits are illustrated in Fig. 2B. When the apparatus is switched on, a conventional suppressor-controlled Miller circuit comprising tubes V_3 and V_4 generates a linear sawtooth waveform, which is synchronized to the line voltage by the action of squaring tube V_1 and the monostable multivibrator circuit of tube V_2. The amplitude of this sawtooth can be varied in six steps by switch S_1. Anode follower V_7 enables push-pull deflection to be applied to the cathode-ray tubes to reduce astigmatism. These deflecting voltages are continuously applied to one pair of plates of the monitor and scanning tubes, so that the risk of burning the screen is minimized.

When reset-and-start pushbutton S_2 is depressed capacitor C discharges, closing relay K_1 (Fig. 2A) and discharging the integrating capacitor. When the pushbutton return to its original position, C recharges and K_1 opens. At the same time a negative-going pulse triggers a monostable multivibrator circuit which gates the suppressor-controlled Miller circuit including tubes V_6 and V_{6B}. A voltage varying linearly with time is thus generated and applied between the other pair of plates of the two cathode-ray tubes. The duration of the scan is determined by the setting of S_3, and has a maximum value of two seconds. Bias voltages in each of the Miller circuits are used as shift controls to ensure that the initial and final positions of the scanning line lie outside the image of the stop S. Thus when the pushbutton is depressed, the spot progressively scans the whole of the area to be measured. The screen of the scanner tube (Type 415C) is 1.5 in. in diameter and is composed of a short-persistence zinc-oxide phosphor in which the light intensity decays to less than 0.01 percent of its original value within 10 μsec of removing the electron beam.

The modulation for the monitor tube is derived from one of the voltages actuating the diode switch (Fig. 2A) to darken the screen during all periods of the scan in which integration is taking place.

To make a measurement on, for example, an X-ray diffraction spot, a region of the clear field near the spot is first positioned within stop S. The brilliance of the scanning spot is adjusted so that the integrator output reading is approximately zero when this area is scanned. The diffraction spot is then positioned within S and the scanning process repeated, giving a larger integrator reading. The difference between these two readings gives, in arbitrary units, the required measure of the total amount of absorbing substance in the spot.

However, small variations occur in successive readings of the integrator output without moving the object, owing to fluctuations in the output of the multiplier phototube and in the intensity of the scanning spot. The mean error from these causes is minimized by using a stop S that is no larger than necessary to enclose the required part of the object, to avoid integrating over large areas of clear field. For the majority of objects studied this error is less than 1 percent, but can be further reduced by averaging several successive readings for the object and the clear field.

Other errors that originate in the optical system limit the instrument accuracy to about 2 percent for most objects, rising to about 5 percent for objects of low (0.1 unit) and high (1.5 units) optical extinction.

It is hoped to use transistors in a future version of the instrument, but this presents certain difficulties. In particular the above method for generating a voltage proportional to optical extinction cannot be used easily, owing to the low input impedance of transistors and the large voltage excursions in the circuit. Also, the integrator circuit is considerably more complex using transistors, as a chopper technique must be used to reduce the input current of the amplifier to a minimum. Such d-c amplifiers have, however, been successfully developed,[4] and it is expected that the advantages derived from the use of transistors will outweigh the added complexity.

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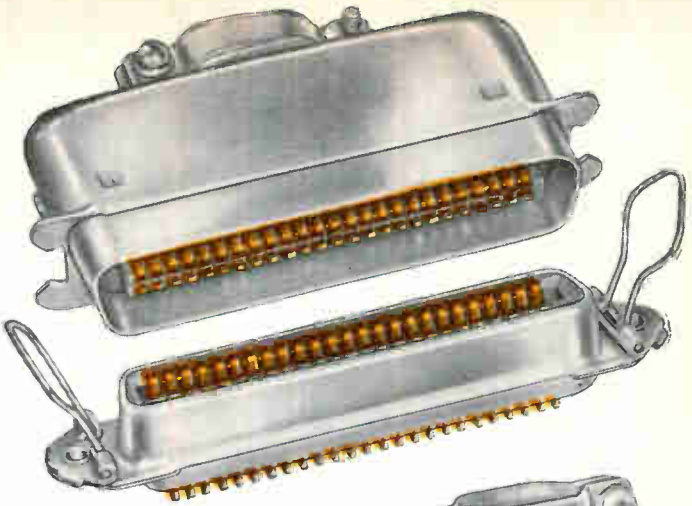

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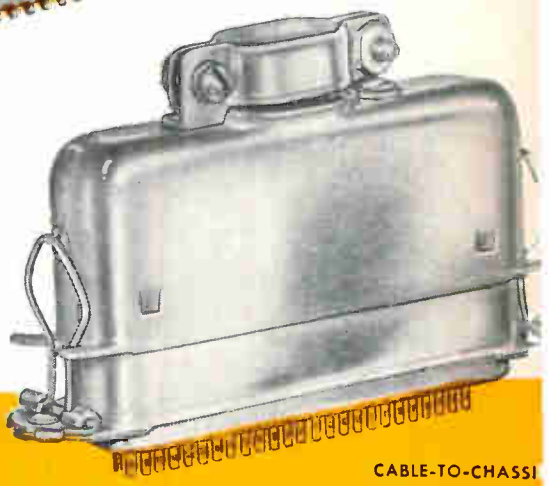

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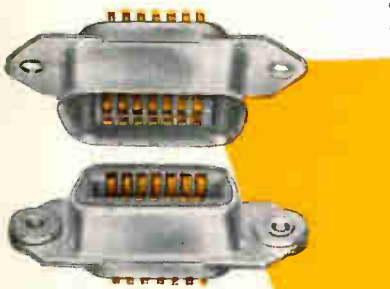

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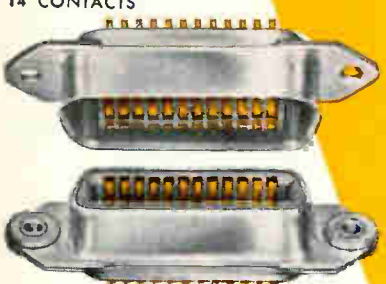

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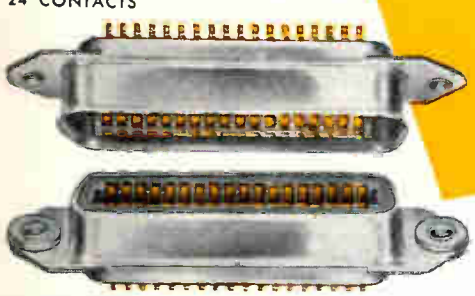

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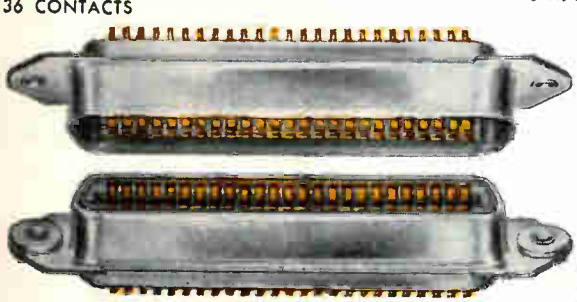

50 CONTACTS

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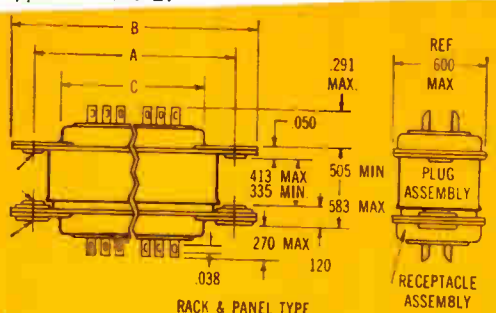

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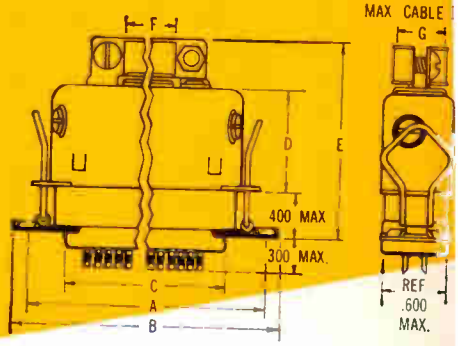
	B	1.750 REF.	2.175 REF.	2.685 REF.	3.280 REF.
	C	.910 REF.	1.335 REF.	1.845 REF.	2.440 REF.
CABLE TO CHASSIS TYPE ONLY	D	.843	.843	.905	1.000
	E	1.668 MAX.	1.668 MAX.	1.730 MAX.	1.825 MAX.
	F	.306 MAX.	.473 MAX.	.640 MAX.	.766 MAX.
	G	.422 MAX	.473 MAX.	.473 MAX.	.473 MAX.



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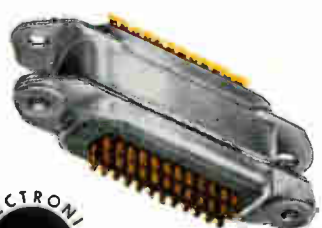

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50	57-10500	57-20500

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Using Varistors To Suppress Relay Sparking

Monograms for choosing the proper varistor in protecting the contacts of relays used in switching inductive loads are presented. Examples are used to solve typical problems

By R. de PROOST, M. B. L. E. Company, Brussels, Belgium
R. SERVRANCKX, Belgian Royal Military College, Brussels, Belgium

VARISTORS have made possible the design of new electronic devices and enabled certain hitherto insoluble problems to be solved. In particular, varistors give good results when protecting the contacts of relays for making and breaking inductive circuits. Analysis of the phenomena accompanying the breaking of such circuits has led to nomograms that allow an immediate choice of the varistor giving the best results.

As the name implies, the resistance of a varistor is not constant, the current that passes through it not being proportional to V, the applied voltage. In approximation, these quantities are related by

$$V = DI^{\beta} \qquad (1)$$

or, alternatively

$$\log V = \log D + \beta \log I \qquad (2)$$

where V is volts and I amperes and β is an exponent whose value generally lies between 0.17 and 0.25. The value of D is supplied by the

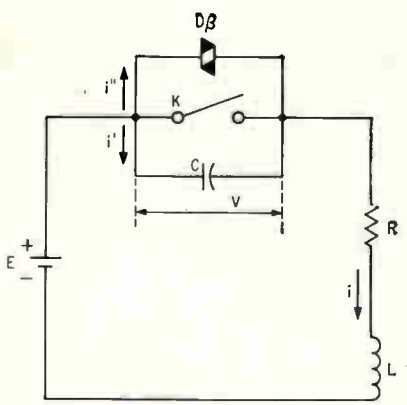


FIG. 1—Circuit shows use of capacitor and varistor to suppress sparks

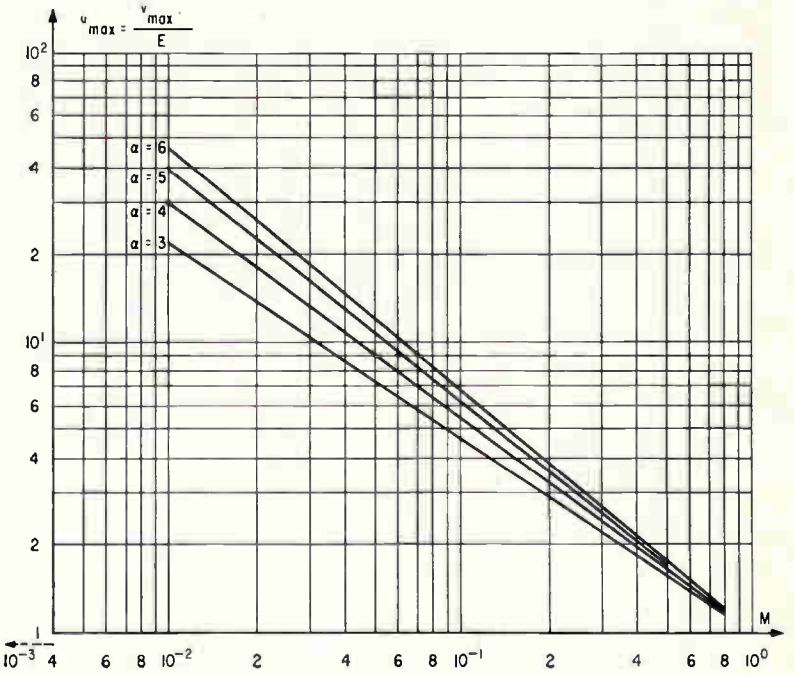
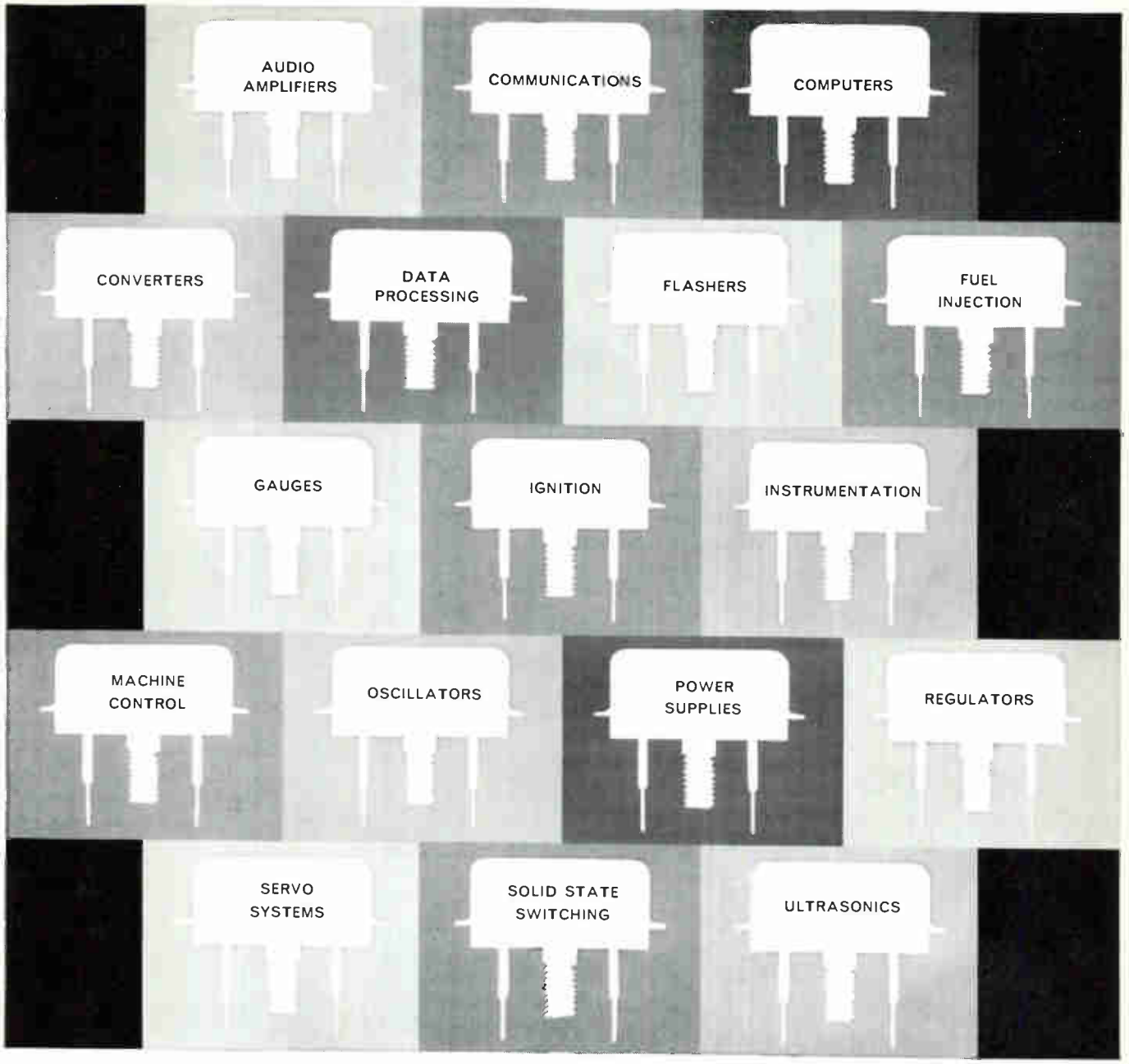


FIG. 2—Graph is used to determine value of M



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CIRCLE 69 ON READER SERVICE CARD 69

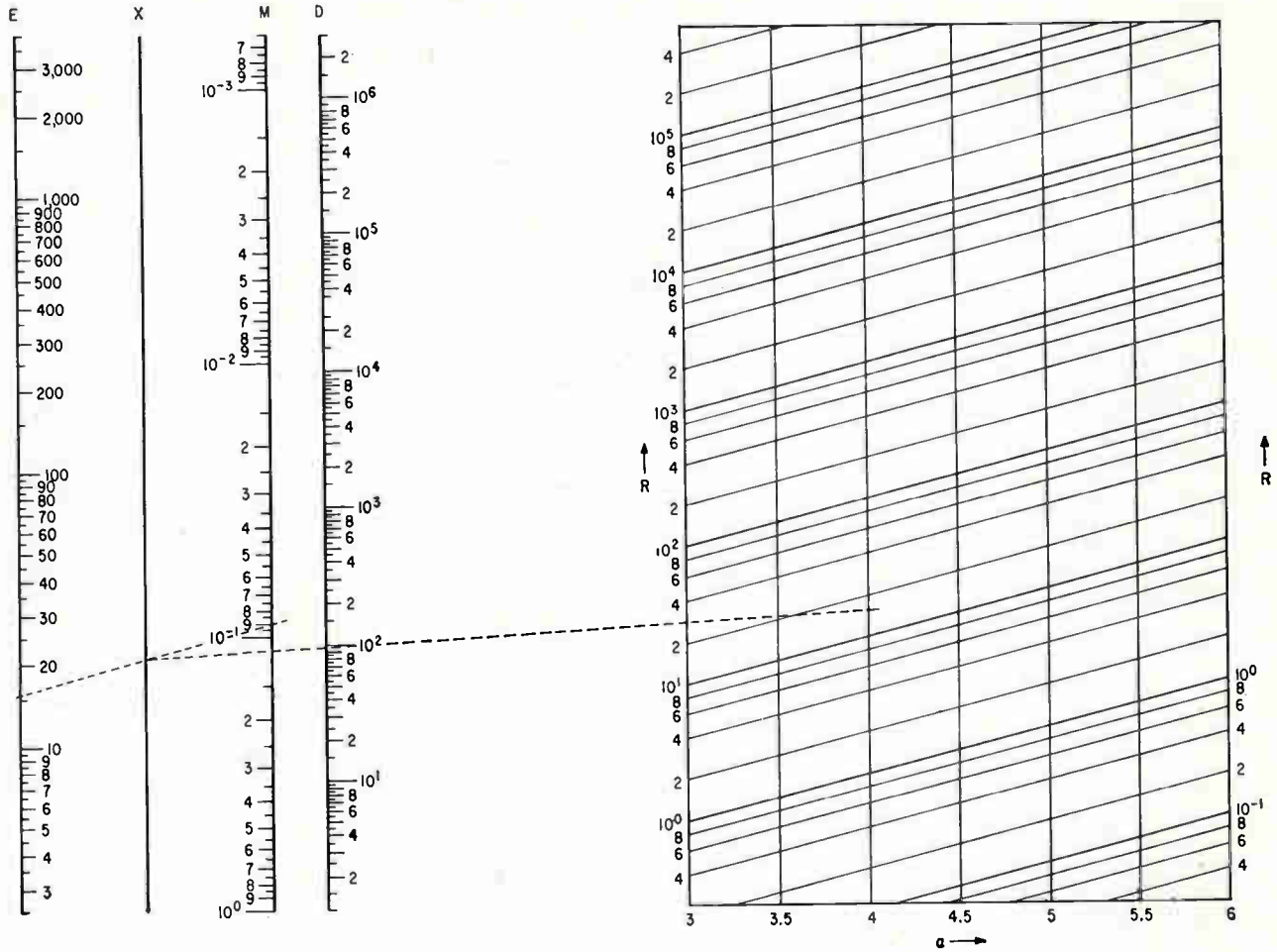

FIG. 3—Dashed lines show how value of D for Example 1 is determined

varistor manufacturer.

The peculiar behavior of a voltage dependent resistance (VDR) is attributable to the complex network of resistances in series and parallel formed by the contacts between the multiple crystals of this material and to the breakdown of the potential barriers arising at these points of contact.

Considering the circuit of Fig. 1

$$E = v + Ri + L\,di/dt \qquad (3)$$

and

$$i = i' + i'' \qquad (4)$$

$$i' = C\,dv/dt \qquad (5)$$

$$i'' = \frac{1}{D^\alpha}\,\frac{v}{|v|}\,|v|^\alpha \qquad (6)$$

where $\alpha = 1/\beta$.

The reduced equation of the circuit is

$$\frac{d^2u}{d\tau^2} = 1 - [1 + |Mu|^{\alpha-1}]u - \left[A + \frac{\alpha}{A}|Mu|^{\alpha-1}\right]\frac{du}{d\tau} \qquad (7)$$

with the initial conditions

$$\tau = 0; \quad u = 0; \quad \frac{du}{d\tau} = \frac{1}{A};$$

and where

$$A = R\sqrt{\frac{C}{L}}; \quad u = \frac{v}{E}; \quad \tau = \frac{t}{\sqrt{LC}};$$

and

$$M = (R/D^\alpha)^{1/(\alpha-1)}E \qquad (8)$$

The numerical solution of this equation shows that the maximum value u_{max} for v/E is practically independent of A.[1] These results are summarized in Fig. 2.

When deriving Eq. 7 it was assumed that the operation of the switch was not being disturbed by any external phenomenon. However, switching off is not accomplished instantaneously. The distance between the switch contacts increases from zero with a rapidity that varies with the speed of switch manipulation. The same applies to the increase in V_d, the breakdown voltage across the contacts.

On the other hand, if the frequency, given by

$$f_o = 1/2\pi\sqrt{LC} \qquad (9)$$

is high, v_{max} is attained after a brief time. It may happen during this brief interval that v_{max} exceeds V_d, resulting in sparks.

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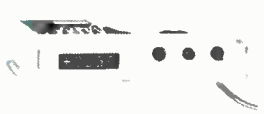

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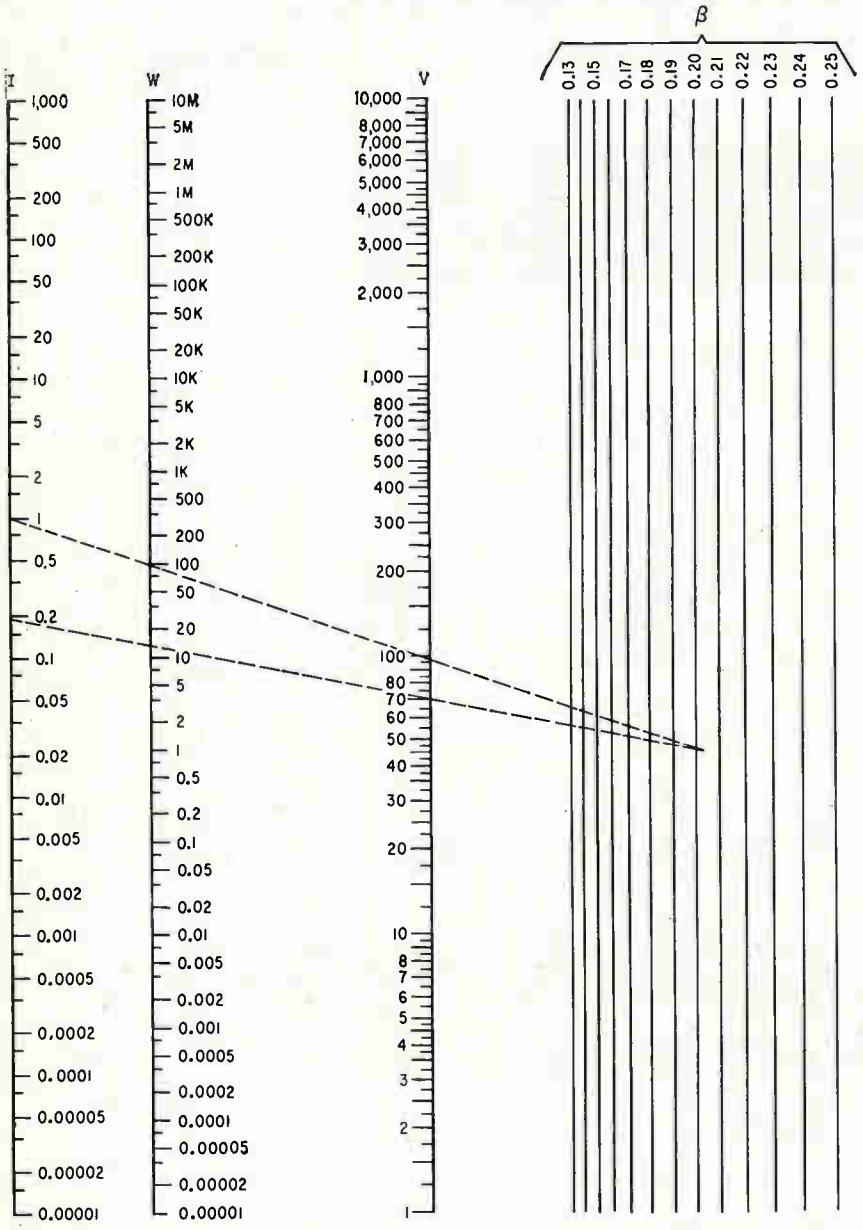

FIG. 4—Nomograph for finding power dissipation. Dashed lines are for Example 3

tional relays the practical limit of f_o occurs at about 1 Kc; Moreover, it is the choice of f_o that determines C.

If E, R and L are given, by imposing a maximum value $u_{max} = v_{max}/E$, M may be found from Fig. 2.

With $f_o = 1$ Kc, C is determined and from Eq. 8, α and D may be chosen. This last operation is simplified by Fig. 3.

The power consumption in the VDR is determined by Fig. 4.[2]

Example 1—Given $L = 51$ mh, $R = 15.5$ ohms, $E = 15.5$ v and making $u_{max} \leq 6$:

For $f_o < 1$ Kc, Eq. 9 is used to find $C \geq 1/4\pi^2 \times 10^6 \times 5.1 \times 10^{-2} = 0.5$ μf. Actually, in this case, an 0.05-μf capacitor corresponding to 3 Kc would be sufficient.

From Fig. 2, $M = 9 \times 10^{-2}$ if $\alpha = 4$ for the VDR used.

In Fig. 3, joining $E = 15.5$ v with $M = 9 \times 10^{-2}$ gives a point on X that linked with point $R = 15.5$ and $\alpha = 4$ in the right-hand-side rectangle gives 95 for D on the D line.

Experiments with a varistor of $\alpha = 3.73$ and $D = 82$ gave an experimental value for u_{max} of 5.8.

Example 2—Given $L = 26.3$ h, $R = 17{,}750$ ohms, $E = 600$ v and imposing $u_{max} \leq 2$.

For $f_o < 1$ Kc, $C \geq 1/4\pi^2 \times 10^6 \times 26.3 = 10^{-9}$ f $= 1{,}000$ pf. From Fig. 2, $M = 4.3 \times 10^{-1}$ if $\alpha = 6$ for VDR used.

In Fig. 3 joining $E = 600$ v with $M = 4.3 \times 10^{-1}$ gives a point on X which linked with point $R = 17{,}750$ and $\alpha = 6$ gives a D of 2×10^3.

Experiments with two varistors with $D = 1{,}000$ and $\alpha = 6$ in series gave $u_{max} = 1.8$.

Example 3—With $D = 96$, $\beta = 0.20$ and $E = 70$ v; find the power dissipated by the varistor. Using Fig. 4, the dissipation is found as follows:

The point corresponding to 1 amp is marked on scale I and that corresponding to the D (96) is found on scale V. (Factor D is generally denoted in catalogs by the letter C, which has been used here for the capacitance across the switch.) A line is drawn through these two points and continued so that it intercepts with straight line β (0.20). Another line drawn through this point of intersection on the β line and the appropriate point E on scale V will cut scale W at a point W' (14 w) indicating the power that will be dissipated by the varistor.

Experimental results agree sufficiently with calculated values to give confidence in the procedure that led to the development of nomograms and graphs shown in Fig. 2, 3, and 4.

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(2) F. Ashworth, W. Needham and R. W. Sillars, *Jour IEE*, 93, p 385, 1946.

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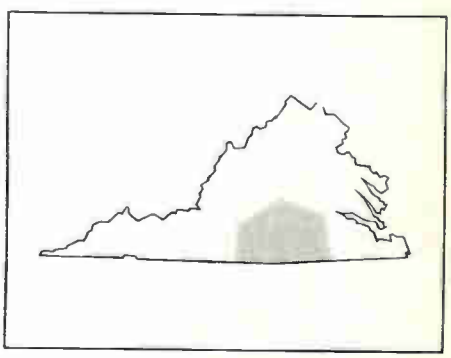

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Silicon Junctions Detect Positive Ions

By F. A. WHITE, J. C. SHEFFIELD
Knolls Atomic Laboratory, General Electric Co., Schenectady, N. Y.

J. W. MAYER,
Hughes Aircraft Co., Culver City, Calif.

DIFFUSED or surface-barrier silicon junction counters may in the future be used in mass spectrometry. Although a *pn* junction cannot now perform the function of an electron multiplier, experiments have demonstrated that it has interesting and potentially important possibilities.

Many-staged electron multipliers[1] detect positive ions directly. Presently, however, only ions of low mass and high kinetic energy (He^+ at 50 Kv) have a range sufficient to penetrate through the gold or diffused layer into the high field region. It is there that electron-hole pairs are generated within the sensitive volume of the detector.

A method has been found to bypass this limitation. Low-energy positive ions (about 10 Kv) emerging from a spectrometer exit slit are allowed to impinge on the negative high voltage terminal of a parallel plate electron converter. The converter in Fig. 1 has different geometry from a type reported[2] and used with a scintillation counter. Secondary electrons generated in this manner are accelerated to the grounded plate and pass through a small slit to the junction detector.

This approach permits the positive ions of several isotopes to be analyzed. The partial mass spectrum of barium in Fig. 2A was obtained using a Hughes diffuse junction counter of appreciable area (about 1 cm^2). It was positioned at the focal plane of a 30-inch radius, 180-degree mass spectrometer.

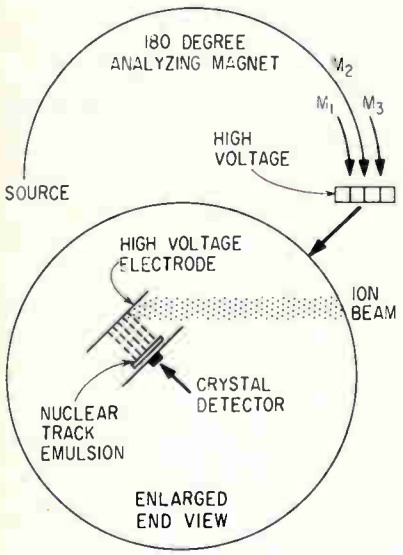
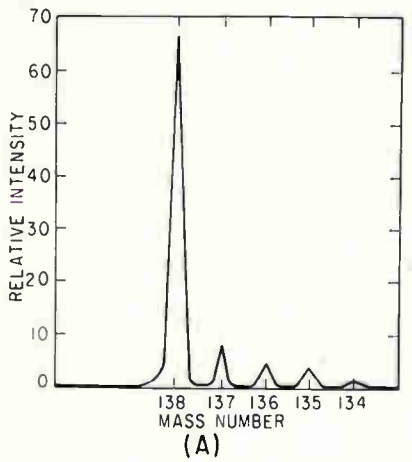


FIG. 1—Low-energy positive ions impinging on negative high voltage electrode cause secondary electron emission



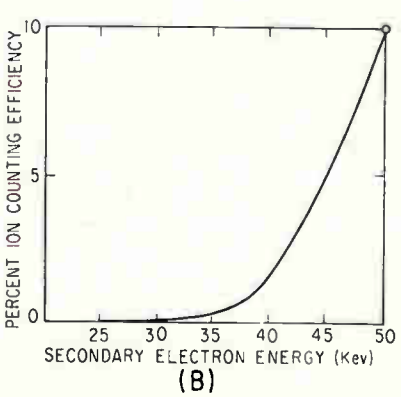


FIG. 2—Partial mass spectrum of barium (A) was made using diffuse junction counter. Ion detecting efficiency (B) although limited indicates possibilities of method

Similar qualitative results have been obtained using surface-barrier junction devices[3] made at Knolls Laboratory, which is operated by GE for the Atomic Energy Commission.

A conventional amplifier, scaling circuit and count-rate meter were used to record the spectrum. The device cannot now be used to record the spectrum. It has no plateau and registers only a fraction of the total number of ions, partly because of the low secondary yields of the ions on the high voltage plate and because of both amplifier and corona noise from the converter.

A one-to-one correspondence of positive ions to detected output pulses has not been achieved, as shown in Fig. 2B. This efficiency curve was determined by measuring d-c current from the Ba^{138} isotope at about 10^{-12} amp on a suitable Faraday cage. The current was then compared with the counting rate of a smaller isotope (Ba^{135}) and normalized. This procedure was necessary to circumvent the very large counting losses that accompany the pulsed-counting of currents of 10^{-12} amp (counting rate of 10^7 pps).

Thus while a *pn* junction is to date not a substitute for a reliable electron multiplier, it has demonstrated potential. A multiplicity of such devices could conceivably be used for simultaneous readout of several ion beams.

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Shock Compression Cools Airborne Electronics

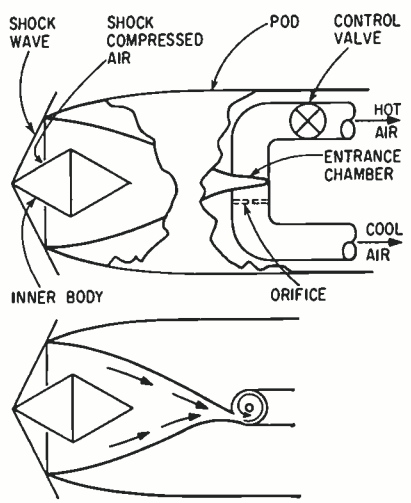
SHOCK COMPRESSION may permit direct air cooling of electronic equipment in supersonic aircraft. Although it is shock compression that

causes a considerable rise in air temperature, a developmental cooling system requires no other source of power.

The Hilsch vortex refrigerator is under development at The Hallicrafter Co. heat transfer laboratory. It separates lower energy (lower temperature) molecules from a stream of compressed air at elevated temperatures without moving parts.

Equipment to be cooled is housed in a pod attached to the aircraft as in the figure. An inlet similar to that of a ram jet engine admits the shock-compressed air, which enters the tube tangentially and is spiralled into a vortex.

An orifice bleeds off the low-energy particles for equipment cooling, while the hotter high-energy air particles are exhausted. A valve in the hot line controls relative air



Cooler air molecules are separated by orifice shown in upper drawing after shock-compressed air is spiralled in vortex shown in cutaway view at bottom

flows, effectively regulating air temperature downstream from the orifice.

At an ambient temperature of 60 F, the stagnated Hilsch tube inlet air temperature of an aircraft at sea level traveling at Mach 2 is 474 F. Using the Maxwell-Boltzman distribution of air molecule velocities under these conditions, it was demonstrated that 65 percent of the air molecules accepted by the tube have a mean velocity corresponding to an air temperature of 131 F.

Ideally, air can be extracted at

1 lb/min at 131 F from each 1.54 lb/min of air at 474 F entering the vortex tube. Even if performance were considerably poorer than ideal, the simplicity of the Hilsch vortex tube promises savings in weight, space, power and cost. This approach to cooling electronic equipment is therefore believed to be a strong contender for consideration in future aircraft designs.

Space Thermoelectric Unit Uses Solar Energy

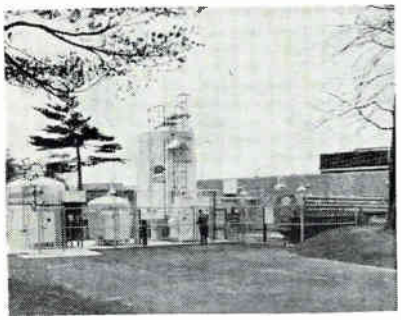
SOLAR thermoelectric generator may provide auxiliary electric power for space vehicles. Preliminary design and evaluation of such a power-generating system has been made possible by the success of some recent experiments.

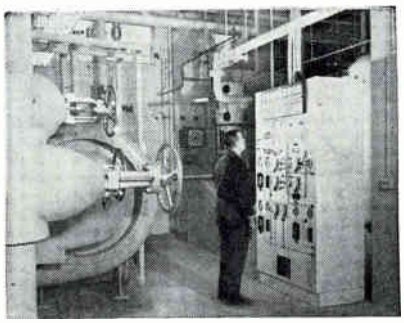
Small, rugged semiconductor elements have been fabricated at General Atomic division of General Dynamics Corp. This achievement combined with a technique for joining the elements to light-weight metallic sheets is believed to have provided a firm experimental basis for such a power source. From this start, it is hoped that energy from the sun can provide limited amounts of electrical power.

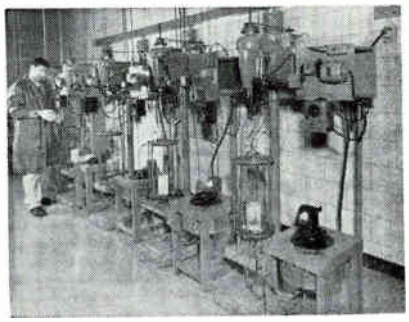
The solar-energy thermonic conversion device consists of the semiconductor elements sandwiched between the light-weight metallic sheets. Heat from the sun is collected by one metallic sheet and conducted through it to the semiconductor element.

Heat energy not converted to electrical energy by the element is passed to the opposite sheet from which it is radiated into space.

Such a system is believed suitable for operation in the range from Mars to Venus. Expected performance of the generators appears attractive at power levels ranging from less than a watt to several kilowatts. Above these levels, performance of other generating systems seems to be more suitable. One such generator is the nuclear reactor system with built-in thermionic cells that is also presently undergoing development at General Atomic.







Gas park, left, adjacent to main plant, enables convenient storage of large amounts of nitrogen, argon, oxygen and hydrogen used in Clevite's manufacturing operations. Gas monitoring panel, center, eliminates laborious and time-consuming measurement of gases. High-purity Airco nitrogen is used in the five vertical crystal-growing furnaces, right

Role of Industrial Gases in Electronics

INDICATES GROWING NEED FOR HIGH-PURITY CONTROLS

ULTRA-PURE INDUSTRIAL gases are fast becoming vital raw materials in many parts of the electronics industry. Electronic producers, especially semiconductor-devices manufacturers, are buying these gases in large quantities and are going to great lengths to safeguard their purity. The new Waltham, Massachusetts plant of Clevite Transistor Products affords an excellent example. Details of this operation were revealed to this column on an exclusive basis.

This Clevite division plant consumes a combined total of several million feet of nitrogen, hydrogen, argon, and oxygen in a typical month's operations. The gases are supplied in highly purified form from the nearby Acton plant of Air Reduction Sales Company. A major share of this Airco plant's industrial gas output goes to electronic manufacturers in the New England area.

Clevite stores the gases on its own property, in a gas park of Airco design, see photos above. Argon, nitrogen, and oxygen are delivered and stored in liquid form; hydrogen, in special pressurized trailers. From the storage park, gases are piped directly to all points of use (except for some small amounts of liquid oxygen, helium, and welding gases kept in the main plant in cylinders).

To assure highest possible quality and reliability in its gold-bonded germanium diodes, transistors, and silicon rectifiers, Clevite recently developed a gas-monitoring system which Airco engineered and constructed to Clevite specifications. The resulting panel, see photos, the only one of its kind now in use by an electronic manufacturer, gives a thorough and continuous means of monitoring gas purity, as well as pressure, liquid level, etc. Laborious and time-consuming manual sampling and measurement of gases are eliminated.

Why is ultra-high purity so important? Clevite's answer doesn't come in statistics. But production and test records have convinced the firm that purity of high order is an essential part of its overall quality control program, aimed at maintaining constantly high reliability in all devices produced.

This much *is* known. In production and testing operations, the presence in the gases of any substantial amounts of impurities has a noticeable effect on the quality and reliability of the finished semiconductor devices. According to a Clevite spokesman, the gas monitoring panel "affords higher quality for lower cost, and helps to eliminate one possible source of product defects."

While some of the company's gas-consuming production processes cannot be revealed, the following summary indicates the broad range of gas applications in which product defects could become a problem if gas purity were not kept within specified limits:

Argon and nitrogen serve as inert atmospheres in crystal growing and refining furnaces.

Forming gas (80% nitrogen, 20% hydrogen composition) keeps out impurities during such operations as soldering of diode leads to bases and glass-to-metal sealing.

Pure hydrogen increases the efficiency of brazing operations by producing a reducing atmosphere which prevents oxidation of metals at elevated temperatures, thereby eliminating the need for fluxes.

Hydrogen is also used for reducing germanium dioxide to metallic germanium.

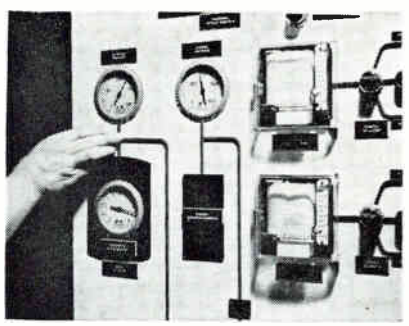
Oxygen is used in conjunction with hydrogen and natural gas to produce pinpoint, high-intensity flames for glass sealing operations.

Clevite does not require extreme purity in most of the oxygen it uses, because most applications of this gas involve enriching of heating flames and similar functions, in which the oxygen does not come into contact with critical semiconductor components.

If the monitoring system shows continuing presence of excess impurities in its main gas supplies, these are automatically or manually shut off. Since such a shut-off would quickly suspend production operations, reserve supplies of all four gases are maintained in the gas

park. Main liquid-storage tanks of argon, nitrogen and oxygen are backed up by reserve banks of pressurized cylinders. Also, two hydrogen trailers are generally kept in the park, so there will be no need to use the standby cylinders except in an emergency.

Via electro-pneumatic transmitters and electrical analyzers located in the gas park, and receivers in the monitoring cabinet (located in the boiler room of the main plant), Clevite has constant visible and recorded certainty that the hydrogen, nitrogen and argon being used contain no more than four parts per million of oxygen and six to seven parts per million of moisture. In the case of oxygen, where extreme purity is not necessary, the system is designed to monitor pressure and liquid level only.

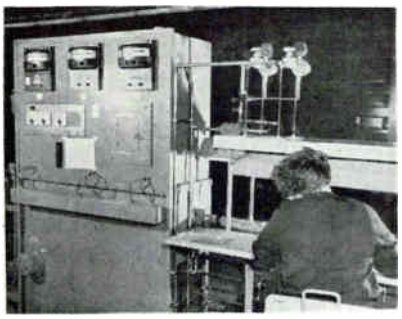


Closeup of monitor panel indicates detailed information available in easy-to-read form

Instrumentation provides permanent records of specified gas compositions and impurities and initiates selective shutdown of faulty equipment when this is called for. It also keeps tabs on the performance of two Airco gas mixing proportioners used to produce forming gas in the precise nitrogen-hydrogen ratio required.

The amount of hydrogen present in the forming gas is watched carefully for two major reasons: First, keeping the amount of hydrogen down cuts costs (since hydrogen is more expensive than nitrogen). Second, use of the minimum required amount of hydrogen increases safety. If, despite this careful control, combustion does occur, hydrogen supply can be immediately cut off and nitrogen used for snuffing.

The graphic-display monitoring panel makes operation of the entire



A nitrogen-hydrogen mixture is consumed in this belt at the rate of about 55 cu ft per hour. The three-heat-zone, at the end of a motorized assembly line, is used to solder diode leads to bases

gas supply setup quickly recognizable. Storage tanks are depicted on the panel, and all gas flow lines are color-coded for easy tracing. The display includes ten indicated pressures, three liquid tank levels, and six recorders indicating purity. Indicators and recorders are arranged and connected with visible flow circuits to provide maximum readability.

Lamp-annunciators are connected to a common audible alarm and visual rotating red beacon. Annunciator service is fully automatic, with individual reset and operating sequence as follows: Momentary or sustained abnormality causes sustained audible signal and flashing message window. Subsequent operation of silencing button by attendant removes the audible signal and changes the flashing light to a steady light. Subsequent removal of the abnormality causes the steady light to extinguish automatically.

Explosion-proofing of all system components that require it is accomplished by purging with nitrogen.

A switching arrangement on the panel section that monitors forming gas can be used when excess oxygen or moisture is detected. This arrangement allows separate measurements to be made of nitrogen and hydrogen feeding into the proportioners, to determine which constituent is carrying the impurity.

Additional gas park instrumentation keeps tabs on hydrogen pressure. When this pressure approaches a preset value, indicating depletion of the hydrogen trailer hooked into the supply line, the second, stand-by trailer is cut in.

Electrolyte Slices Semiconductor Crystals

By RICHARD A. PEAK,
Advanced Development Lab., Raytheon Co., Semiconductor Div., Newton, Mass.

ELECTROLYTIC SLICE ETCHING is being used experimentally here to prepare extremely thin wafers of germanium crystal. It produces high quality specimens for development of new transistor types. Slicing is consistent and reproducible.

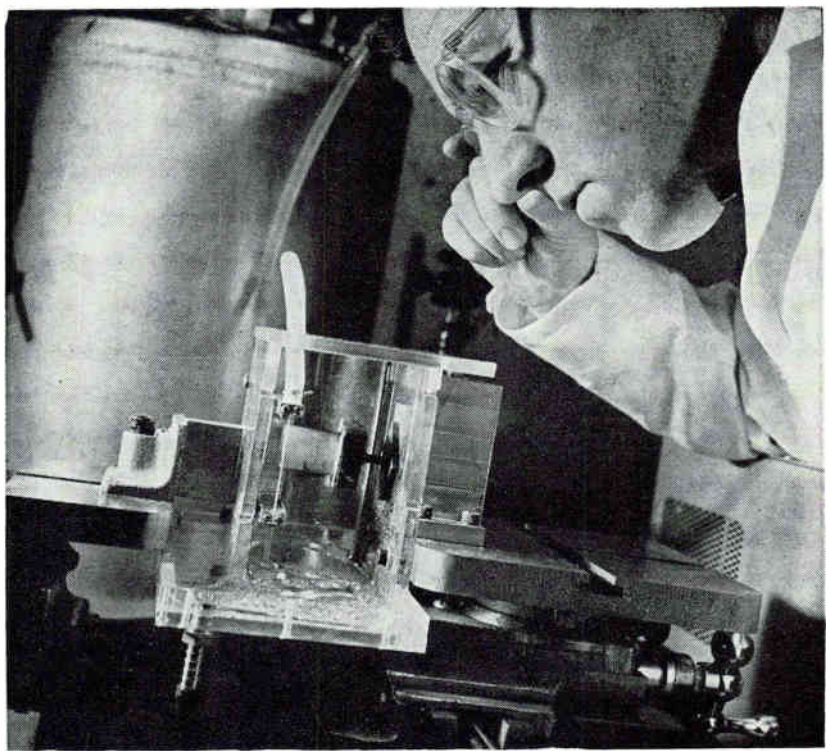
Wafers have been cut as thin as 0.0005 inch, thinner than conventional methods allow. The wafers are free of mechanical surface damage and require little or no lapping, polishing and etching. Optically-flat surfaces have been observed.

These advantages, combined with kerf reduction, permit far more efficient use of valuable semiconductor material. Kerfs are as narrow as 0.014 inch at maximum cutting rates. Present cutting rate is 1.5 inches an hour, but this can be increased. Crystals 1.5 inches thick are readily sliced.

Some of the applications include investigations of diffusion and alloying processes and electrical device characteristics obtained from materials processed this way.

While primary attention has been given germanium, work on silicon and intermetallics is also under investigation. Among the parameters involved are electrolyte composition and concentration, current-voltage relationships, anode rate, kerf, cathode diameter and material, flow rate, temperature, jet size, and surfaces.

The new technique employs a jet stream of electrolyte flowing over a small diameter wire, restricting removal of the anode material (crystal) to a relatively narrow area. In addition, the stream sweeps out of the active region the reaction products and gas bubbles formed at the cathode (wire).



Author observes etch slicing of germanium crystal

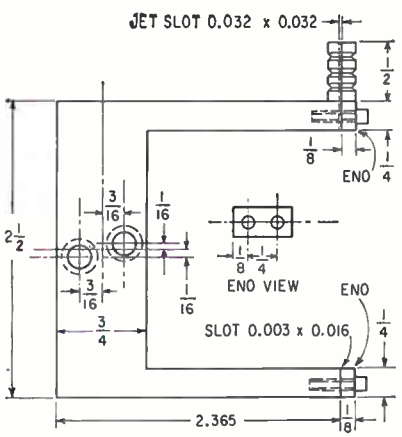


FIG. 2—Dimensions of holder

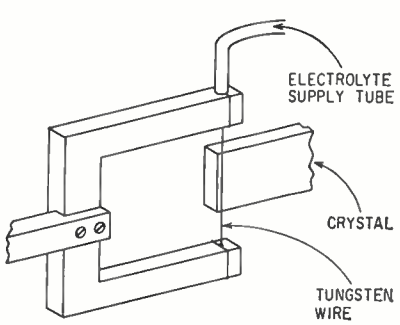


FIG. 1—Jet Cathode holder

The jet is made of stainless steel. The cutting cathode is a three-mil tungsten wire which is passed through the jet opening (Figs. 1 and 2). A spring in the arm keeps the wire taut. Electrolyte is forced down the supporting wire under constant pressure and at a flow rate dictated by the experiment. The wire provides a path for current flow while the stream serves as both etchant and coolant.

A regulated (0.0015 percent regulation) voltage supply in series with a choke and two large resistors minimizes fluctuations in d-c output. This prevents differences in the rate at which the anode passes through the cathode.

The movement of the specimen must be limited to maintain smoothness along the cutting cathode. This is accomplished by a direct drive system (Fig. 3). A motor drives a set of calibrated gears. The gears rotate a precision-ground thread in a precision-ground nut, which in turn moves a lathe compound holding the crystal jig. Side cutting is held constant by a constant ratio between the current density and forward velocity of the anode.

Precision of the machine and its component is most important. Ex-

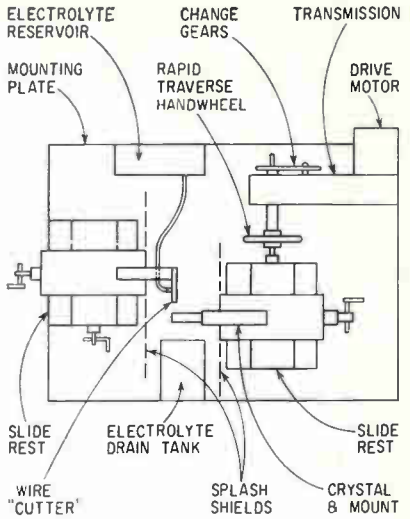


FIG. 3—Mechanical layout of cutter

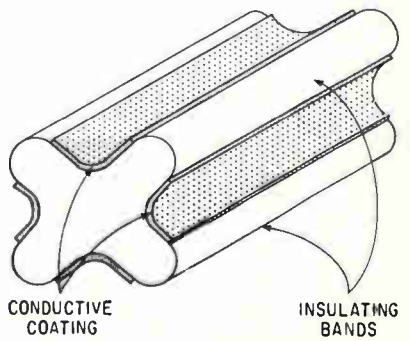
tremely rigid requirements must be placed on the system to obtain pure translation in the direction of the cut. An indexing and orienting device has been attached to cut very thin oriented wafers.

Tiny Die Extrudes Ceramic Cartridges

STEREOPHONIC reproducer cartridge made by Erie Technical Ceramics, State College, Pa., is produced from barium titanate slurry extruded in continuous lengths with a cruciform cross section.

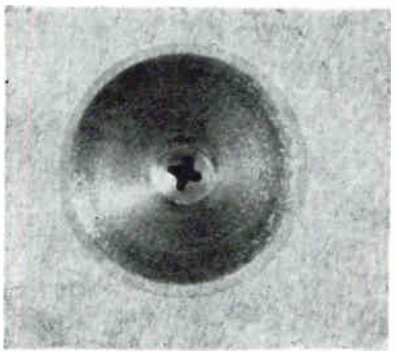
The slurry, about the consistency of stiff mud, is fed into the extrusion press from an overhead hopper. A hydraulic ram, exerting a pressure of 15,000 psi, forces it through a die. The extrusions are oven dried on grooved hardboard trays and cut into two-inch lengths with a diamond wheel.

The elements are fired at 2,500 F



Sketch of metallized cartridge element

for 24 hours in an electric furnace in a neutral or reducing atmosphere. The fired elements are metallized in the valleys of the cross to provide alternate conductive and insulating bands. The element is polarized by connecting d-c voltage to opposing pairs of conductive surfaces.



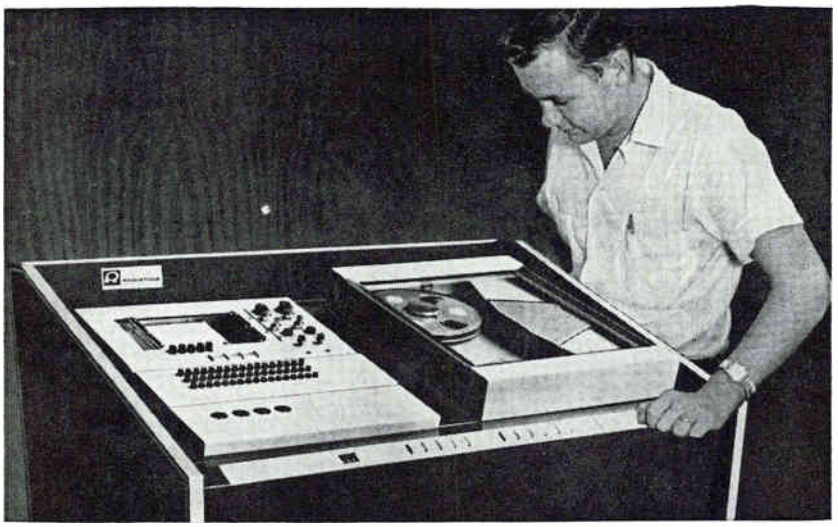
Magnification of entrance face of the die

The extrusion die was made by the Punch and Die Division, F. J. Stokes Corp., Philadelphia, Pa. The shape and size of the die prevented it being made in one piece. It was made in two matched pairs of segments. Each pair was mated by grinding and matching under an optical comparator. The four segments were assembled in a ring expanded by heat and the assembly was then reground as a unit. The length of each arm of the cross is 0.0310 inch and the inside diameter of the holding ring is 0.5625 inch.

Shipping Carrier Aligns Transistors

TRANSISTOR PACKAGE that may be used as a production carrier was recently introduced by Radio Corporation of America's Semiconductor and Materials Division, Somerville, N. J. It is a plastic tube with a raised spine, or slide-rail, running the length of the bottom. Up to 25 short-lead computer type transistors can be inserted in the tube with their cases resting on the rail and their leads just clearing the bottom Pressure sensitive tabs seal the ends of the tube. The siderails keep the transistors oriented in the tube, making it feasible to insert tubes in handling machinery.

New On The Market



Low-Cost Data System

MOBILE UNIT COLLECTS AND PROCESSES

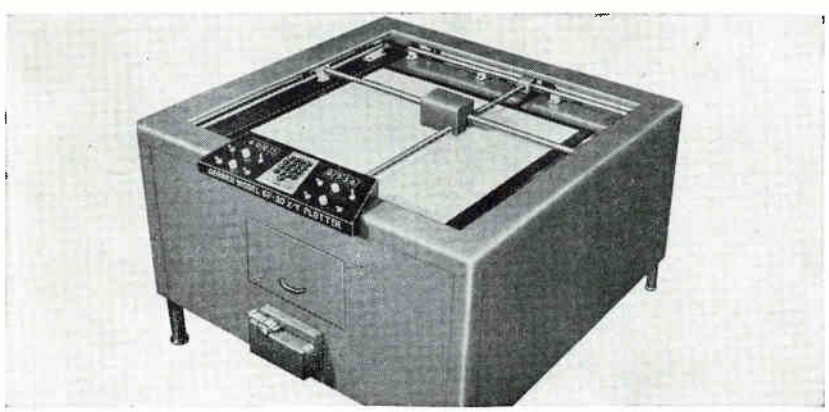
MOBILE low-cost data handling system, has been developed for automotive, processing, defense, and manufacturing industries by Radiation Inc., Melbourne, Fla.

RADAC I, in a mobile enclosure four feet high, will collect data on speed, fuel flow, temperature, pressure and other variables and will process and prepare the information for direct entry into many computers. Information is prepared on magnetic tape for direct use with IBM 650, 704, 1260 and 7090 systems and other installations.

Users of the device need not own digital computers since the magnetic tape can be analyzed by computing services.

The system is composed of a Radiplex high-speed multiplexer, a Radicon coder for analog digital conversion, Radilog digital standard logic circuits, an Ampex FR-400 digital tape transport, and power supplies. Optional features such as quick-look recorders, automatic run controls, remote controls and others are available.

CIRCLE 301 ON READER SERVICE CARD



X-Y Plotter

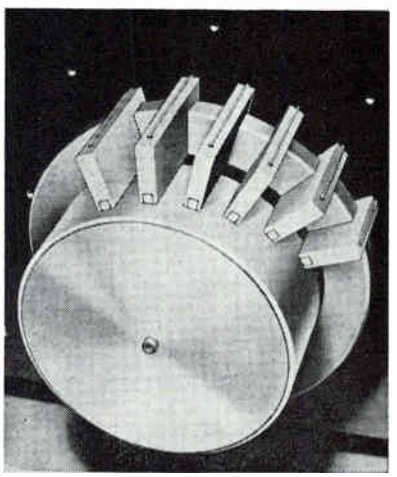
SEVERAL TYPE INPUTS

X-Y PLOTTER accurate to 0.05 percent of full scale that repeats exactly from any direction is announced by the Gerber Scientific Instrument Co., Hartford, Conn. The solid-state plotter offers high reliability and reproducibility over its 31 × 31 in. working surface. Standard models are available to 48 × 48 in. and larger models can be developed with the same built-in accuracy.

Input to the plotter can be from punched cards, punched paper tape or keyboard; slewing speed is up to 20 inches per second. The printing head contains twelve symbols, any of which can be selected at random; other print sectors can also be added to plot digital as well as symbol information.

The plotter comes complete with keyboard, tape and card input and facilities for setting scales on one X channel and one Y channel (additional Y channels are optional).

CIRCLE 302 ON READER SERVICE CARD



20-Channel Magnetic Drum

9,000 BITS PER CHANNEL

MAGNETIC DRUM delay/memory system in a building block style is available for process or equipment control systems. Components of the system are designed for low initial investment with add-on features. Manufacturer-designer is Electron-Ohio, Inc., Box 9527, Sonon, Ohio.

Basic to the delay/memory system is a 20-channel magnetic oxide drum with storage densities to 9,000 bits per channel. Recording heads adjust circumferentially to provide continuously variable delays of from two to 60 seconds.

A modular-constructed console contains the drum (12 in. diam, 5 in. wide), drum drive and power supply, record and playback heads, permanent magnetic erase head and panel-mounted plug-in record and playback amplifiers.

Input is from standard transducers, load cell, strain gage, thermocouple, eddy current, photoelectric cell, etc. Drum drive is by synchronous motor, synchro (servo

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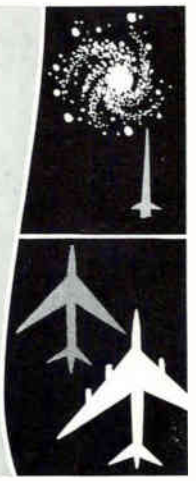
- 100% tested for reliability
- Sine wave, square wave or DC outputs
- Quick delivery on units below



DC TO SINE WAVE *Model KB* (Stock Item)

Input Voltage: . . . . 24-30 VDC
Output Voltage: . . . . 115 VRMS
Output Frequency: . . . . 400 cps (other frequencies available)
Output Power: . . . 50 volt-amps
Frequency Regulation: 0.3% for 6 V line variations
Harmonic Distortion (Total): 2% at specified load (4% max.)
Size and Weight: . . 2½"x4"x2½" high; 26 oz.

DC TO DC *Model 591HC*

Input Voltage . . . . 24-30 VDC
Output Voltage Range . from 6 VDC to 3500 VDC
Output Power . . 60 watts (max.) regulated
Regulation . . ±1.0% for 6 V line variations; ±1.5% for 50% load variations
Ripple . . . . . 0.3% RMS
Size and Weight . 3" OD x 3 3/16" high; 22 oz.

DC TO SQUARE WAVE *Model 591ACB*

Input Voltage . . . . 24-30 VDC
Output Voltage Range . 1.0 to 3500 VRMS, square wave, 400 cps (other frequencies available)
Output Power . . . . . 50 V. A.
Regulation . Frequency and Voltage: ±1.0% for 6 V line variations; ±1.0% for 50% load variations
Size and Weight . . 3" OD x 3" high; 19 oz.

Constant frequency, voltage and output as battery discharges. Units withstand short circuit, reversed polarity and input voltage transients of 60 volts. Load power factors as low as 0.2 (lead or lag) may be applied.

Literature with performance curves sent on request. Literature includes "easy to order" information—no need to write complicated specifications.

ARNOLD MAGNETICS CORP.
6050 W. Jefferson Blvd., Los Angeles 16, Calif.
VErmont 7-5313

CIRCLE 87 ON READER SERVICE CARD 87

controlled) or direct coupling. Output is digital in the form of on-off pneumatic, hydraulic or electrical process control signals. The power requirement is 110 volts at 60 cycles.

Applications include process control for flaw detection, recording and rejection without stopping processing; other applications are material sorting and quality control alarms and similar devices.

CIRCLE 303 ON READER SERVICE CARD

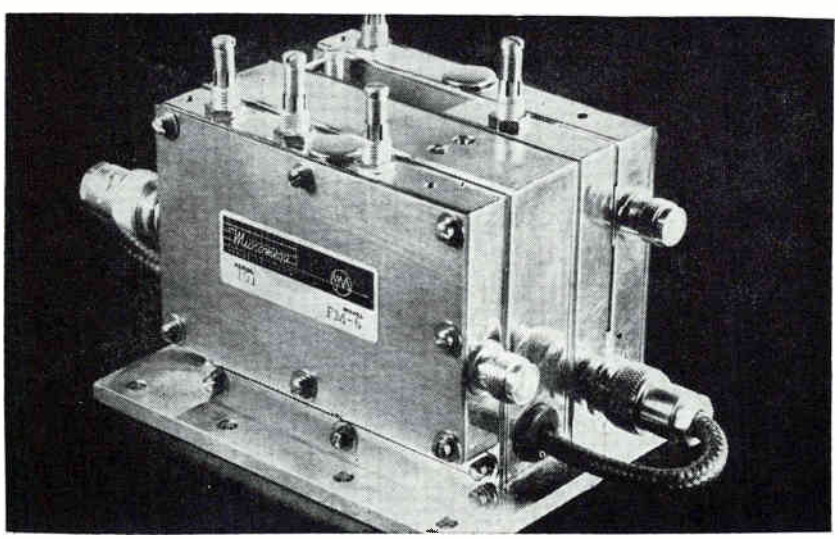
High-Voltage Connectors

7,500 VRMS, POSITIVE THREAD COUPLING

A SERIES of small, threaded high-voltage connectors are available as a cable plug (EDD 2539). The connectors are BNC size but have positive thread coupling. The connectors are capable of operating at 7,500 volts rms, 60 cps at sea level. Designed to accommodate RG-59, 62, 71 or equivalent high voltage cables, the series has contacts of heat treated beryllium copper, a retaining ring of phosphor bronze, Teflon dielectric and silicone rubber gaskets. All metal parts are silver plated with contacts—gold plated over silver; threads are 7/16-28 NEF-2.

The connectors are weatherproof, will operate at −65 F to +260 F and meet MIL-E-5272A. Manufacturer is General RF Fittings, Inc., 702 Beacon Street, Boston 15, Mass.

CIRCLE 304 ON READER SERVICE CARD



Varactor Multiplier

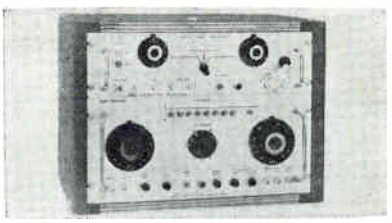
TUNABLE OUTPUT: 870 TO 990 MC

HIGH-POWER Varactor multiplier that uses printed strip transmission line resonators at 150 Mc is announced by Micromega Corp., Venice, California.

The Model FM-6 high-efficiency, high-power multiplier can replace vacuum tube stages of the exciter multiplier chain of a station's transmitter, and the local oscillator chain of a receiver.

Performance characteristics of the solid state unit are: input frequency, tunable from 145 to 165 Mc; output frequency, tunable from 870 to 990 Mc; output bandwidth, 30 Mc; multiplication factor, 3 × 2 = 6; conversion efficiency at 2 w input, −7 db at −20 db spurious output, and −8 db at −60 db spurious output, maximum input power, 2 w; operating temperature range, −50 C to 75 C.

CIRCLE 305 ON READER SERVICE CARD



Test Instrument

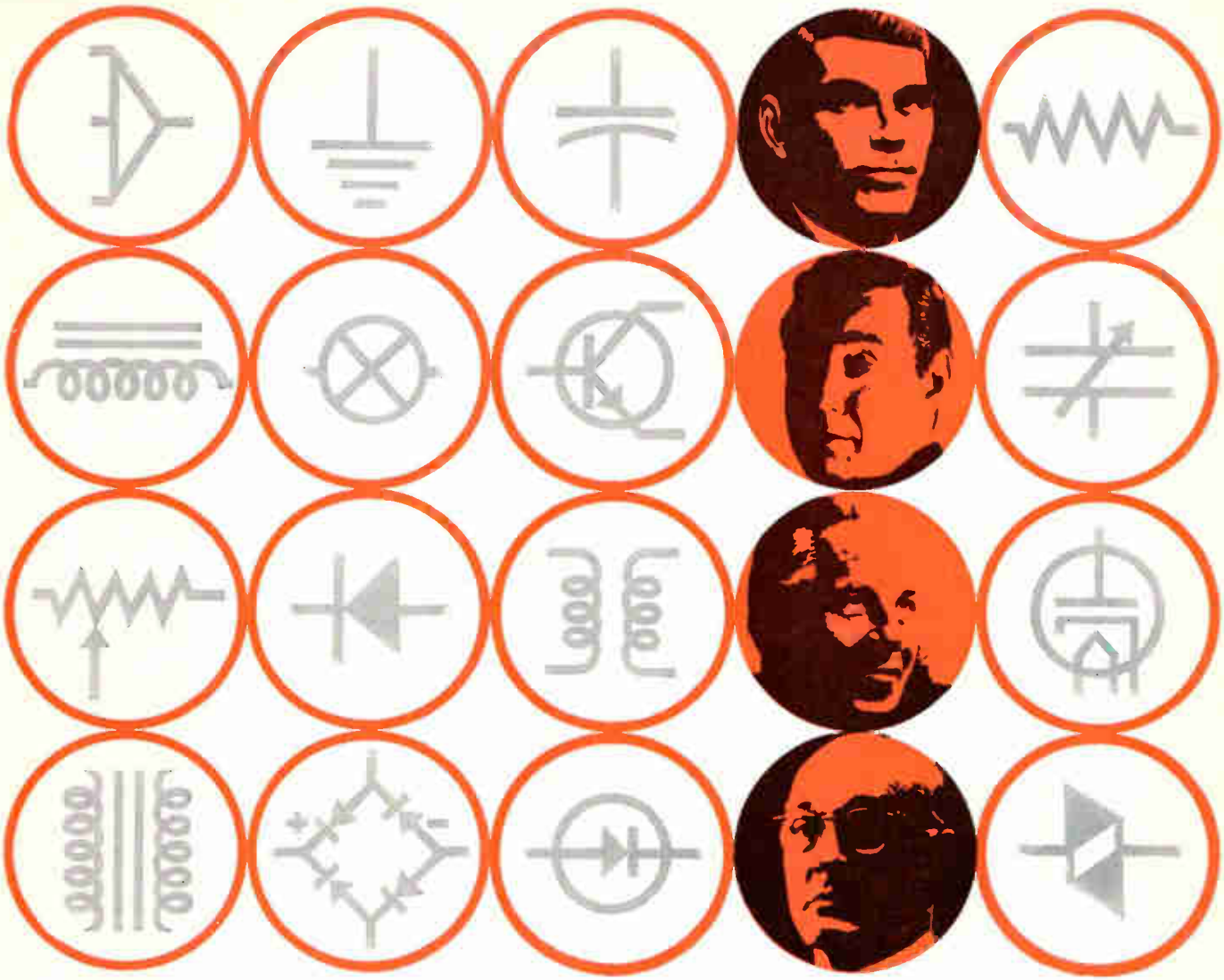
FOR R-F CIRCUITS

TEST INSTRUMENT for determining vswr and attenuation values of r-f components or circuits has been announced by Telonics Industries, Inc., Beech Grove, Ind.

The set uses a pair of coaxial switches operating at 30 cps to produce a dual oscilloscope trace. The two traces, representing a reference value and an unknown, provide instantaneous readings of vswr or attenuation for the device under test.

Model SP 160 operates from 200 to 475 Mc and uses a Telonic SD-2M sweep generator to provide the swept signal. A comparator module, equipped with input terminals and two r-f attenuators completes the test set.

The generator section operates at a fundamental frequency using a sweep oscillator with a precision vibrating capacitor; the generator response is flat within 5 percent over its maximum sweep width, it has an output of over 0.75 v into 50 ohms and has a variable frequency marker. Set size is 24 × 16 × 16; weight is approximately 85 lb. The test set can be supplied with gener-



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0.12

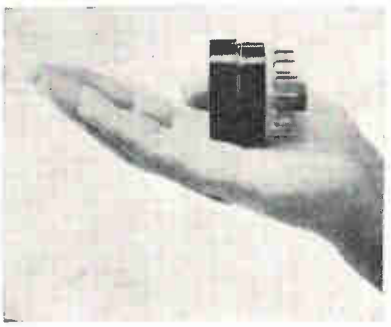
ators with a frequency to 1,000 Mc; attenuators can be provided for any db values desired. Prices range from $1,600 to $1,800.

CIRCLE 306 ON READER SERVICE CARD

Ultra Pure Indium
SEMICONDUCTOR GRADE

ALPHA METALS, INC., 56 Water St., Jersey City 4, N. J. Indium 99.999+ percent pure to meet the critical requirements of semiconductor device manufacturers is now available. It contains less than 1 part in each million of either silver or copper. Tin and lead content is less than 3 parts per million each. Other elements are not detected by spectrographic analysis. The indium is available in bars or special shapes.

CIRCLE 307 ON READER SERVICE CARD



Preamp Reduces Pickup
FOR IMAGE-ORTHICONS

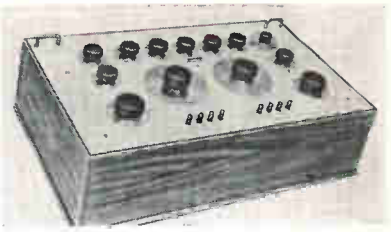
STRAY PICKUP normally encountered in image-orthicon tube applications is reduced by transistorized preamplifier mounted in the i-o tube base socket.

A product of Dage Division, Thompson Ramo Wooldridge Inc., Michigan City, Ind., the amplifier consists of a transistor circuit mounted on a printed-circuit board and potted within a standard 14 pin i-o base socket. Noise level is decreased by reducing the length of leads to the high impedance video source of the i-o tube.

The preamplifier is 2⅜ × 1½ inches, a match to the tube; signal to noise ratio is at least 60 db when output is 1 volt peak-to-peak. Output signal is black positive with a maximum undistorted signal of 1.5v peak-to-peak.

The amplifier is compensated for an i-o having 18 pf output load capacitance across 68,000 ohms, giving flat frequency response ± 1 db to 8 Mc with an overall gain of 10.

CIRCLE 308 ON READER SERVICE CARD



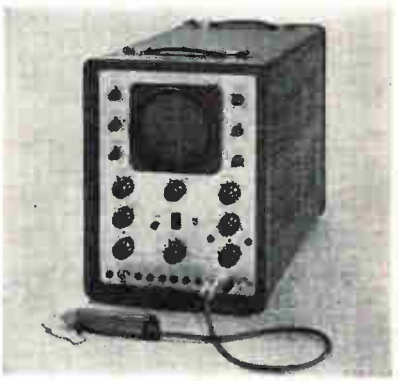
D-C Potentiometer
MEASURES 0.1 MICROVOLT

TYPE 9144 is a 4-dial, 6-figure, dual-range (× 1: × 0.1) d-c vernier potentiometer with a total measuring capability of 2.101010 v. It is self checking and has an accuracy of ± 0.001 percent, warranted for a period of 5 years. Initial adjustment is guaranteed to be within ± 0.0002 percent (2 ppm); stability is guaranteed to be within ± 0.00015 percent (1.5 ppm) per year or better. Thermal emf's are less than 0.1 microvolt and resolution is to 0.1 microvolt.

Besides being for measuring, the potentiometer can be used as a resistance comparator accurate to 2 ppm; as a saturated standard cell comparator that will detect differences of 1 microvolt; and as a constant temperature enclosure. Unit contains 2 saturated standard cells.)

The potentiometer is available from Sensitive Research Instrument Corp., 310 Main St., New Rochelle, N. Y.

CIRCLE 309 ON READER SERVICE CARD



H-F Oscilloscope
DIFFERENTIAL INPUT

N. V. PHILIPS' GLOEILAMPENFABRIEKEN, Eindhoven, The Netherlands. Type GM5603 oscilloscope features:

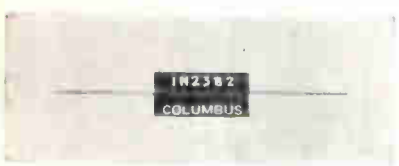
vertical amplifier—differential input; bandwidth d-c to 15 Mc; sensitivity 50 mv $_{p-p}$/cm—5v $_{p-p}$/cm (accuracy ± 3 percent); signal delay. Time base —40 nsec/cm to 1 sec/cm in 21 steps (accuracy ± 3 percent); magnification X2 and X5 (accuracy ± 5 percent); stable triggering (up to 2 Mc) and synchronization. Crt—13 cm flatfaced tube with 10 Kv accelerating voltage. Two d-c coupled cathode follower probes to enable differential measurements down to 50 mv/cm and two attenuator probes are delivered with the instrument.

CIRCLE 316 ON READER SERVICE CARD

Rotary Switch
REMOVABLE WAFER

CHICAGO DYNAMIC INDUSTRIES, INC., 1725 Diversey Blvd., Chicago 14, Ill., announces a miniature maintenance-saving rotary switch, any wafer of which lifts out instantly without disassembling or unsoldering for immediate cleaning or replacement. Series RS15 measures 1⅜ in. by 1⅜ in. by 2⅞ in. long for a 6 wafer type. Up to 18 XXXP or epoxy rhodium plated flushed wafers are available in a 10-position single pole configuration. Switch can be supplied to meet MIL-3786 or for commercial applications. Operation is manual or motor.

CIRCLE 317 ON READER SERVICE CARD



Silicon Rectifiers
COMPACT PACKAGE

COLUMBUS ELECTRONICS CORP., 1000 Saw Mill River Road, Yonkers, N.Y. Series 1N1341 through 1N1348

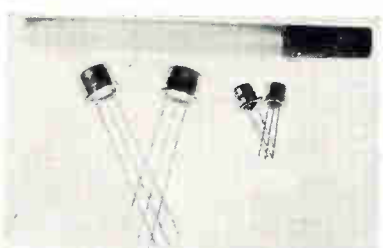
double diffused silicon rectifiers provide 6 amp output current at 150 C at piv's of 50-600 v. The units are produced in the compact ⅜ in. stud package and are available for military and commercial application. Company produces more than 350 JEDEC type double diffused silicon rectifiers as well as all seven JAN power type rectifiers.

CIRCLE 318 ON READER SERVICE CARD

Insulating Adapters
TNC & TM CONNECTORS

GENERAL RF FITTINGS, INC., 702 Beacon St., Boston 15, Mass., has available TNC and TM insulating adapters which make possible the use of coaxial connectors for many applications where otherwise a triaxial connector would be required. These components may be used with many TNC and TM connectors to insulate and isolate the entire connector from the mounting panel, or where it is desired to isolate a coaxial ground line from the panel, rather than ground to the panel. Complete specifications are given in engineering data drawing 3721-2.

CIRCLE 319 ON READER SERVICE CARD



Silicon Transistors
SMALL-SIGNAL

TEXAS INSTRUMENTS INC., P. O. Box 312, Dallas 21, Texas. A full line of silicon mesa transistors is characterized for small-signal applications such as audio and servo amplifiers, power supplies and medium-speed switches. Included are the 2N734, 2N738, 2N1564 and 2N1572 series. Design is facilitated by a choice of TO-18 or TO-5 cases; 60 or 80 v BV_{CEO} and betas of 20-50, 40-100 and 80-200. Beta is guaranteed at four conditions: 25C, −55C, f = 30 Mc and I_E = −1 ma. The industry standard TO-5 packaged units offer an additional 100 mw free air power dissipation as compared to the TO-18 where space is not critical, while the TO-18 package meets miniature transistor needs. Units in the TO-5 package have a power dissipation of 1,200 mw at 25C case temperature and 600 mw free air. TO-18 packaged units have 1,000 mw dissipation at 25C case temperature and 500 mw in free air.

CIRCLE 320 ON READER SERVICE CARD

D-C Supply
TRANSISTORIZED

HEWLETT-PACKARD CO., 1501 Page Mill Road, Palo Alto, Calif., announces a stable transistorized d-c power supply with an output of 0 to 60 v at 0 to 2 amperes. Model 722 AR's special circuit limits output current to a preset value, thus preventing costly damage to transistors under test. The instrument has low output impedance, and load regulation is better than 5mv for 0 to 2 amperes current change. All specifications apply from 0 to 55 C. Unit's low noise and ripple (less than 250 μv rms) enhance measuring accuracy. Ten percent variation in line voltage results in less than 2.5 mv change in the output voltage. Price is $525.

CIRCLE 321 ON READER SERVICE CARD

Computer Delay Lines
FOR P-C BOARD USES

IMC MAGNETICS CORP., Gray & Kuhn Division, 570 Main St., Westbury, L. I., N. Y., offers modular type electromagnetic delay lines which, by means of their internal construction, may be ganged for p-c board

applications. Series DL-251 units are constructed of non-nutrient, flame retarding, plastic materials. Impedances range from approximately 300 to 600 ohms with delay times of 0.1 to 0.8 μsec available. Units are 0.625 in. wide and run from 2 to 4 in. in length. Delay time to rise time ratios of up to 10:1 are available depending upon unit impedance and size. Operating temperature range is −55 C to +105 C.

CIRCLE 322 ON READER SERVICE CARD

Nanoammeter
LINE POWER OPERATED

DYNATRAN ELECTRONICS CORP., 178 Herricks Road, Mineola, N. Y. Model 1811AR nanoammeter is an improved rack mounted unit for measuring low level currents from less than 1 na to 3 ma. It features a high gain, chopper stabilized amplifier with feedback that results in the elimination of a zero adjust and a full scale voltage drop of only 10 mv on all ranges. Unit is line power operated and can withstand high overloads without damage. Price is $169.

CIRCLE 323 ON READER SERVICE CARD

Coax Attenuator
HIGH POWER

MERRIMAC RESEARCH & DEVELOPMENT, INC., 517 Lyons Ave., Irvington, N. J. This high power coaxial attenuator continuously withstands 100 w of c-w power for 24 hours with no change in performance characteristics. It offers zero insertion loss and provides up to 60 db of attenuation in the 300-5,000 Mc frequency range.

CIRCLE 324 ON READER SERVICE CARD

Literature of the Week

ELECTRICAL CONTACTS Engelhard Industries, 75 Austin St., Newark 2, N.J. A detailed study of precious metal electrical contacts, their applications and selection criteria is included in the company's *Technical Bulletin* Vol. 1, No. 2.

CIRCLE 325 ON READER SERVICE CARD

TINY CHOPPER Airpax Electronics Inc., Cambridge Division, Cambridge, Md. Specification 266 details characteristics and ratings for the model 30 electromechanical chopper which has dimensions of 21/64 in. by 21/32 in. by ⅝ in. and weighs but 9 grams.

CIRCLE 326 ON READER SERVICE CARD

SOLID STATE INVERTER Arnold Magnetics Corp., 6050 W. Jefferson Blvd., Los Angeles 16, Calif. A two-color catalog sheet offers detailed technical data on a small-size fully transistorized solid state inverter.

CIRCLE 327 ON READER SERVICE CARD

CONVERTER Potter Aeronautical, P. O. Box 1123, Union, N. J. A 2-page, 2-color data sheet describes model 574 frequency to analog converter which is designed for advanced state of the art instrumentation.

CIRCLE 328 ON READER SERVICE CARD

R-F MILLIVOLTMETER Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif. Volume 12, No. 1 of the H-P *Journal* describes a new r-f millivoltmeter for convenient measurements to 1,000 Mc.

CIRCLE 329 ON READER SERVICE CARD

MAGNETIC SHIELDING Magnetic Shield Division Perfection Mica Co., 1322 N. Elston Ave., Chicago 22, Ill. Data sheet 154 explains how Netic Co-Netic magnetic shielding prevents distortion of relatively low velocity electron beam systems in tubes such as the Tonotron.

CIRCLE 330 ON READER SERVICE CARD

CIRCUIT CHECKOUT Lavoie Laboratories, Inc., Box 2, Morganville, N.J. A 12-page brochure outlines the company's Robotester applications in electronic circuit checkout.

CIRCLE 331 ON READER SERVICE CARD

PUSH BUTTON LIGHTS Transistor Electronics Corp., 3357 Republic Ave., Minneapolis 26, Minn. Bulletin 69 describes the Tec-Lite MBL series combination miniature indicator light and push button switch that has application in computers, data processing, industrial control or signal systems.

CIRCLE 332 ON READER SERVICE CARD

CONNECTORS AMP Inc., Harrisburg, Pa., has published a two-page bulletin describing its line of multiple circuit connectors called AMPEEZ, which feature high amperage ratings plus low insertion and extraction forces.

CIRCLE 333 ON READER SERVICE CARD

AUTOMATIC SPRAY MACHINE Conforming Matrix Corp., 417 Toledo Factories Building, Toledo 2, Ohio, has available a brochure on a whirling gun automatic spray machine that continuously whirls two opposing guns or holds them in fixed position for the economical painting of round, deep-drawn, and intricately designed parts with diameters up to 15 in.

CIRCLE 334 ON READER SERVICE CARD

SELECTOR SWITCHES CTS Corp., Elkart, Ind. A 4-page, 2-color catalog illustrates and gives complete technical details on the series 212 1¼ in. diameter, 12 position, 30 deg indexed rotary switches designed primarily for low power r-f, vhf and uhf circuit applications.

CIRCLE 335 ON READER SERVICE CARD

MILITARY COMPONENTS Clarostat Mfg. Co., Inc., Dover, N. H. A listing of the latest military components manufactured by the company is now available.

CIRCLE 336 ON READER SERVICE CARD

TINY RELAY Filtors, Inc., Port Washington, N. Y. A single-page bulletin covers the series A Pillbox microminiature relay.

CIRCLE 337 ON READER SERVICE CARD

Electronics and Nucleonics Dictionary

By NELSON M. COOKE and JOHN MARKUS

McGraw-Hill Book Co., Inc., New York, N. Y., 1960, 543 *p*, $12.

FOR YEARS, the first *Electronics Dictionary* authored by Cooke and Markus in 1945 was recognized as an authoritative source of definitions and spelling style. But its use is limited in the fields of nucleonics, solid-state electronics, space and avionics, computers and logic, and other branches of technology now well developed.

This fully revised edition, long overdue, closes that huge gap and reflects the state of the art in electronics, nucleonics and allied fields in late 1960. A thorough check on the book's timeliness, practicality and completeness cannot be made in the few weeks available to prepare a review. However, this reviewer made a point of referring to it as often as possible during the past month. Whenever a definition was sought, it was found.

The definitions were also spot-checked against an Air Force manual of terminology and a major scientific dictionary. It appears to be superior to the manual, except for the omission of various acronyms, nicknames and abbreviations used by the military. It does not delve as deeply into theory, physics and formulas as the scientific dictionary, but this detracts little from its utility as a comprehensive desk-top source of every day information.

The new edition contains some 13,000 entries, more than double the 1945 content. Most of the older definitions have been updated and condensed, making the new information content greater than double. A consistent style of spelling compound words and acronyms is followed, furthering its use as an engineering and business style manual. The definitions are worded in plain English combined with terms included in the dictionary, so it can be used by laymen as well as technicians and engineers.

In many cases, the definitions are reinforced with methods of comput-

ing values, construction diagrams, circuits or other design hints. There are some 450 illustrations of this type. G. S.

Foundations of Electrodynamics

By PARRY MOON and DOMINA EBERLE SPENCER

D. Van Nostrand Company, Inc., Princeton, N. J., 1960, 314 *p*, $9.75.

This book offers a novel and refreshing approach to a classical subject. Although it is intended for seniors or first year graduate students in electrical engineering, practicing engineers should find it to be an excellent addition to their library.

The strength of the book lies in stating clearly from the beginning the basic postulates of electromagnetism and stressing topics too easily dismissed in other texts dealing with the subject. The authors are to be complimented for their treatment of retarded potentials, their careful derivation of the divergence and Stoke's theorems in terms of retarded quantities and their logical development of electromagnetic induction.

Unlike many texts which stress the study of static fields and relegate retardation phenomena to the last chapters, Moon and Spencer, following a brief introduction to vector analysis, present the mechanism of radiation in Chapter 1 and retarded potentials in Chapter 2. In Chapter 3, Maxwell's equations are derived after defining electric and magnetic fields in terms of potential functions; special care is given to the presentation of boundary conditions and to the derivation of the Lorentz condition using the principle of conservation of charge. Chapters 4 and 5 cover electrostatics and magnetostatics. Transient and harmonic wave propagation as well as Poynting's theorem are introduced in Chapter 6. Chapter 7 deals with skin effect. Chapter 8 covers electromagnetic waves in free space and reflections at plane boundaries. Waveguides are taken up in Chapter 9 and antennas in Chapter 10.

The *piece de resistance* is found in Chapters 11 and 12. Lorentz's

transformation as well as other transformation between moving systems of coordinates are presented in Chapter 11 and attention is given to Ritz's theory as well as Moon and Spencer's pet theory of universal time. Chapter 12 covers relativistic electrodynamics using the four-vector formulation; it also presents a long-overdue logical development of the theory of electromagnetic induction in moving media partly based on the works of E. G. Cullwick and G. I. Cohn, thus clearing much of the confusion brought about in previous texts.

A summary plus copious references and an excellent set of problems are included at the end of each chapter, making the book ideal for self-study as well as for classroom use.

As a piece of constructive criticism, the reviewer would like to see a future edition elaborate more on the relationship between circuit and field concepts via Maxwell's equations. A proof that the curl and divergence uniquely determine a vector field should be included as well as a more careful restatement of Poynting's theorem stressing the lack of uniqueness in the interpretation of the Poynting vector as power flow at a point.

In this day and age of conformism, when most texts tread lightly over little-understood subjects and limit themselves to what is considered acceptable and free of controversy by the scientific community, it is refreshing to find two authors who have dared to pose unanswered questions in order to stimulate the reader's intellect.—H. HODARA, *Head of Space Communications, Research and Development Div., The Hallicrafters Co., Chicago, Ill.*

THUMBNAIL REVIEWS

Wave Generation and Shaping. By Leonard Strauss, McGraw-Hill Book Co., New York, 1960, 520 p, $12.50. Information on this subject is usually found in bits and pieces in many different textbooks. This book has organized the subject in a logical manner and should therefore prove valuable in practice to the electronic designer. A piece-wise linear analysis of the simpler wave-shaping circuits is attempted for practical simplicity. The book has five major divisions: models and shaping, timing, switching, memory, and oscillations. There are ample examples and exercises. Vacuum tube and solid state circuits are considered indiscriminately.

Handbook of Chemistry and Physics. 42nd edition. Chemical Rubber Publishing Co., Cleveland, Ohio, 1960, 3365 p, $12. An up-dated edition of the standard handbook, this volume probably includes the most current data in physics and chemistry. One of the most useful books available.

Radargrammetry. By Daniel Levine, McGraw-Hill Book Co., Inc., New York, N. Y., 1960. 330 p, $12.00. Radargrammetry is the science of obtaining reliable measurements using radio aids; this book is consequently of more interest to the basic planner than to the hardware specialist. Scarcely a circuit is shown. The book is divided into such chapters as The PPI, Cartography, Display and Map Projection, Relief Displacement and Radar Parallax, Theory of Radar Returns, and Design Aspects.

Motorola Power Transistor Handbook. Edited by Ralph Greenburg, Motorola Semiconductor Products Div., Inc., Phoenix, Arizona. 1960. 205 p, $2. Compiled by the Applications Engineering Department of Motorola, this first edition is an excellent source of information covering the design, application and measurement techniques of power transistor circuits. Welcome addition to the design and applications engineer, hobbyist and to the experimenters bookshelf.

Magnetic Amplifiers, Principles and Applications. By Paul Mali, John F. Rider Publisher, Inc., New York, 1960, 101 p, $2.45. The book starts off well with lively cartoons showing early applications of saturable reactors in lighting control and in wartime military usage, but then Mr. Mali lets the side down by following with a dry-as-dust magnetic and filings approach to fundamentals. The book swiftly recovers from this setback and uses well organized drawings and characteristic curves to further the theory. There is rather an abrupt transition from saturable reactors to self-saturated magnetic amplifiers, but nevertheless the book is much less heavy-going than so many texts on the subject and will serve as a useful introduction for this reason.

Hoffman Unveils Science Center

ANOTHER spawning ground for futuristic electronics, the Hoffman Electronics Science Center was recently unveiled in Santa Barbara, Calif. Situated atop La Mesa Hill, highest point in the city, the center overlooks Santa Barbara bay from the base of the Santa Inez mountains.

The center consists of three separate buildings: one for administration and library usage, and two for laboratory purposes. They are joined by landscaped patios. There is an adjacent heated swimming pool, used weekends and evenings.

Situated on a 10-acre site, the present facilities of 1,500 sq ft are expected to triple.

Initial staff consists of a nucleus of 10 senior scientists, each a Ph.D., and an equal number of technicians and administrative staff. The center is designed to accommodate 50 scientists and supporting personnel. When facilities are tripled the staff will increase proportionately.

Each scientist has a general area of research, but there is considerable overlapping in various projects. The center is engaged primarily in product-oriented research in support of the company's other operating divisions. Generally these are military, industrial, semiconductor and consumer products. The emphasis is on solid state physics.

Newest product area at Hoffman is industrial electronics. Research in this field is expected to result in a broadened base of new business.

A sortation system for speedier materials handling is near completion. System is designed for use in retail merchandising, post offices and factories. Under investigation are: electronic controls and computers for optical instruments; an attachment for spectrophotometer chart data reduction; designs for data processing instruments and techniques for specific applications not requiring large scale computers. The Hoffman Safety Satellite, a solar-powered short wave emergency calling system for installation on highways, is now under consideration by highway regulatory agencies in a number of states.

Hoffman's Military/Space research, expected to offer close support to the company's Military Products division, is making contributions in areas of energy conversion to provide new and improved power sources, semiconductors, infrared components, fuel cells and radiation measuring devices.

Thin film coatings for Hoffman-developed solar cells for space satellites reportedly promise increased efficiency and reduction of damage caused by heat and radiation. A regenerative fuel cell with indefinite operating life offers secondary power source capabilities for both military and private industry.

An analog computer, used with a spectrophotometer, enables precise measurement of the sunlight conversion efficiency of Hoffman solar cells.

The new structure is headed by Dr. Lloyd T. Devore, director and vice president. The center cost about $1 million.

Texas Instruments Elects Dunlap

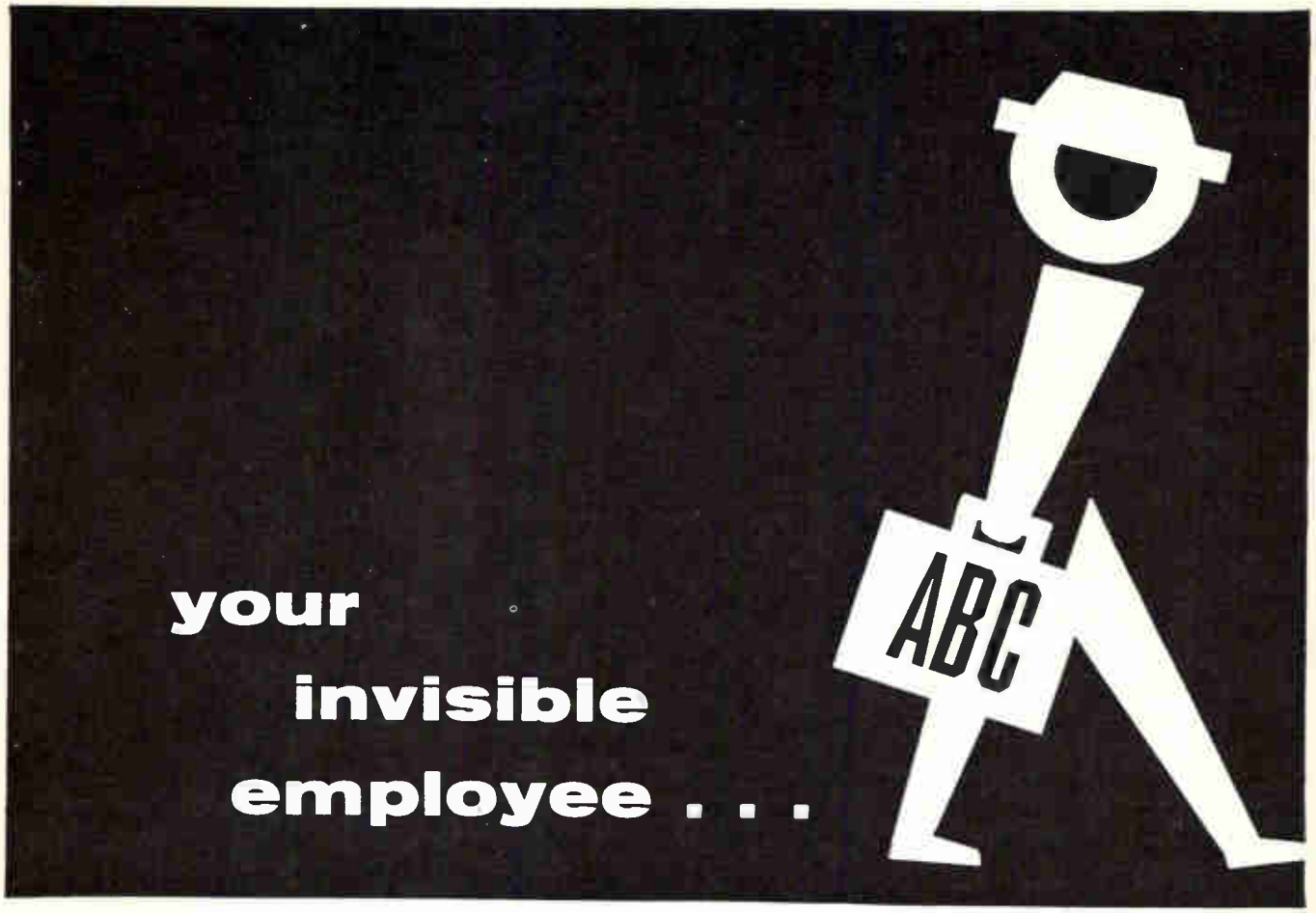
ROBERT C. DUNLAP, JR., has been elected a vice president of Texas Instruments Inc., Dallas, Texas. He will become operating head of the company's geosciences activities and will continue to serve as president of Geophysical Service Inc., TI's wholly-owned exploration subsidiary.

Burnell & Co., Inc. Names Guillemin V-P

ERNST A. GUILLEMIN, Webster Professor of electrical engineering at MIT, who has been chosen by the IRE to receive its highest technical award, has been named a vice president and director of research of Burnell & Co., Inc. The firm, located in Pelham Manor, N. Y., is a major independent producer of electronic filter networks.

Schaevitz Promotes Edward E. Williams

PROMOTION of Edward E. Williams to manager of the design and development section, Schaevitz Engi-



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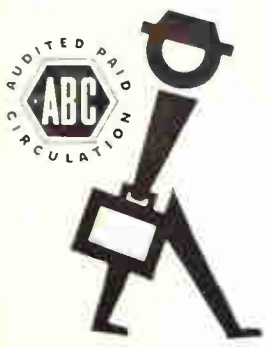

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ORGANIC SEMICONDUCTORS

April 18 and 19, 1961
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Invited papers will cover the following areas:

David Fox, State University of New York
Theoretical Aspects of Electrical Transport

R. G. Kepler, E. I. DuPont de Nemours and Company
Conductivity in Anthracene Single Crystals

Jan Kommandur, National Carbon Research Laboratories
Characteristics of Charge-Transfer Complexes

Oliver Le Blanc, General Electric Research Laboratories
Interpretation of Conductivity in Molecular Crystals

Herbert A. Pohl, Princeton University
Electrical Properties of Pyrolyzed Polymers

Marvin Silver, Office of Ordnance Research
Surfaces and Contacts in Organic Semiconductors

For further information contact James J. Brophy, Co-Chairman, Physics Division, Armour Research Foundation, Technology Center, Chicago 16, Illinois.

neering, Pennsauken, N. J., is announced.

Williams, who joined the company in 1955 as a design draftsman, previously was promoted to chief draftsman, design engineer and project engineer.

Electronics Co-Sponsors Inter-Industry Conference

ORGANIC SEMICONDUCTORS will be reviewed at a special inter-industry conference, April 18 and 19, at Chicago's Morrison Hotel. It will be co-sponsored by Armour Research Foundation and ELECTRONICS magazine.

Purpose of the conference will be to present a comprehensive coverage of organic semiconductors, including the latest results of research in industrial and government laboratories in this field. These will include organic semiconductor physics, molecular crystals, charge transfer complexes, pyrolyzed polymers, photoconductivity, electrical and thermal transport, surface and contact effects, and organic semiconductor devices.

Plans for the conference were formulated by Dr. James J. Brophy, assistant director of physics research at ARF, and W. W. MacDonald, editor of ELECTRONICS. They will serve as co-chairmen.

Program chairman is Dr. John W. Buttrey, supervisor of solid state physics at ARF. Inquiries concerning the conference should be addressed to Dr. J. J. Brophy, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

EDP Corp. Hires Project Engineer

WILLIAM E. LANE, specialist in transistor and analog computer tech-

niques, has been named project engineer for the EDP Corp., Orlando, Fla.

He was formerly with the Martin Co. where he worked on the development of a transistorized control computer for the Pershing Missile.

Clarostat Selects Production Manager

DOUGLAS HAYNES, production control manager of Clarostat Mfg. Co., Inc., Dover, N. H., since joining the firm in 1958, has been promoted to production manager.

Clarostat manufactures precision potentiometers and other resistors for missiles, computers, radio-tv and other electronic equipment.

MacLeod Instrument Names O'Maley

MACLEOD INSTRUMENT CORP., Fort Lauderdale, Fla., announces the appointment of James B. O'Maley as vice president, engineering. He was formerly associated with Kollsman Instrument Corp. as automation consultant to the president and also research engineer.

Bendix Computer Appoints Robinson

APPOINTMENT of James A. Robinson as senior reliability engineer for

Bendix Computer Division, Los Angeles, Calif., has been announced. He was formerly chief engineer for the Walkirt Co.

Trevor Law Joins Motorola Division

J. TREVOR LAW, former member of the technical staff at Bell Telephone Laboratories, has been named senior engineer of the materials department at Motorola Semiconductor Products Division, Phoenix, Ariz.

In his new position, Law will be concerned with research on crystal growth techniques, including epitaxial processes, gallium arsenide and other exotic materials.

Olympic Products Elects President

CHARLES A. VOLZ, Jr., has been elected president of Olympic Products Co., Inc., Alpha, N.J. He moves up from the position of vice president and general manager.

Olympic manufactures deep drawn and fabricated metal parts for the electronics industry.

Form Tube Company In Connecticut

A NEW FIRM, Electronic Industries, Inc., has been established in South

Norwalk, Conn. The company has begun production of a line of industrial special purpose electron tubes, including thyratrons and diodes; also, special purpose gun mounts for oscilloscope and Vitacon tubes and electron optic devices.

Marcellus Best, Jr., has been named general manager of the company. He was formerly general manager of Thermosen, Inc., Stamford, Conn. Stephen Prince is production manager.

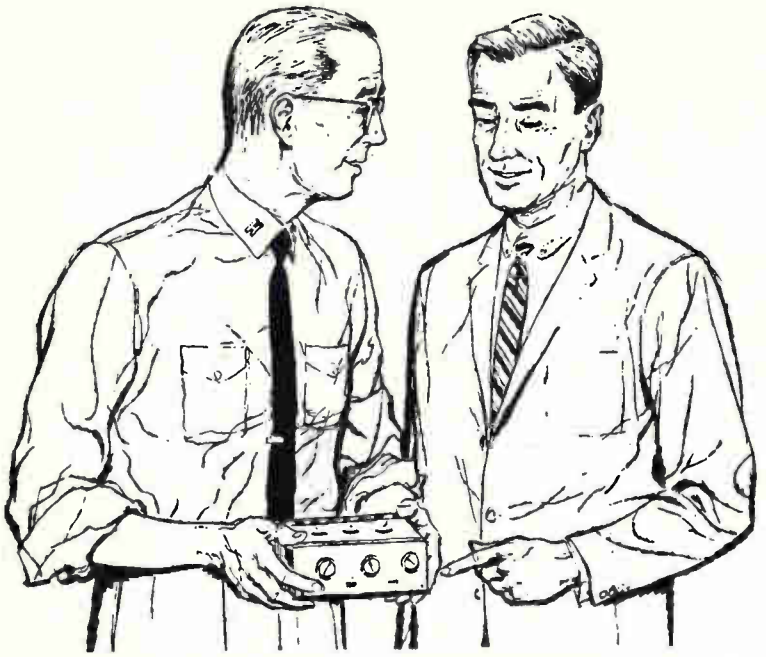
Chudleigh Assumes Vice Presidency

WALTER H. CHUDLEIGH, JR., staff engineer for General Atronics Corp., Bala-Cynwyd, Pa., and co-inventor of Atronics' probability ratio sequential detector for search radars, has been appointed a vice president of the firm's subsidiary, Atronic Products Inc.

Falstrom Heads Up New Cubic Facility

Cubic Corp. of San Diego, Calif., has selected William Falstrom as president of its newly organized subsidiary, TEMEC, Inc., in Van Nuys, Calif.

Formerly associated with Canoga Corp. of Van Nuys, Falstrom served as chief mechanical engineer and head of production.



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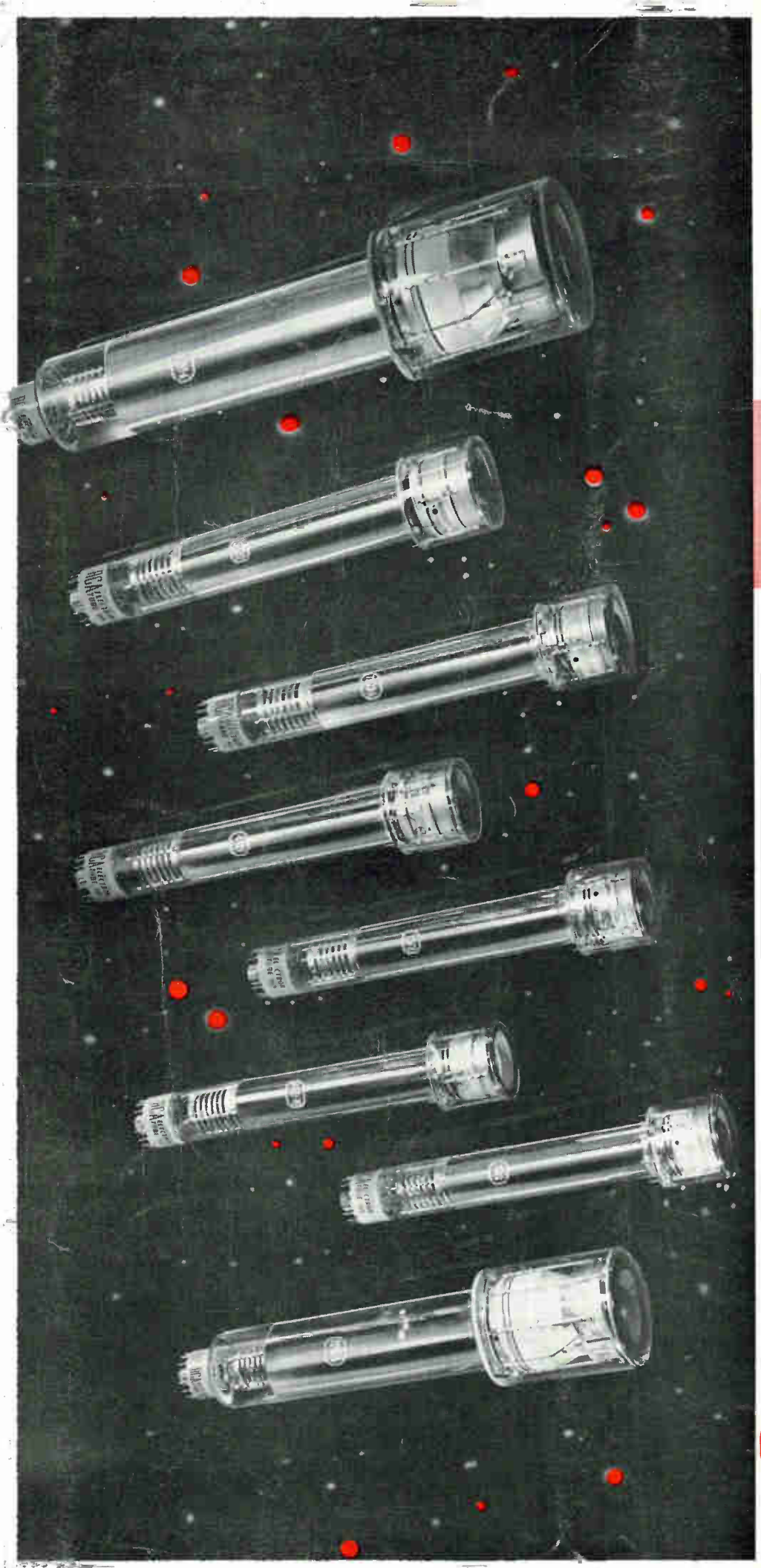

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