SEPTEMBER 18, 1959

electronics

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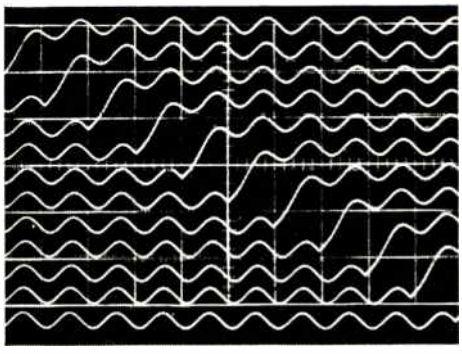

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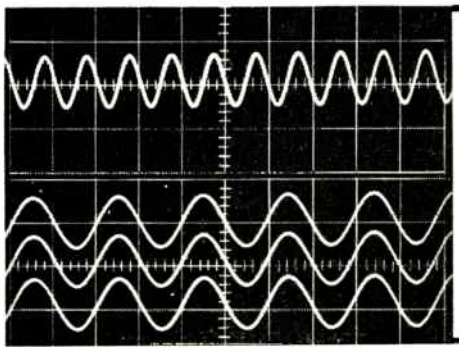
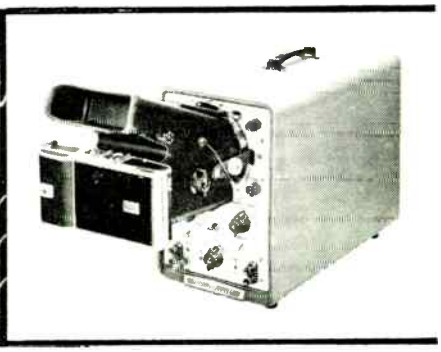


Two 4 x 10 cm field exposures. No overlapping



New -hp- 196A Camera on -hp- 120A Oscilloscope

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Check the specifications below, and ask your hp representative for demonstration on your oscilloscope.

Object/Image Ratio:	1 to 0.9. (Adjustable to 1:1 ratio)	**Film:**	Polaroid® Land types 42, 44, 46, 46-L.
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electronics

SEPTEMBER 18, 1959

A McGRAW-HILL PUBLICATION
Vol. 32 No. 38

Issue at a Glance

Business

Engineering

Departments

"We grew too fast for our bank"

When he was fourteen years old, Jim McClain earned pocket money by rewinding motors and transformers. Thirteen years later James Ernest McClain, with very little capital but lots of know-how and drive, started his own business, specializing in the repair of distribution transformers.

In its first year, ESCO Manufacturing Company, of Greenville, Texas, consisting of 27 years old McClain and a hired mechanic, grossed $35,000, netted $7,000. Last year, gross was several millions, and net profit, correspondingly substantial.

In the early years the local bank was able and willing to supply all the credit that Esco needed. But the growth was so rapid and the matching need for working capital so great, the local bank wasn't quite able to go along. So Mr. James Ernest McClain, then head of a company grossing better than a half million dollars, and not willing to dilute his equity or surrender any voice in management, turned to Textile Banking Company for financing cooperation and advice.

Mr. McClain says: "In addition to the advantages we enjoy in using TBC's funds as equity capital, and the savings we effect in eliminating credit losses and the cost of a credit department, there is perhaps an even greater advantage. Though we are far away from the industrial and financial centers, we have the privilege of being able to call on TBC's experienced executives for advice in solving many problems, financial and otherwise. Their experience, their contacts, their ability to supply us with nation-wide credit information usually give us the right solution."

At TBC, we don't work miracles. We help growing companies, whose sales exceed $500,000 annually, meet all the capital needs of rapid expansion, without surrendering any management control, or without any dilution of profits. If you want to know more about how we do it, write for a free copy of our new booklet, "How to get the *cash* to keep your business growing."

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electronics

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SHOPTALK . . . editorial

UNDERWATER EXPLORATION. Recent highly publicized preparations for sending man into space have overshadowed another new frontier: the four-fifths of the earth's surface that lies under oceans.

The advent of nuclear-propelled submarines that can remain submerged for months on end has made man more of a sea creature. The dim, unknown undersea world may provide farms to enhance the world's food supply, mines and oil fields to replenish mineral resources, trade routes free from storms, and possibly the battlefield of a future war.

Nearly every important maritime power is devoting major effort to oceanography these days. And electronic equipment is playing an important role. The Oceanographic Congress held at the United Nations in New York early this month brought scientists and their ships and equipment and ideas from all over the world.

Associate Editors Janis and Solomon teamed up to cover the event. They attended technical sessions, interviewed delegates in hotel rooms, climbed over oceanographic vessels berthed nearby. They talked to everyone in sight from Edgerton of M. I. T. and Hershey of Woods Hole Oceanographic Institution to Second Mate Belyushov of the USSR oceanographic vessel *Mikhail Lomonosov*.

For a story of ships that are really floating electronics laboratories see p 18. And watch forthcoming issues of ELECTRONICS for engineering details on the latest equipment developed especially for underwater exploration.

Coming In Our September 25 Issue . . .

THE EYES HAVE IT. An interesting branch of medical electronics is pupillography, in which the pupillary movements and reflexes caused by light changes, near vision and various psychosensory stimuli are recorded and analyzed. Such analysis can yield valuable insight into the condition of the lower brain and brain stem, which is ordinarily difficult to examine. Now George W. King, of General Precision Labs in Pleasantville, N. Y., has devised an electronic pupillograph with direct-writing features that eliminate complex, time-consuming operations necessary with some previous instruments of this type.

The device can plot pupillary diameters with an accuracy of 1 percent.

SIMULATING RADAR ECHOES. Authentic simulation of radar echoes from wooded terrain and metorological phenomena has been hampered by the difficulty of reproducing the particular statistical and spectral properties of reflections from this class of targets. J. Atkin of Columbia University's Electronics Research Labs and H. J. Bickel and M. Weiss of the Federal Scientific Corp. in New York describe a device that generates Rayleigh-distributed clutter which produces audio fluctuation rate of the video at constant range. Key components are an ultrasonic delay line memory and a 30-mc Gaussian noise source.

NEW SYNCHRO APPLICATIONS. Several unusual uses for synchros have evolved from the development of test equipment in the Army's missile program. These unusual ways to use synchros, described by D. J. Salonimer of the Missile Electronics Laboratory at Redstone Arsenal, include a difference-frequency generator and a direct-reading frequency deviation meter.

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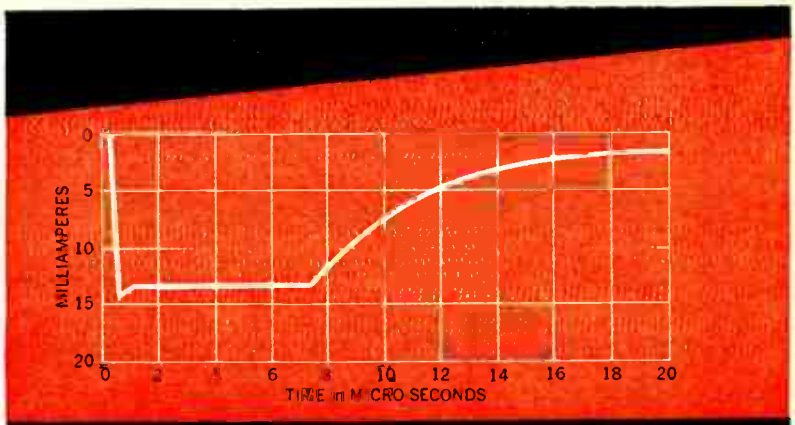
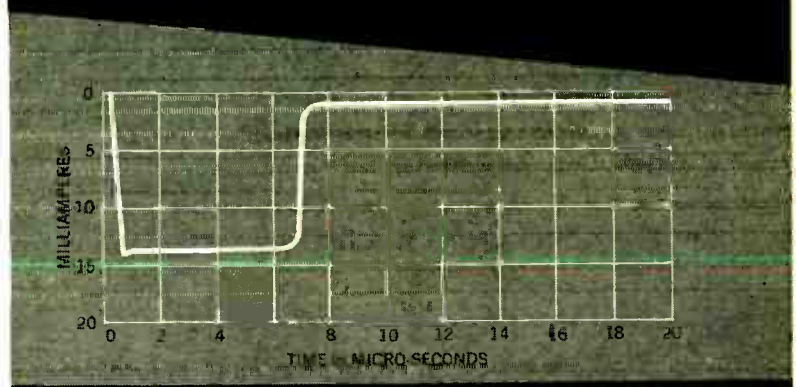
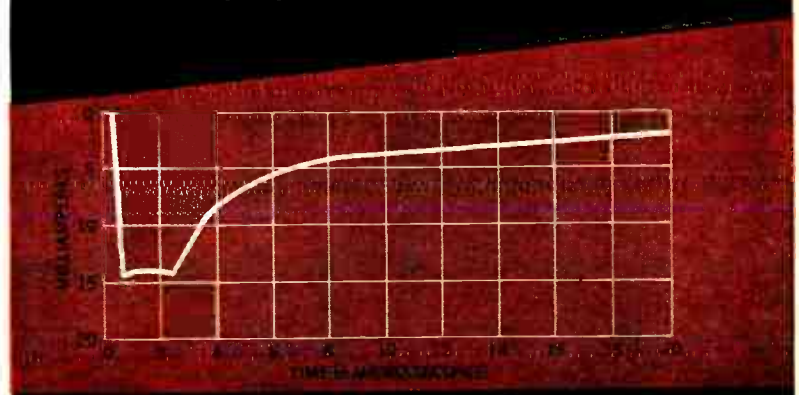


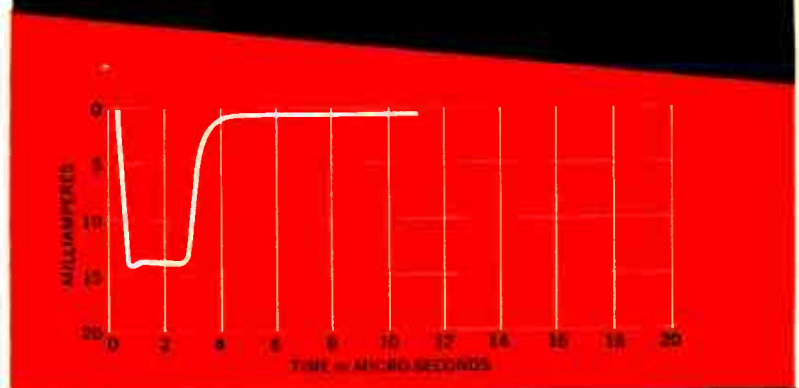
SOME silicon rectifiers give you slow start — slow rise



SOME silicon rectifiers give you slow start — fast rise



SOME silicon rectifiers give you fast start — slow rise



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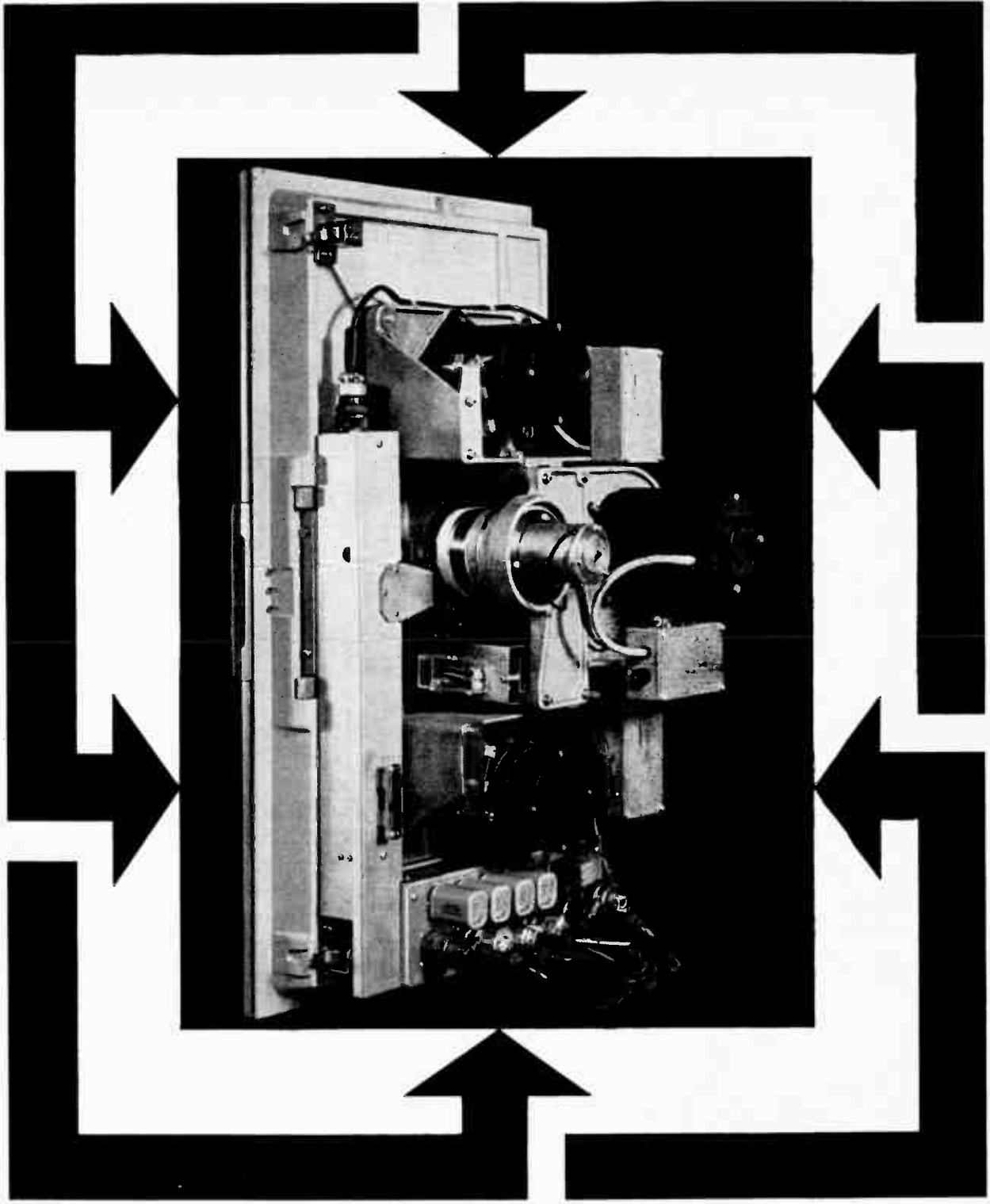


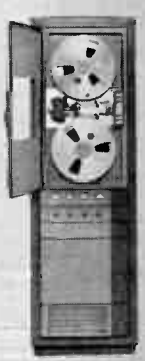
AMPEX PRECISION NOW 'LOCKED IN'

Lose the precise alignment of tape guiding and driving components in an instrumentation recorder and you lose the fine edge of designed-in performance. As alignment is lost, flutter and skew set in.

In the new Ampex FR-100B analog recorder, the possibility of misalignment—even under conditions of shock and vibration incidental to shipment or installation — is now eliminated by a framework of three precision castings with machined 'V' mating surfaces that lock all critical parts into a single rigid unit. The result: an instrumentation recorder with built-in performance and reliability that stays built in.

Other advanced features: 1. A unique electrical holdback system keeps tape tension constant within narrow limits, reducing flutter and eliminating mechanical feedback of speed variations. 2. Modular plug-in amplifiers and power supplies give quick versatility for direct, FM carrier, PDM, and NRZ digital recording. 3. Front-panel, four-speed switching over a six-speed range from 1⅞ to 60 ips allows flexibility in selecting upper frequency limit for maximum tape economy.

These and other features of the new Ampex FR-100B add up to unmatched performance and reliability. The full story is available in the new Ampex FR-100 brochure.



AMPEX INSTRUMENTATION,
934 Charter Street, Redwood City, Calif.

AMPEX
CORPORATION

Sola reduces prices on ±1% static-

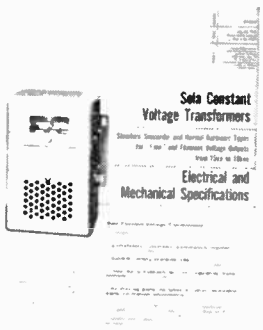
Sola Sinusoidal type Constant Voltage Transformers for universal application, now moderately priced

Housed unit with mounting plate typical of structures employed in 60va to 1kva ratings.

An important advance in the field of voltage regulation is the development of a new line of Sola Standard Constant Voltage Transformers with sinusoidal output. New design enables us to price them about the same as previous models not having sine-wave output. Now you can have the advantages of ±1% static-magnetic voltage regulation in new applications requiring harmonic-free input where previously the cost was a deterrent.

These new units provide output voltage regulation of ±1% for line voltage variations as great as ±15%. They regulate automatically and continuously. Fast response time averages 1.5 cycles or less. Output has less than 3% total rms harmonic content, and formulae based on sinusoidal wave shape may be used in designing related load circuitry.

Design and production innovations make these new units substantially smaller and lighter than previous models. They are relatively compact compared to other equipment for comparable ac voltage regulation. They are easy to select and order —the buyer merely selects the stock unit whose output capacity equals or exceeds the desired equipment input. Sola Standard Sinusoidal CV Transformers are available in nine stock output ratings from 60va to 7500va. Custom designs to meet specialized requirements are available in production quantities.



Write for full information . . .

With electrical control systems and components continuing to increase in number and complexity, and imposing more rigid reliability requirements, these new Sola Constant Voltage Transformers provide many advantages and virtually unlimited application. They are the result of over four years of development, design, and production engineering in the Sola laboratories and plant.

These developments mean superior voltage regulation, giving you a bonus in equipment reliability and performance at no increase in cost.

For full information, please write for technical literature on Sola Constant Voltage Transformers. We will mail it promptly, or if you wish, we will have a representative call on you.

magnetic voltage regulators

Sola Normal-Harmonic type Constant Voltage Transformers now specifically designed and priced for component use

End-bell unit with separate capacitor typical of structures engineered for component use.

Re-design of Sola "Normal-Harmonic" type static-magnetic voltage regulators has resulted in a significant reduction in their size and weight. Prices on many of these units have been reduced. Now it's possible for you to improve equipment performance by using them in many new fields at less cost than ever before. Re-design has in no way sacrificed the performance of these units—they provide all the outstanding benefits which have made them the standard of the industry for more than fifteen years.

Sola Normal-Harmonic type voltage regulators provide ±1% output voltage with line voltage variations as great as ±15%. This group has an average of 14% total rms harmonic content in its output voltages and is suited to equipment not extremely sensitive to voltage wave shape.

Sola Normal-Harmonic type voltage regulators are available in nineteen stock ratings from 15va to 10kva, including those mechanical designs specially engineered for use as built-in components. With many of the most popular ratings now reduced in price, these Sola Constant Voltage Transformers provide one of the most economical means of close voltage regulation in a broad range of applications.

SOLA

Sola Manufactures: Constant Voltage Transformers, Regulated DC Power Supplies, Constant Wattage Mercury Lamp Transformers and Fluorescent Lamp Ballasts

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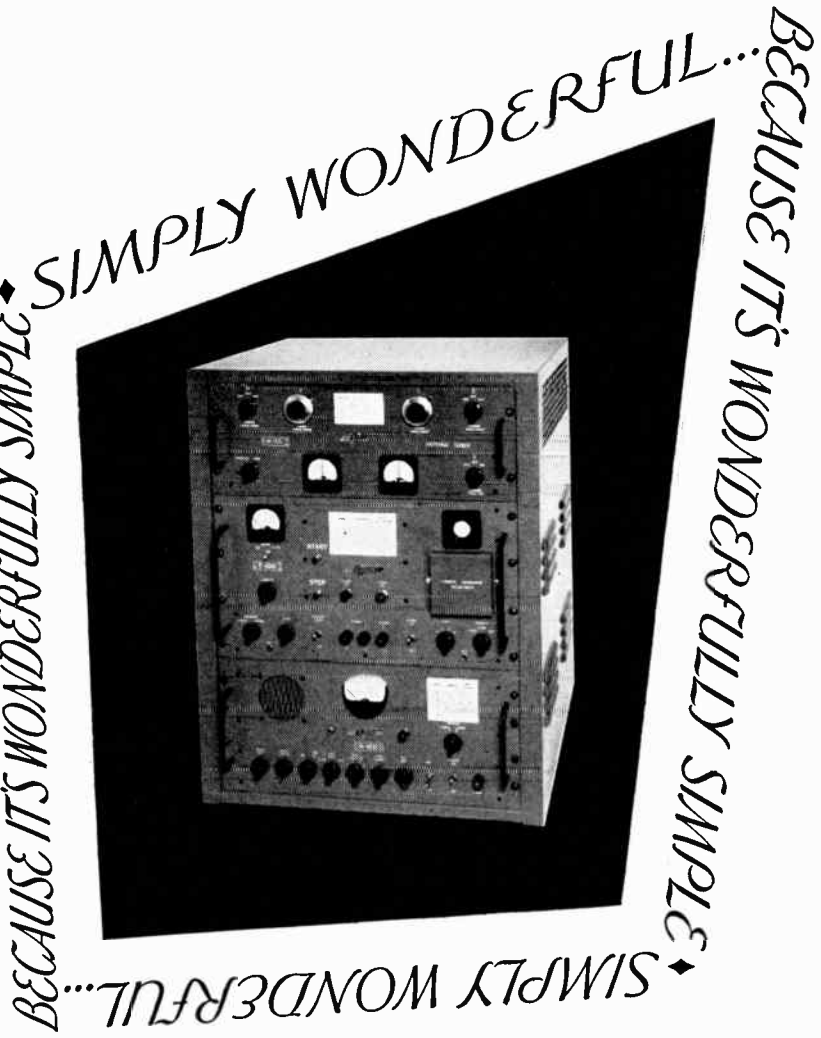

Because of its wonderful simplicity, more and more governmental and business organizations are converting to Single Sideband communications systems by Eldico. In addition to the recognized advantages of SSB—far greater range, increased intelligibility, and a smaller package—Eldico equipment is engineered for pre-eminence in every way.

A case in point is the Eldico S-100 system, whose 100 watts minimum peak envelope power is equivalent to approximately 400 watts in AM gear. Use is greatly simplified by Eldico's preset channel selector, which requires no tuning by the operator. Only three "set and forget" controls are needed for operation, and optional remote features permit functioning up to five miles away. Thanks to Eldico's antenna tuner, only one antenna is necessary.

Faster communication is enabled by this true duplex system, with independent receiver and transmitter. It's supremely versatile, too, as the S-100 can be used in *all* modes of operation: SSB, AM, CW, and—with auxiliary gear—teletype.

The compact unit, which includes a microphone bias supply, is designed for easy servicing. Best of all, the Eldico S-100 is compatible with your existing equipment. Conversion to this advanced apparatus may be as gradual or prompt as you wish!

ELDICO

Radio Engineering Laboratories • Inc

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ELECTRONICS NEWSLETTER

RADIO-ENERGIZED HEAT TESTING device reported by GE's Communication Products Dept. will concentrate a total of 10 million watts of r-f energy in a 100 sq ft area in simulating high-speed flight temperatures. Company says induction heating has advantages over infrared lamps, plasma jets, shock tubes and similar gear in space vehicle experiments; device can be controlled like an electronic oven but creates temperature changes rapidly, says GE. System, dubbed Project Heat, has been carried out under a multimillion dollar AF contract. Equipment will be installed at Wright Patterson AFB where it will furnish test data to aircraft, missile and spacecraft designers. Forty power loops will be associated with load matching networks, each capable of handling 250,000 watts of r-f power at 200 kc to 2 mc frequencies; gear may be extended to 5 mc.

Central inertial guidance laboratory that will test and evaluate components and complete systems is being planned by ARDC. Located at the AF Missile Development Center, Alamogordo, N. M., the lab is expected to be operational by 1963 and will be the first site for testing advanced inertial guidance systems.

BANK CHECK PROCESSING by means of a new solid state automatic data processing system is now offered by Burroughs, which just unveiled its B251 Visible Record Computer. The system, which uses magnetic ink character recognition, reads information from checks or other papers of various size. Machine processes the data, then automatically computes, selects and posts directly to the customer's account. Firm says $217,400 list price or monthly rental of $3,975 will extend data processing use to banks of all sizes, adds that the system can also be used for many bank accounting operations and in compiling statistical reports. Burroughs says only one person is needed to operate the system, which is capable of performing 4,000 arithmetical functions a minute.

B-70 INTERCONTINENTAL JET BOMBER will get its mission and traffic control system from Motorola's Military Electronics division under a multimillion dollar contract from North American Aviation's Los Angeles division. Amount was not disclosed. The system includes several types of communications gear, electronic identification units, navigational equipment and electronic landing aids.

Minuteman reentry vehicle prototype development is being pushed by the Air Force with the award of a $36,655,000 contract to Avco Corp.'s Research and Advanced Development division.

POLARIS INERTIAL NAVIGATION system for precisely fixing the missile's underwater launching position has completed laboratory tests and is now undergoing at-sea tests aboard the *USS Compass Island*. System is North American Aviation Autonetics division's N7A autonavigator, which incorporates a 1½ cu ft digital computer.

Titan's all-inertial guidance system will use a light-weight digital computer to be developed by IBM's Federal Systems division for AC Sparkplug. Basic platform design will be based on the Skipper inertial guidance system originally developed by MIT's Instrumentation Lab.

UNDERWATER LIGHTNING device that can store up electrical energy and release it within 40-millionths of a second with a force equal to 6,000 hp is reported by Republic Aviation. The energy is being used experimentally for certain metal-forming operations, a principle previously reported (ELECTRONICS, p 24, Oct. 17, '58). Republic sees explosive forming as a potential solution to high-strength metal problems of advanced aircraft and space vehicles, says equipment is simple and inexpensive. Gear consists of a battery of capacitors, with wires from plus and minus terminals attached to two electrodes immersed in water. Switch releases spark which travels through water so fast it creates the shock wave. Firm believes Soviet scientists are experimenting along similar lines.

SOLID STATE CONTROL SYSTEM for a steam generating unit of Union Electric Co., St. Louis, will be supplied by Hagan Chemicals & Controls, Pittsburgh. Contract covers controls for automatic combustion, fuel, air flow, furnace draft, pulverizer mill suction and pulverizer temperature. Controls use Hagan's d-c magnetic amplifier; 2¼ x 5¼-in. units are mounted on a control console with transmitters and power drives located at the generator. One rack contains all other components. System uses 110-volt, 60-cycle power supply.

Experimental plasma engine at Republic Aviation has generated 8,000 lbs thrust for one microsecond. Firm says it's expanding research in plasma engines under contracts from Office of Naval Research and USAF's Office of Scientific Research. Work is starting on a magnetic pinch plasma engine; propulsion needs for satellite control and interplanetary missions are involved.

FUSION POWER research grants of $500,000 to MIT and $300,000 to Harvard University have been awarded by the National Science Foundation. Independent basic research at each institution involving more than 100 scientists aims at possibility of using ionized gases for spacecraft power.

INERTIAL BOMBING-NAVIGATION SYSTEMS and ground support gear for SAC's first wing of 36 B-58 supersonic bombers will be supplied by Sperry Gyroscope under a $142-million contract just announced. Tactical support gear accounts for some $38 million of the contract. Automatic navigation system uses doppler-inertial and stellar information, permits the Convair Mach 2 plane to fly inertial for hours. Sperry will also provide bombing-navigation systems for SAC's second B-58 wing for which the Air Force recently authorized long-lead time items.

WASHINGTON OUTLOOK

WASHINGTON—MANUFACTURERS MAY NOW RESERVE 20 to 30 percent of their power and transmitting electron tubes for commercial sales under a new Commerce Department order.

Power and transmitting tubes were added to the list of other electronic parts placed on a commercial reserve basis effective Sept. 4. Products already covered included transistors, crystal diodes, and other types of electron tubes.

Previously, all production was subject to rated (defense) orders. Companies could not promise commercial deliveries because they never knew when a defense order might preempt a whole month's production. H. B. McCoy, Business and Defense Services administrator, says an increase in supply permits easing up on restrictions.

In general there is an adequate supply for both commercial and defense orders. But defense purchasers have sometimes placed large orders all at once instead of spreading them out. New rules discourage this.

Another practice that had sprung up under the rated orders system was purchase of one company's entire output by defense buyers, perhaps because the product was uniquely superior for defense purposes. This kept the company completely out of the commercial market.

Military needs are still protected by a monthly review of the market situation. If overriding military needs are shown, the BDSA can temporarily set aside commercial sales rights.

- **Washington officials concerned** with international trade anticipate a sharper, harder-hitting drive from Japanese makers of radios and other goods to tap U. S. market.

  Reason: A change in U. S. consumer attitude towards Japanese goods. This was revealed by a detailed analysis of the attitudes of the U. S. consumer on the quality of Japanese merchandise. The consumer was asked how he feels about Japanese precision goods as compared, say, with imports from Germany and England. He also was asked to compare Japanese products with U. S. items.

  Buyers have conflicting attitudes about Japanese products. They may associate Japanese goods with poor quality in certain contexts. But 60 percent of those asked believe: "If you know how to judge a product, you can often find Japanese products which are much less expensive and just as good as American-made products."

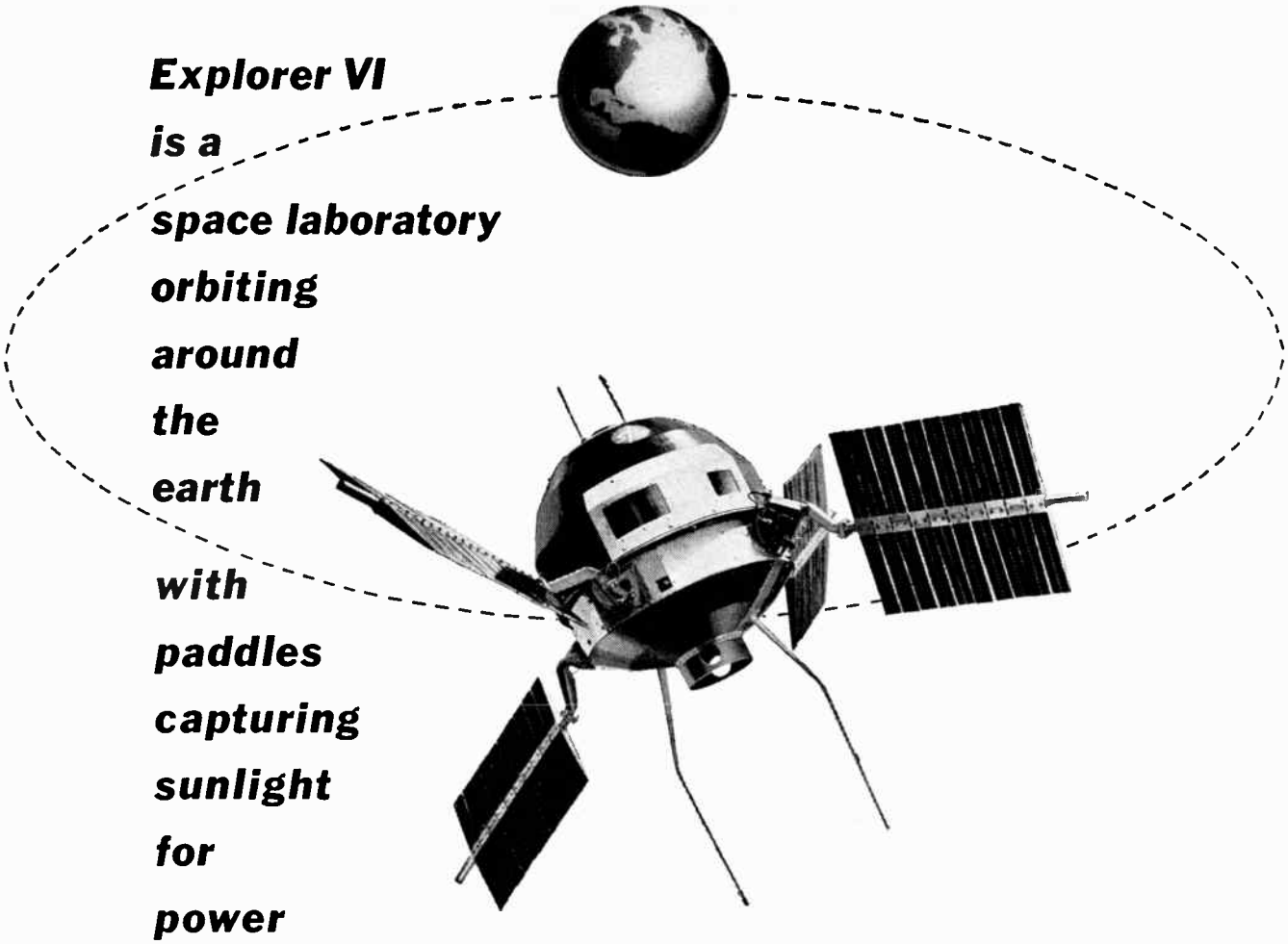
  The report, done for the U. S.-Japan Trade Council, finds that 78 percent of the people questioned in "depth interviews" believe that Japanese quality is below that of U. S. products—yet one-third believe they are seeing an improvement in Japanese quality to perhaps a level close to U. S. quality.

  Buyers still don't associate Japan with radios. When asked "Can you recall any products you have seen or bought recently which you recognized as having been made in Japan?", only 9 percent answered "transistor radios"—despite the fact that radios are among Japan's most important exports to the U. S.

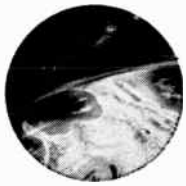
- **National Science Foundation** has been dragging its feet on development of a scientific manpower register and clearing-house, says the House Space Committee. The committee points out in a report that less than one percent of NSF's budget has been devoted to manpower problems, although the agency's 1950 charter specifically spells out the duty to develop a register.

  The foundation has, in fact, compiled the beginnings of a register to be used in national emergencies. It has collected data on IBM cards in its center at Raleigh, N. C., for some 175,000 scientists—about half the scientists considered eligible for listing.

Explorer VI is a space laboratory orbiting around the earth with paddles capturing sunlight for power



The scientific data that will some day enable us to probe successfully to the very fringes of the universe is being recorded and transmitted at this moment by the space laboratory Explorer VI, a satellite now in orbit around the earth ● This project, carried out by Space Technology Laboratories for the National Aeronautics and Space Administration under the direction of the Air Force Ballistic Missile Division, will advance man's knowledge of: *The earth and the solar system . . . The magnetic field strengths in space . . . The cosmic ray intensities away from earth . . . and, The micrometeorite density encountered in inter-planetary travel* ● Explorer VI is the most sensitive and unique achievement ever launched into space. The 29″ payload, STL designed and instrumented by STL in cooperation with the universities, will remain "vocal" for its anticipated one year life.



How? Because Explorer VI's 132 pounds of electronic components are powered by storage batteries kept charged by the impingement of solar radiation on 8,000 cells in the four sails or paddles equivalent to 12.2 square feet in area ● Many more of the scientific and technological miracles of Explorer VI will be reported to the world as it continues its epic flight. The STL technical staff brings to this space research the same talents which have provided systems engineering and over-all direction since 1954 to the Air Force Missile Programs including Atlas, Thor, Titan, Minuteman, and the Pioneer I space probe.

Important staff positions in connection with these activities are now available for scientists and engineers with outstanding capabilities in propulsion, electronics, thermodynamics, aerodynamics, structures, astrophysics, computer technology, and other related fields and disciplines.

Inquiries and resumes are invited.

Space Technology Laboratories, Inc.

P. O. Box 95004
Los Angeles 45, California

IMMEDIATE DELIVERY
NEW LOW PRICES!

NORTH ELECTRIC IR-226 RELAY
SENSITIVE
COMPACT
RELIABLE

hermetically sealed, shock and vibration resistant, meets MIL-R-5757C

In use in many airborne applications, specified as a component for power amplification in plate circuits, this sensitive, compact, reliable North Electric miniature relay has proven itself in countless millions of operations. The IR-226 answers your requirements for a hermetically sealed, vibration and shock resistant relay that fully lives up to our 75 year old reputation for advanced engineering and precision production.

The rotary armature principle incorporated in this relay, long recognized as THE approach which affords maximum security against malfunction due to shock and vibration, was FIRST successfully engineered into this type of component by North Electric.

IR-226 SPECIFICATIONS

GENERAL

Ambient Temperature Range	−65° C to +125° C
Weight	3 ounces maximum
Height	1¾" above mounting surface
Width	1" square
Enclosure	Hermetically sealed

CONTACTS

Arrangement	Double Pole Double Throw (DPDT)*
Rating	2 amps—30 volts D.C. resistive
SHOCK TEST	50 Gs
VIBRATION TEST	10- 500 cps—at 10 Gs

SPECIAL RELAYS

*Various coil resistances and contact arrangements available. Design may be specified to meet various Military Specifications. Contact material available for low-level switching requirements. Write for detailed specifications.

NORTH ELECTRIC COMPANY
4910 SOUTH MARKET STREET • GALION, OHIO
Available in Canada through Ericsson Telephone Sales of Canada, Ltd., Montreal 8, P. Q.

New Finance Move Slated

TAKING PART in a quarter-million dollar financing program for **Narda Ultrasonics Corp.**, Westbury, N. Y., **Midwest Technical Development Corp.**, Minneapolis, announces it will provide $100,000 of the amount for 6-percent subordinated notes due in 1964.

The notes will carry five-year warrants to purchase 16,600 shares of Narda common stock at $8 a share. Private sources will provide the remainder of the $250,000.

Narda is the sixth investment for MTD, which was founded last October to specialize in investments in technically-oriented companies.

• **Ampex Corp.**, Redwood City, Calif., stockholders have given final approval to merger plans with **Orr Industries, Inc.**, magnetic tape manufacturer. Also approved is an amendment to the Ampex stock option plan authorizing an additional 50,000 shares for which options may be granted, making a total of 137,000 shares available under the plan, or 6.2 percent of the total shares outstanding.

• **Ling-Altec Electronics, Inc.**, Culver City, Calif., announces that all of its outstanding 5¾-percent convertible debentures due Dec. 1, 1970, have been called, as well as all of its $1 par value 6-percent cumulative convertible preferred stock as of the close of business on the 30th of this month. The debentures are redeemable at 100 percent plus accrued interest, and the cumulative preferred stocks are redeemable at 105 percent of par plus accrued interest.

• **Victoreen Instrument**, Cleveland, and **Tenney Engineering**, Union City, N. J., have called off merger plans which were announced last month. No date for new plans has been set. A joint statement by the two companies attributes the deferment to "increasing volume of business in both companies, and the work involved in other expansion moves."

• **General Instrument Corp.**, Newark, N. J., announces formation of a **Thermoelectric Division**, which will occupy itself exclusively with thermoelectric devices. GIC expects the market for such equipment to reach $100 million within five years, and hopes to capture a share of it through the new facility, which will operate as an autonomous division.

• **American Electronics Labs.**, Philadelphia, manufacturer of electronic and medical equipment, reports record net earnings of $32,940 on sales of $1,164,000 for the first eight months of this year. Last year's earnings for the same period were $10,240 on total sales of $728,000.

25 MOST ACTIVE STOCKS

WEEK ENDING SEPTEMBER 4

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Sperry Rand	907	23⅜	22	22⅞
RCA	840	63⅞	58	59⅛
Avco Corp	723	14¼	13½	13⅞
Intl Tel & Tel	645	34¼	32½	32¾
Gen Electric	570	82⅛	77½	79¼
Burroughs	552	31½	30	31¼
Gen Tel & Elec	505	73⅛	71	71¾
Elec & Mus Ind	400	7⅜	7	7⅛
Univ Control	394	18½	16⅞	16⅞
Westinghouse	326	93⅞	89¼	90½
Gen Dynamics	321	50⅛	48	48½
El-Tronics	270	1⅝	1⅜	1½
Raytheon	266	48⅝	45½	45⅞
Texas Inst	244	145	132½	137¾
Reeves Soundcrft	236	8¾	7¾	7¾
Litton Ind	234	116⅞	107¾	116⅞
Standard Coil	228	16	14⅜	15¾
Gen Instr	225	26	22⅝	27⅞
Philco	209	26¼	24⅞	24⅞
Emerson	193	15⅜	14⅜	14¾
Zenith	187	108¾	101	104½
Amer Bosch Arm	173	29⅝	27¾	28
Victoreen	154	15¼	14¼	14⅜
Intl Bus Mach	152	425½	409¼	411½
Gen Transistor	140	37½	35⅛	35¼

The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co.

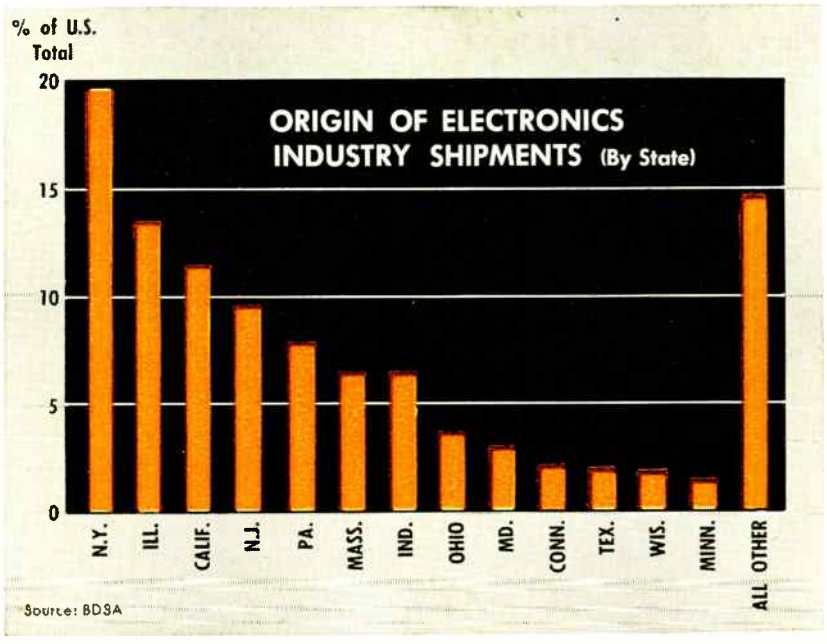
NEW PUBLIC ISSUES

	No. of Shares	Issue Price
Radio Frequency Co.	100,000	3
Technical Material Corp.	80,000	*
U.S. Transistor	180,000	2
Space Components Inc.	200,000	1

*to be announced

STOCK PRICE AVERAGES

(Standard & Poor's)	Sept. 2 1959	Aug. 5 1959	Change From One Year Ago
Electronic mfrs.	87.54	87.95	+67.39
Radio & tv mfrs.	107.26	111.15	+96.37
Broadcasters	96.21	99.29	+41.78



State Sales Guide Issued

WHAT ARE THE SALES of electronic products by states?

This is one of the questions most frequently asked by electronics industry marketers who use this information in setting sales quotas, evaluating sales force performance and other sales-estimating work.

Consequently, the above chart which shows estimates of the percentages of total industry shipments originating from individual states, is a valuable industry-marketing tool.

Data comes from Business and Defense Services Administration, which has also prepared similar origin-of-shipments estimates for electronic equipment, tubes, semiconductors and other components. Information is contained in BDSA's Midyear Review and Outlook for 1959 of the Electronic Industries.

The midyear review estimates electronics industry sales, excluding research and development expenditures, will reach $8.5 billion this year, a 20-percent gain over 1958.

The agency's 1959 sales estimates for industry product groups are: consumer $1.7 billion, other equipment $4.0 billion, tubes $0.9 billion, semiconductors $0.3 billion, other components $1.6 billion. Comparative 1958 estimates are: consumer $1.35 billion, other equipment $43.25 billion, tubes $0.79 billion, semiconductors $0.21 billion, and other components $1.34 billion.

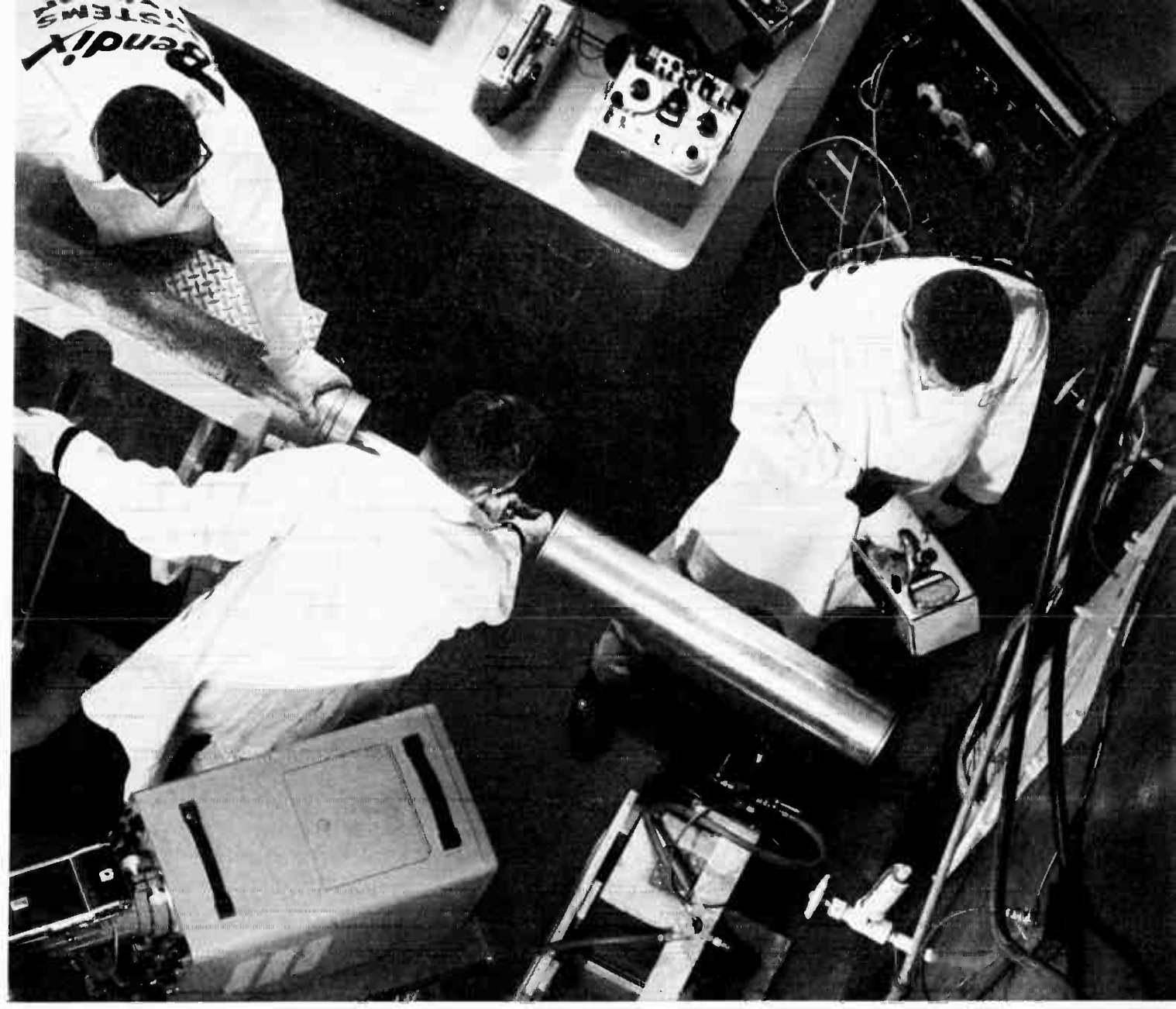
• **Major manufacturers** of missile guidance and control equipment produced $602.2 million worth of equipment in fiscal 1959, a 35-percent increase over fiscal 1958. Electronic missile ground support production in the 1959 period was worth $553.1 million, as against $594.1 million in 1958. Data was compiled by DOD for the Dept. of Labor for minimum wage determination.

Value of electronic aircraft equipment excluding missiles produced by major manufacturers was $612 million in 1959, including $146.2 million of special-purpose equipment. In 1958 production was valued at $449.5 million, of which $67 million was for special purposes.

FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	Aug. 28 1959	July 31 1959	Change From One Year Ago
Television sets	142,162	91,507	+5.37%
Radio sets, total	287,977	191,695	−1.97%
Auto sets	87,951	47,436	+27.60%



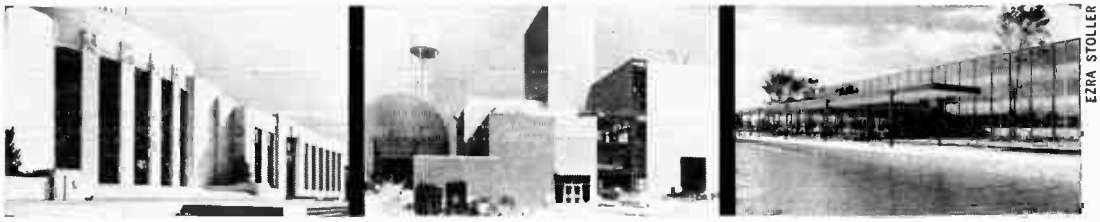
Bendix engineers use the University's Ford Nuclear Reactor to test radiation resistance of airborne communications equipment.

IN SOUTHEASTERN MICHIGAN:

A SCIENTIFIC CLIMATE FOR THE ELECTRONICS INDUSTRY

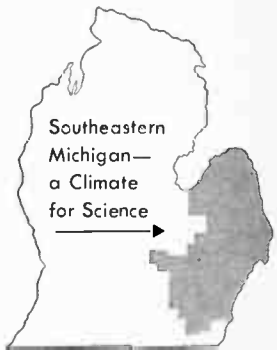
The Bendix Systems Division in Ann Arbor is typical of the firms in this area which use the extensive facilities of The University of Michigan to further research and development projects. This is but one example of how one of several nationally known schools in the area helps to create the scientific climate so vital to the electronics industry.

A climate which stimulates and aids the search for knowledge, important as it is, is not all you'll find in Southeastern Michigan. A great place in which to live and work, the area also has many communities which have planned conscientiously and carefully for their prosperous growth—and yours. These communities are confident when they extend an invitation to industry-on-the-move because area planning has been done under the guidance of skilled professionals. We would welcome the opportunity to discuss this subject with you further.



EZRA STOLLER

Southeastern Michigan's scientific climate is illustrated by (*left*) headquarters for the Engineering Society of Detroit and for the forty-nine engineering groups which are affiliated with it, (*center*) The Enrico Fermi Atomic Power Plant near Monroe, (*right*) Research Building at the General Motors Technical Center at Warren, Michigan.



Write to Plant Location Service, Area Development Division

DETROIT EDISON

Soviet oceanographic ship *Mikhail Lomonosov* in New York this month during International Oceanographic Congress at UN

Oceanography: Defense Must

Warm water pockets and magnetic fields conceal submarines from conventional sonar and magnetic detection gear

OCEANOGRAPHIC research and survey ships of many nations today ply the seas at will marking out a no-man's land of scientific adventure. This great unknown—sometimes referred to as "inner space"—might also be the most critical battleground in the event of global war. Knowledge means survival.

New electronic instruments and techniques called for by the Navy and civilian researchers will be the key to our future knowledge of marine science. A huge R&D effort building up in the Defense Department is enlisting the support of newly organized underwater research groups in industry. Here's why:

There are natural conditions of the oceans that hide the lurking submarine and foil the sub hunter. Two major ones are warm water masses or flowing "bubbles" inside larger cold water masses and magnetic irregularities beneath the ocean floor.

Conventional sonar is ineffective in the warm water pockets. Magnetic underwater detection devices don't work in areas where the magnetic anomalies exist.

The ideal rendezvous for an attacking submarine fleet would be a part of the ocean where both warm water flow and subsurface magnetic irregularities are present. Such a situation exists in a sizeable area of the Atlantic and in other places.

Hence, the very oceans that protected the United States through most of its history now furnish a would-be aggressor with a safe avenue of attack for his missile-carrying submarines.

Serious Problems

Undoubtedly of grave concern to U. S. submarine defense planners, for example, are oceanographic facts of life such as these: (1) The warm waters of the Gulf Stream flow right through the Atlantic missile range; (2) a huge, highly-magnetic subsurface area exists along the 25th parallel, the Tropic of Cancer, which also runs through the Atlantic missile range; and (3) magnetic irregularities and warm water flow exist in parts of the Pacific and near the Panama Canal.

These conclusions about submarine defense are inferred from technical reports on peaceful exploration of the oceans presented at the International Oceanographic Congress held recently under UN auspices, and from chats with oceanographic experts.

The U. S. has not had a full-scale oceanographic program or even one ship designed originally for oceanographic research. U. S. oceanographic work is being done largely by about 45 small research and survey ships converted from other uses. These have been considered uneconomical by experts.

Defense Department director of research and engineering Herbert York recently cited oceanography as one of two priority areas of basic research, said the program has been expanded this year. In 1958 some $23 million was spent in applied and basic oceanographic research.

Despite the small effort up to now, excellent work has been done and new discoveries made—for example, the existence of four great subsurface currents 1,000 times greater in flow than the Mississippi.

During the UN Conference several small U. S. research ships, the French *Calypso* and the Soviet *Mikhail Lomonosov* were open to accredited visitors at a Hudson River pier. Most sophisticated of the American research ships, from the electronics point of view, was

the *USNS Chain*, a converted Navy salvage vessel, now operated for Woods Hole Oceanographic Institution.

Chain's equipment included echo-sounding gear for profiling the ocean bottom, a new stereo camera that can be accurately positioned by a sound pinger, a winch containing about 600 ft of chain with about 25 evenly spaced thermistors, broadband receiving transducers including Rochelle salt and barium titanate hydrophones, recording and tape gear, a new deep-sea telemetering hydrophone, a sound velocimeter and seismic profiling gear.

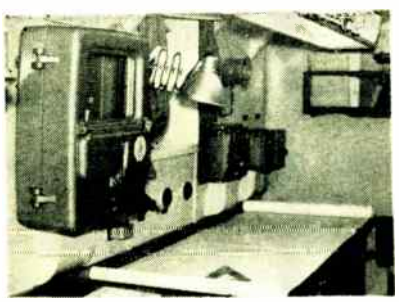
Soviet Ship Visited

The *Mikhail Lomonosov*, according to its third mate, carries seven scientists and has been sailing the Atlantic. The ship itself is much larger than any U. S. research vessel, was built in East Germany specifically for oceanography and contains accommodations that are plush by the standards of its U. S. counterparts. Its official mission: to take soundings for compilation and correction of maps, for profiling sea floor relief and for geomorphological analysis.

Electronic equipment shown to visitors that does this job on the Soviet ship was of "Model T" vintage in the opinion of some American observers. This equipment was of both West and East German manufacture. Shown were three deep sea echo sounders with accuracy of 1-2 percent. One of these had an additional horizontal oscillator for searching out fish shoals.

The Soviets have a number of other specially designed oceanographic vessels, the converted submarine *Severyanka* (ELECTRONICS,

(Continued on p 21)



German echo sounder (foreground) is one of three aboard Soviet oceanographic ship *Mikhail Lomonosov*, which recently visited New York. Chart on table is a profile of the Atlantic bottom

buys a packaged plan for the future

. . . with the help of the Ætna Life's Business Planning Department

The King Electronics Company is a close corporation manufacturing television components. The stock of the company is held by President Herbert F. King and members of his family. They operate the business.

Recently a member of the local Ætna Life Business Planning Department explained how death of a principal stockholder can create major problems. His heirs may be forced to unload a substantial block of stock to pay death taxes, thus watering down their control of the corporation. With the help of their Ætna Life representative, attorney and accountant, a plan was developed to avoid this danger by taking advantage of certain favorable tax legislation designed for just such a situation.

If you own or operate any kind of business, it will pay you to investigate the vital need for a business continuation plan — and no one is better equipped to serve your interests than the Business Planning Department of your local Ætna Life General Agency.

ÆTNA LIFE
INSURANCE COMPANY

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Oceanography . . .

(Continued from p 19)

p 31, Mar. 20), and probably more than 30 research and survey ships converted from fishing trawlers.

Last year the Navy formed the Oceanic Research Division at the Navy Ordnance Test Station, China Lake and Pasadena, Calif. This group and three other West Coast Navy labs are studying the factors that affect sound propagation in the sea, light scattering and polarization, infrared radiation phenomena, hydrodynamics of sea animal locomotion, movement of water masses and problems of exploring the deepest portions of the oceans.

The program needs both manpower and new instruments for research. Most of the present instruments available to oceanographers are relatively bulky, inaccurate and inefficient for collecting data.

The Navy gives this recently-developed instrument as an example of the type of gear it needs: a transistorized instrument for recording temperature, pressure and sound-velocity, which permits continuous measurement accuracies between 0.001 and 0.0001.

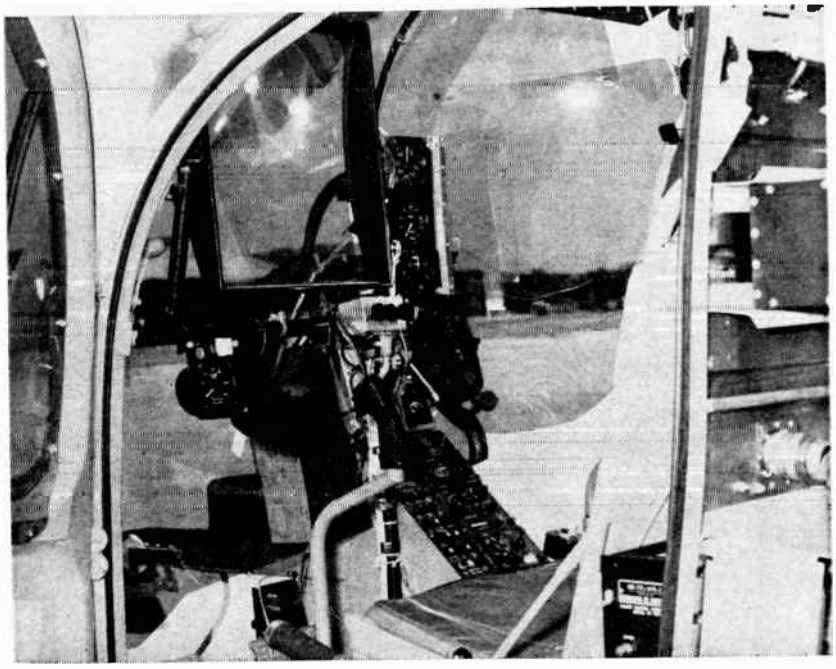
In the area of data processing, new techniques are needed. Paper chart records now used yield immediate data but must be hand-processed. Space limitations suggest use of magnetic tape but conventional analog methods of magnetic recording are impractical, says the Navy.

Research Submarine

This month the UN oceanographic congress heard two men from the China Lake, Calif., Naval Ordnance Testing Station outline a design for a three-man deep-sea research submarine of 83 tons.

The vessel, designed for exploration at all depths, will undertake photographic exploration, sounding and mapping of the bottom, oceanographic measurements relating to sound waves, temperature and content of water, and ocean currents, light propagation, scattering and polarization.

Overall U.S. oceanographic research efforts are being fostered by the Committee on Oceanography formed in 1957 by the National Academy of Sciences-National Research Council.



Trichroic mirror (upper left) is part of Bell Helicopter's contact analog display which shows pilot flight information during 'blind' flying

Pilots Get New Display Gear

Army-Navy Instrumentation symposium reveals marked progress in flight-data presentation

DALLAS, TEX.—Exhibits and technical papers at the recent Army-Navy Instrumentation Program (ANIP) symposium here revealed real progress in providing simple, integrated flight data presentation for today's and tomorrow's pilots.

Particular headway is being made in contact analog and cathode ray tube type presentations for blind-flying helicopters; development of short-range, high-resolution obstacle avoidance radar; an acoustical and electromagnetic air-speed indicator; new techniques for design and manufacture of microcircuits; development of thermoelectric materials; and micromagnetic properties of thin films.

Three Major Areas

Basic objective of the program, which began six-and-a-half years ago, is to provide instrumentation, display and control capabilities for aircraft, submarines and surface ships.

The program is broken down into three major areas of interest: Air, supervised by Army Signal Corps and Navy's Office of Naval Research; SUBIC, Submarine Integrated Control, supervised jointly by ONR and BuShips; and SURIC, Surface Integrated Control, by ONR and BuShips.

The aircraft group, which has been operating longest, is the most advanced. Coordinator for helicopter/VTOL (Vertical Take-Off and Landing) work is Bell Helicopter, which currently has 10 major contractors.

Douglas, coordinator for fixed-wing craft (ELECTRONICS, p 17, Nov. 20, '57), today has contracts with 14 firms.

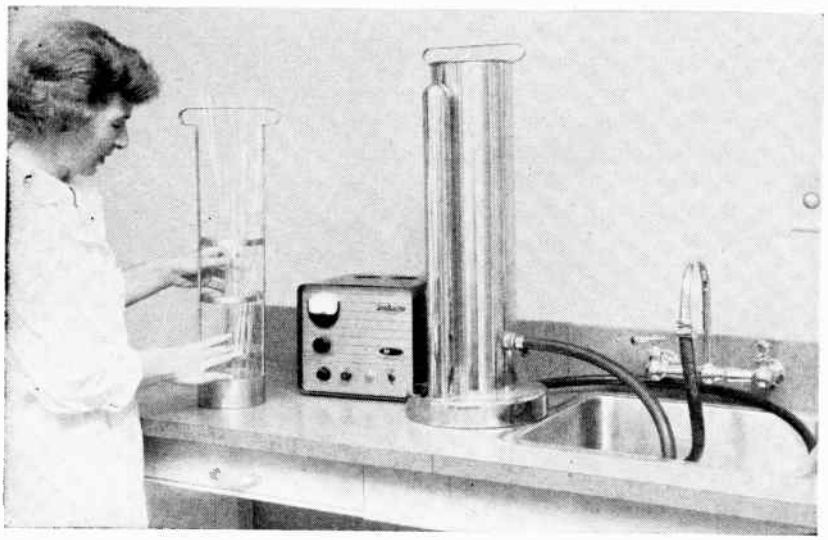
According to Douglas, hundreds of millions of dollars worth of useful by-products have resulted from techniques learned from work thus far.

Coordinator for SUBIC, Electric Boat Co., has still not awarded contracts for computers, display generator, mechanism amplification, display media and controls.

Sperry Rand, coordinator for SURIC, has no contracts let to date.

Hospitals: A New

Convention points small but growing trend toward medical acceptance of newer technologies



Now undergoing field tests is Narda Ultrasonics Corp.'s pipette washer

DOCTORS, head nurses and hospital administrators attending the American Hospital Association convention at New York's Coliseum late last month had an opportunity to see some new ways in which electronics is serving humanity.

Electronics exhibits at the AHA show were a small but significant fraction of the total. They point an important trend in the medical profession: a willingness to explore the newer technologies and take advantage of methods originally devised to serve other sciences and industry.

Item: a high-speed automatic blood-cell counter developed by Coulter Electronics, Chicago. This device, first discussed at the National Electronics Conference in 1956, is now being accepted by doctors and hospitals. Also: such devices as the Laryngostrobe, which permits doctors to inspect vocal cords in motion and analyze dynamic faults.

New Techniques

Doctors—and hospital administrators as well—have traditionally been wary of electronics, nucleonics and other advanced technologies. But increasingly, electronics is leading the way in new techniques of diagnosis, hospital safety, administration and even therapy.

For example, to get white-cell counts, lab technicians used to count diluted blood samples through a microscope; at best, one technician could count 20 or 30 samples a day, with a high sampling error (about 20 percent) and a fairly high human error.

The Coulter counter does this job automatically, making use of the fact that some diluents are conductive and white cells are not. An electrical current is passed through a hole, 0.1 mm in diameter, in the side of a test tube. The current passes between two electrodes, one inside and the other outside the tube, by way of the cell suspension. An external vacuum initiates flow of the sample through the aperture; as white cells pass through, they momentarily raise the resistance of the circuit, causing a voltage pulse of amplitude proportional to cell size. Pulses above a set threshold are counted in a digital counter.

When two cells pass through simultaneously, they count as one. Resulting error from the instrument's method is about 2 percent, and can be discounted through application of Poisson distribution data.

Market

Wallace Coulter, who developed the device, indicates that it can also be used for counting red cells and for counting and sizing bacteria. But so far the medical profession seems inclined to use it primarily for white-cell counts to replace the optical hemocytometer.

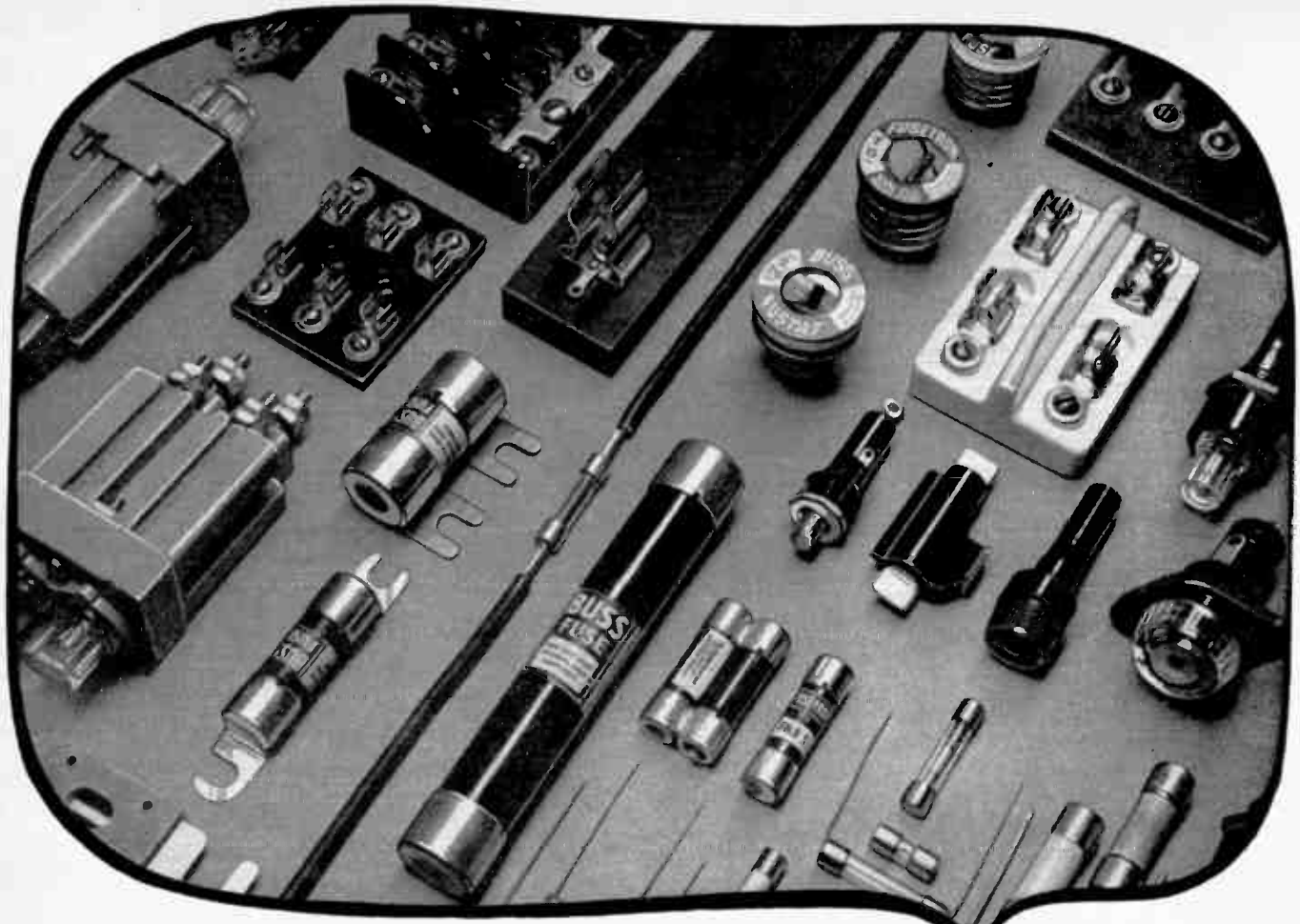
Administration and Safety

Hospital safety and administration are areas in which electronics has established major beachheads. There's no more "calling Dr. Kildare" in today's hospital, for instance; electronic signaling systems and paging devices do the job without disturbing patients.

Infrared detectors and chemical chambers detect smoke and fire to work fire alarms. And radiological detectors are found increasingly frequently in hospitals. Curtiss-Wright's "Gamma Sentry," for example, not only warns of gamma radiation but also dangerous levels of X-radiation.

Ultrasonic cleaners have been accepted for hospital use, and now radiological sterilizing is being suggested to substitute for the steam autoclave. In a plan proposed by Curtiss-Wright, sealed cartons of materials and instruments to be sterilized would be mounted in a conveyor belt, pass by and around a central radiator of cobalt-60 for cold sterilization by gamma rays. C-W figures the method should reduce labor costs, permit sterilization of heat-sensitive materials (plastics, bone grafts, cartilage), counteract the dangerous and rising incidence of penicillin-resistant staphylococcus infections in hospitals by permitting complete sterilization of mattresses and bedding.

Hospital business offices, of course, are using more electronic recordkeeping systems. Television shows up frequently in patients' rooms, and closed-circuit tv is gaining acceptance to help nurses keep watch on corridors or critical patients. And metering instruments are in constant evidence on the pneumatic and hydraulic devices, the pressure chambers, pumps, manometers and so forth.



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every BUSS Fuse is electronically tested!

Before a BUSS or FUSETRON fuse ever leaves the plant, it must meet our high quality control standards.

Each fuse is tested in a sensitive electronic device that automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

Thus . . . by specifying BUSS and FUSETRON fuses you have one more way to help safeguard the reputation of your equipment for service and reliability.

Complete Line For All Your Fuse Needs

Single-element fuses for circuits where quick-blowing is needed.

Single-element fuses for normal circuit protection.

Dual-element, slow-blowing fuses for circuits where harmless current surges occur.

Indicating fuses where signals must be given when fuses open.

BUSS fuses range in size from 1/500 amperes up — and there's a companion BUSS line of fuse clips, blocks and holders.

If You Have A Special Protection Problem

The BUSS fuse research laboratory, world's largest, plus experience gained by solving all types of electrical protection problems for over 44 years — is on call to you at all times. BUSS fuse experts will work with your engineers to help you find the best, yet most economical solution.

For more information, write for BUSS bulletin SFB.

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BUSS fuses are made to protect - not to blow, needlessly.

BUSS makes a complete line of fuses for home, farm, commercial, electronic, electrical, automotive and industrial use.

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BUSS
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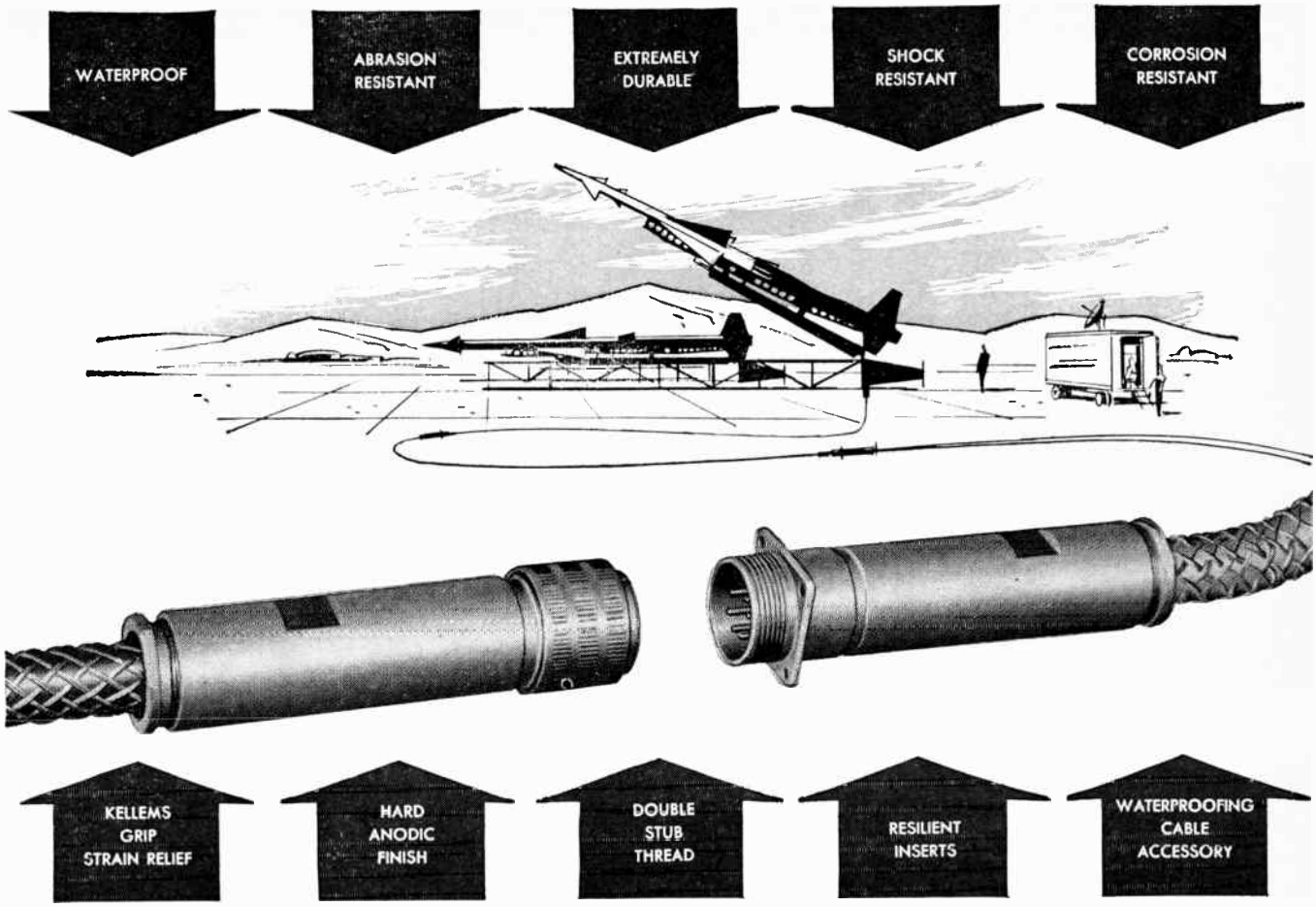

Why it pays you to specify

BENDIX QWL ELECTRICAL CONNECTORS FOR USE WITH MULTI-CONDUCTOR CABLE

Used extensively on ground launching equipment for missiles and on ground radar, and other equipment, the Bendix* QWL Electrical Connector meets the highest standards of design and performance.

A heavy-duty waterproof power and control connector, the QWL Series provides outstanding features:

- The strength of machined bar stock aluminum with shock resistance and pressurization of resilient inserts.
- The fast mating and disconnecting of a modified double stub thread.
- The resistance to loosening under vibration provided by special tapered cross-section thread design. (Easily hand cleaned when contaminated with mud or sand.)
- The outstanding resistance to corrosion and abrasion of an aluminum surface with the case hardening effect of Alumilite 225 anodic finish.
- The firm anchoring of cable and effective waterproofing provided by the cable-compressing gland used within the cable accessory.
- The watertight connector assembly assured by neoprene sealing gaskets.
- The additional cable locking produced by a cable accessory designed to accommodate a Kellems stainless steel wire strain relief grip.
- Prevention of inadvertent loosening insured by a left-hand accessory thread.
- The high current capacity and low voltage drop of high-grade copper alloy contacts. Contact sizes 16 and 12 are closed entry design.

These are a few of the reasons it will pay you to specify the Bendix QWL electrical connector for the job that requires exceptional performance over long periods of time.

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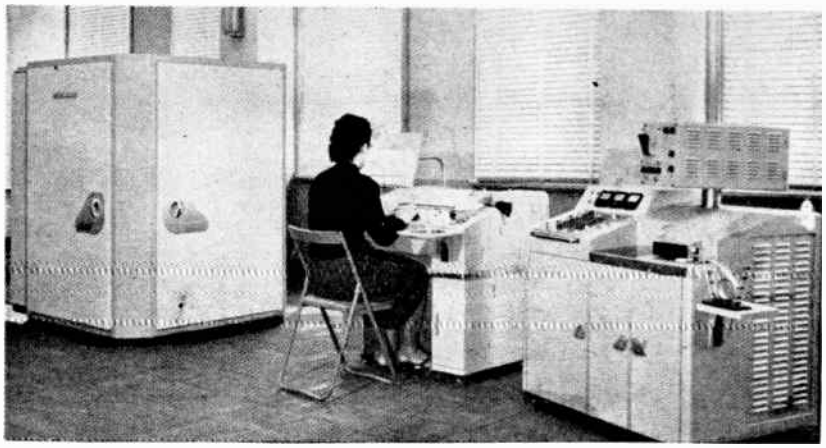

Computers like this one by Nippon Electric are increasingly important to Japanese electronics. From 1952 to 1959, 28 models were developed

Computers Thrive in Japan

The year is far from over, but already Japan's computer industry has unveiled 13 new models

JAPANESE DIGITAL COMPUTER development is climbing sharply, according to information received exclusively this week by ELECTRONICS.

Starting in 1952 with a six-word capacity unit developed by Electrotechnical Laboratory (comparable to U. S. Bureau of Standards), Japan's computer industry has mushroomed. This year alone it has unveiled 13 new models from 10 different sources.

Several of the 1959 models are successors to units completed in 1957, when a total of five new computers were announced by four manufacturers and Electrotechnical Laboratories. In 1958, six additional models were introduced. Of these, two were developed by Japanese universities and four by commercial manufacturers.

Magnetic Drums Popular

A check on the 13 computers introduced this year shows that nine of them rely on magnetic drums for storage and four use core matrixes.

One model, called the TAC and developed in February by the University of Tokyo, uses a Braun tube. This computer has an access time of 0.005 microseconds and a 512-word capacity.

Tokyo Shibura in April introduced a model called the TOBAC III which uses a transistor counter for memory storage. This is the only unit revealed to date in Japan as having this type of storage.

It's now estimated Japan is about five years behind the U. S. in computer technology. As a result, Japanese computer users are continuing to rely on American equipment and are reluctant to invest in Japanese gear.

Since the invention of the parametron by G. E. Goto in 1954, and its successful mass production, Japanese manufacturers are basing much of their design on this device. The HIPAC I, completed by Hitachi, Ltd. in Dec. 1957, uses 4,500 parametrons in its basic circuitry.

In January of the same year, Nippon Denshi Sokki, Ltd. introduced a parametron-based computer, followed in March of 1958 by the University of Tokyo's PC-1 model which also uses parametrons.

In all, there are presently eight different Japanese computer types using parametrons in their basic circuitry. Ten models use dynamic transistor circuits, while the remainder rely on relays, vacuum tubes or static transistor operation.

Some designers are using the pulse regeneration amplifier (so-called dynamic flip-flop) circuit. Dip-soldered modules are to be found in several models.

MEETINGS AHEAD

Sept. 17-18: Engineering Writing & Speech, Dual National Symposium, PGEWS of IRE, Sheraton-Plaza Hotel, Boston; Ambassador Hotel, Los Angeles.

Sept. 17-18: Nuclear Radiation Effects in Semiconductors, USASRDL, Western Union Auditorium, New York City.

Sept. 21-25: Instrument-Automation Conf. & Exhibit, ISA, International Amphitheater, Chicago.

Sept. 22-24: Industrial Nuclear Conf., Armour Research Foundation & NUCLEONICS (McGraw-Hill), Morrison Hotel, Chicago.

Sept. 23-25: Non-Linear Magnetics and Magnetic Amplifiers, AIEE, ISA, PGIE of IRE, Shoreham Hotel, Washington, D. C.

Sept. 28-30: Telemetering, National Symposium, PGTRC of IRE, Civic Auditorium & Whitcomb Hotel, San Francisco.

Sept. 30-Oct. 1: Industrial Electronics Symposium, PGIE of IRE, AIEE, Mellon Inst., Pittsburgh, Pa.

Oct. 5-7: Communications Symposium, National Conf., PGCS of IRE, Hotel Utica, Utica, N. Y.

Oct. 5-9: Society of Motion Picture & Television Engineers, Annual Convention, Statler-Hilton Hotel, New York City.

Oct. 12-14: National Electronics Conference, AIEE, EIA, IRE, SMPTE, Hotel Sherman, Chicago.

Oct. 12-16: Aeronautics and Space Administration Inspection, NASA, Langley Research Center, Norfolk, Va.

Oct. 19-21: National Academy of Sciences, Research Council, URSI, IRE Fall Meeting, El Cortez Hotel, San Diego, Calif.

Oct. 28-29: Michigan Industrial Electronics Exposition, Electronics Representatives, Inc., Detroit Artillery Armory, Oak Park, Mich.

Mar. 21-24, 1960: Institute of Radio Engineers, National Convention, Coliseum & Waldorf-Astoria Hotel, New York City.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 68.

PROGRESS IN PLASTICS

THE TROUBLE WITH PRINTED CIRCUITS— AND HOW CDF WORKS TO SOLVE IT

The honeymoon is long since over; suppliers and manufacturers are engaged now in the humdrum activity of making printed circuits *work*. The industry found in time that there was still a long way to go before the *magic* of printed circuitry was proved incontrovertibly in practice. The truth: Too many mass-produced printed circuits simply were no good. Why?

The trouble was not in the theory. Or in approved manufacturing techniques. It lay—and still lies—in raw materials, primarily in the consistency of quality of base laminates.

We're not here to say that CDF has a totally rosy record in this field. No, we've had our share of failures along with our many triumphs. In fact, our failures during the early years of copper-clad laminates taught us certain important things that our competitors have yet to learn.

But we do emphasize this: We've made—and are still making—great progress at CDF in licking problems that have beset the printed-circuit producer and the printed-circuit user in obtaining top-quality laminates on every order, regardless of grade.

Here, for example, are a few areas where CDF R&D has been particularly active:

1. Consistent quality. A major cause for printed-circuit rejects has been delamination and blistering of the base laminates when subjected to high temperatures in processing. New developments in CDF raw-materials control promise a heartening break-through in this respect. Also, CDF technical personnel are engaged in counseling circuit manufacturers in optimum handling and processing techniques.

2. Foil-bond strength. Certain metal-clad laminates seem to pass the most rigid laboratory tests, only to fail at the end of manufacture when dipped in solder or when put through long-term operational tests at elevated temperatures. The foil-bonding strength of CDF Di-Clad® laminates, however, is recognized throughout the industry as superior in every grade.

Nevertheless, improvements are being made daily in foil adhesives and bonding methods at CDF, and bond strengths are being increased—not only in number of pounds required for foil separation, but in length of safe solder-immersion and high-temperature operation time.

3. Range of selection. CDF has consistently offered the widest range of metal-clad grades—in phenolic and epoxy paper-base, epoxy-glass, and Teflon*-glass. And CDF Di-Clad Teflon-glass grades remain the only laminates of their kind approved by the military. CDF Technical Bulletin 11,900 gives the latest information on all Di-Clad printed-circuit grades.

* du Pont's TFE fluorocarbon resin

4. Flexible grades. Newly-perfected *flexible* grades of CDF Di-Clad promise the designer even greater freedom. One of the headaches in the use of printed circuits has been their rigidity. They tend to hamper independent movement and vibration of connected systems. They occasionally dictate inconvenient housing shapes. Flexible printed circuits, however, overcome these objections and provide many additional benefits of their own. Details on how CDF flexible Di-Clad materials can help see you out of a printed-circuit problem can be obtained from your CDF sales engineer. Look up his phone number in the Product Design File (Sweet's), Electronics Buyers' Guide, or your own CDF catalog. Or send us your print or your problem, and we'll return recommendations based on your individual needs.

NEW CDF LITERATURE

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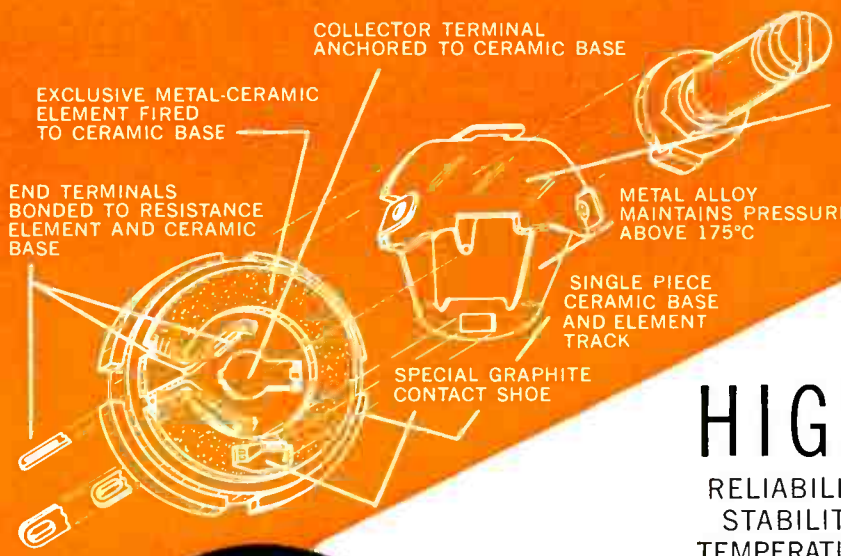

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COMPARATIVE TEST DATA: No carbonaceous variable resistors (either film or molded) can equal Series 600 performance. Ideal for critical applications requiring high stability and reliability. Far exceeds MIL-R-94B.

Tests	MIL-R-94B (Style RV6, Char. Y) Requirement	Series 600 CTS Maximum	Series 600 CTS Average
Load life 1000 hrs.			
½ watt @ 125°C, 350 V max.	±10% @ 70°C	±7% @ 125°C	±4% @ 125°C
¾ watt @ 85°C			
Thermal Stability (1000 hrs. @ 175°C no load)	No test in MIL-R-94B	±5%	±3%
Temperature Co-eff.* (Room to −63°C; room to +175°C)	No test in MIL-R-94B		
25K and over		±250 PPM/°C	±150 PPM/°C
under 25K		±500 PPM/°C	±300 PPM/°C
Moisture Resistance	± 6% avg. ±10% max.	± 2% avg. ± 4% max.	±1.3%
Low Temp. Storage	±2%	±1%	±.5%
Low Temp. Operation	±3%	±2%	±1%
Thermal Cycling	±6%	±3%	±2%
Voltage Co-efficient	No test in MIL-R-94B	±.01%/volt	±.005%/volt
Rotational Life	±10% (after 25,000 cycles)	±10%	±7.5%
Acceleration	±3%	±2%	±1%
High Freq. Vibration	±2%	±2%	±1%
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* Lower temperature coefficient can be developed for specific applications.

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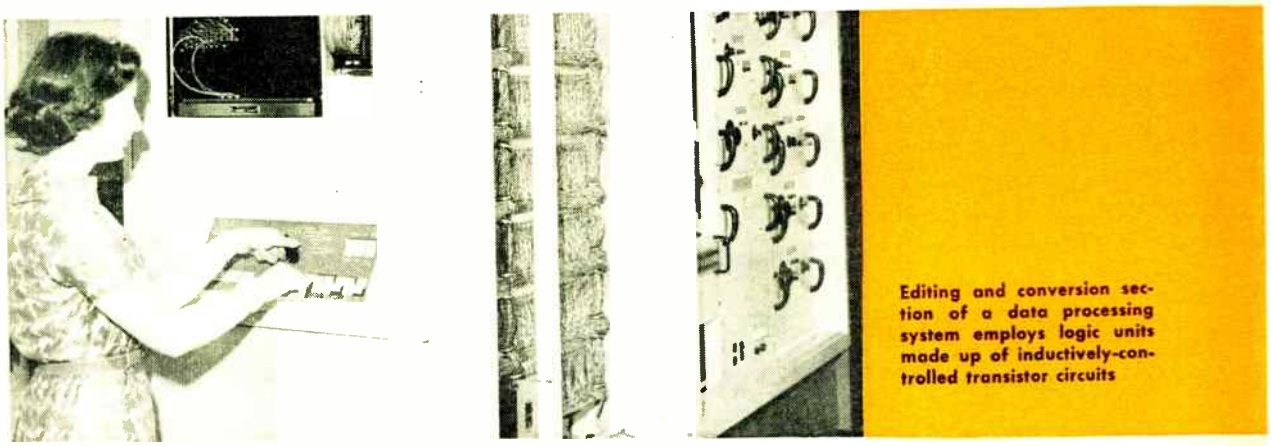


Editing and conversion section of a data processing system employs logic units made up of inductively-controlled transistor circuits

Using Inductive Control In Computer Circuits

In the design of switching circuits, capacitance is the parameter most often used as the passive time-measuring or storage element. In transistor circuits, however, current storage with inductive elements provides many advantages

By WILLIAM M. CAREY,
DATAmatic Division, Minneapolis-Honeywell Regulator Co., Newton Highlands, Mass.

EVERY TYPE OF DIGITAL data processor requires some type of time measuring circuits. Depending on the logical function they serve, they are called clocks, multivibrators, single-shots, scalars, differentiators or counters. Regardless of the name applied, the conventional technique has been to use capacitance as the storage medium. For vacuum tube circuits, which are inherently voltage controlled, a voltage store is ideal.

However, when designing transistor circuits, which are inherently current controlled, a current store has certain advantages. For example, a transistor circuit reacts to a pure voltage source in an extremely nonlinear manner, but is quite linear in response to a current source.

ADVANTAGES—A perusal of the several circuits illustrated here will show many advantages of inductance control over capacitance control.

First, there is designability. The circuits are designed around simple linear equations which involve no exponentials. There are no "tail" effects. Second, there is consistency. Once a circuit has been designed with a particular type of transistor, it will function as designed with any other transistor of the same type. Third, there is the important factor of design range. The same configuration and the same equations govern the design, whether the time involved is 0.1 microsecond or 100 milliseconds. In addition, there are many other advantages.

The base input characteristic of a typical transistor

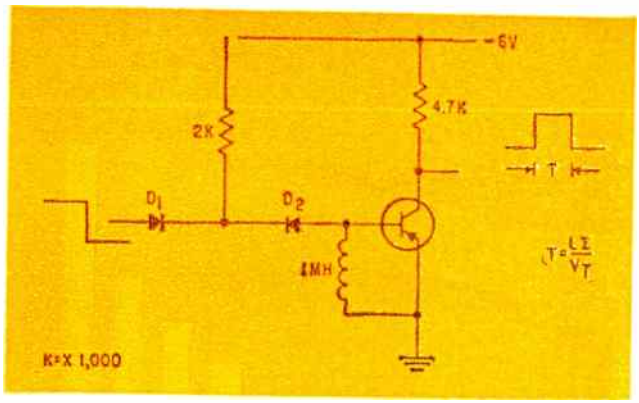


FIG. 1—Differentiator circuit uses inductance to control on time of transistor

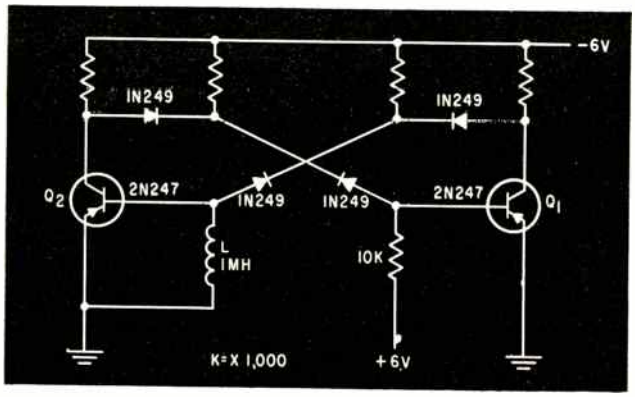


FIG. 2—Single-shot multivibrator provides output pulses longer in duration than input trigger

exhibits a feature which makes inductance a particularly useful tool when used with transistors.

The extremely steep slope of the characteristic curve near saturation indicates that in this region, the transistor has an extremely low input impedance which can be approximated by an ideal battery.

DIFFERENTIATOR—A circuit which uses this characteristic, and which is sometimes referred to as a differentiator, is shown in Fig. 1.

In the quiescent state, with the anode side of D_1 grounded, no current flows through the choke because of the threshold voltage (about 0.6 volts) of silicon diode D_2 in series with the choke. When the anode side of diode D_1 is ungrounded, a step of current is supplied to the base circuit.

Initially, all of this current flows through the base of the transistor, since the choke will not support a step change in current, and therefore, the transistor is driven rapidly into saturation. But as has already been seen, the choke now has what amounts to a pure voltage source across it and therefore the current through the choke increases linearly until the transistor comes out of saturation, at which time the fall time is abrupt.

If the transistor is originally so heavily overdriven that practically all the base current has to be shunted through the choke before the collector comes out of saturation, the width of the output pulse at the collector is given by the simple equation $T = LI/V_T$ where V_T is the base voltage described before.

PULSE INVERTER—The above circuit can also be used as a straightforward pulse inverter, where it is desired to reduce carrier storage effects. Note that if the input pulse is somewhat less wide than T in the above equation, then at the trailing edge of the pulse, the transistor will still be in saturation but a large current will be flowing through the choke. As soon as diode D_1 begins to conduct, the choke, in an effort to maintain its current constant, kicks back into the base of the transistor, thus quickly turning the transistor off.

In the differentiator circuit, an input pulse is required which is wider than the output. For the case where the output must be wider than the input, the single-shot circuit shown in Fig. 2 is used. This can be triggered by either a negative or positive pulse. The width of the output is determined by the same equation which governed the differentiator output.

A logical extension of the single-shot is the choke-controlled, free-running multivibrator, shown in Fig. 3. Here, small resistors have been inserted between the chokes and ground in order to bias the transistors initially into the active region and thus insure self-starting. There are also additional cross-over resistors whose purpose is to insure that the chokes recover rapidly. This is particulary important in an asymmetrical multivibrator, where one side has a duty cycle of greater than 50 percent.

TRANSFORMER CONTROL—The choke-controlled multivibrator is practical, designable and functions well. However, there is another configuration which serves the same purpose and which is superior in that it gives sharper trailing edges and also gives much tighter control over the ratio of the "on" times of the two sides. This circuit is shown in Fig. 4. The only difference between this circuit and the preceding one is that the two chokes are replaced by a single transformer.

IMPROVING FALL TIME—With the resistance values as shown, at the time of a transition from one state to the other the current supplied to the

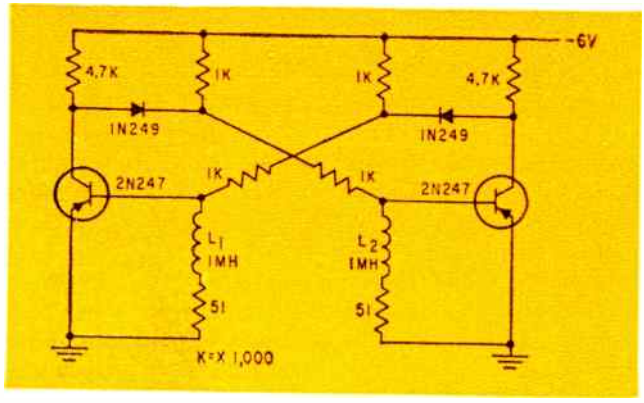


FIG. 3—Choke-controlled free-running multivibrator is made self-starting by addition of small bias resistors in series with the chokes

base is the current through the resistors plus the induced current due to transformer action. This means that wider pulses may be obtained for the same amount of supply current and the same inductance value, than was possible with the simpler choke scheme. Also, the transformer action considerably improves the fall time of slow transistors.

CALCULATING PULSE WIDTHS — It is informative to calculate the ratio of the pulse widths at the two collectors if the resistor nets are symmetrical. If we call I_s the current delivered by the supply through the resistors, and apply the formula $T = LI/V_r$, then $T_1 = [L_1(I_s + NI_s/N_1)] V_r^{-1} = k N_1 I_s (N_1 + N_2) V_r^{-1}$. Similarly, $T_2 = k N_2 I_s (N_2 + N_1) V_r^{-1}$; thus $T_1/T_2 = N_1/N_2$.

The latter equation says that the ratio of the pulse widths is the turns-ratio of the transformer. There are applications where accurate ratios of the pulse widths are vital.

A completely different way of using inductance in computer circuits is the use of a transformer to store information—a perfectly normal, linear transformer, not one whose core has a square hysteresis loop.

Figure 5 shows a counter circuit which uses this technique. Note first, that the middle portion of the figure is a conventional bistable flip-flop. Next, consider the status of the transformer if the reversing input is floating. If, say, the left-hand transistor is conducting, then current flows through the primary from left to right. If now the reversing input is grounded, this effectively throws a short around the primary and its series resistor. Current in the primary begins to decay, and hence the right side of the primary goes positive with respect to the left side. This voltage is coupled to the secondary with polarities as shown, thus driving the right-hand base negative, causing this transistor to conduct and reversing the flip-flop.

Now some completely arbitrary time later, the reversing input is ungrounded. Since the right hand transistor is now conducting, current begins to increase through the primary in a right-to-left direction. Thus, once again the right side of the primary goes positive. This rise is coupled to the secondary with polarities as shown, and the right hand base once again is driven negative, thus affirming the status of the flip-flop. If the reversing input is grounded once more, the flip-flop once again reverses, and when the input is ungrounded, its state is affirmed.

SHIFT REGISTER—If instead of connecting the primary between collectors of the same flip-flop we connect the primary between corresponding collectors of adjacent flip-flops we have a shift register as shown in Fig. 6. In this case the 'reversing' input becomes a 'transfer' input.

Actually, the name 'shift register' does not adequately describe all the functions this device can perform. Registers can be built which shift forward, backward, or in n dimensions. In fact, given

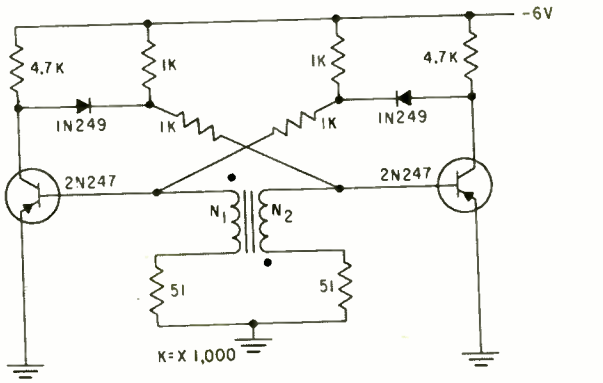


FIG. 4—Another form of free-running multivibrator is controlled by transformer instead of the two chokes used in Fig. 3

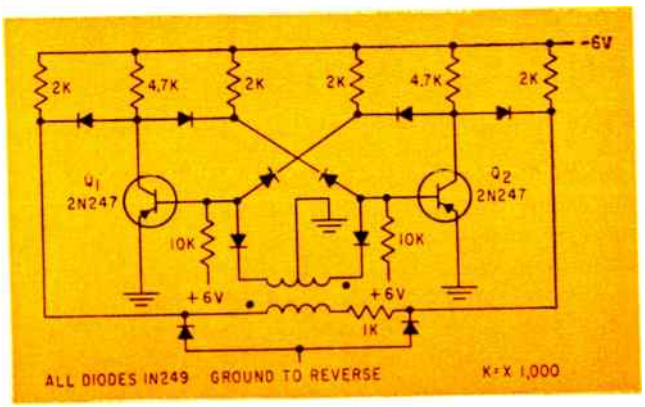


FIG. 5—Counter circuit uses conventional linear transformer instead of usual square hysteresis loop core

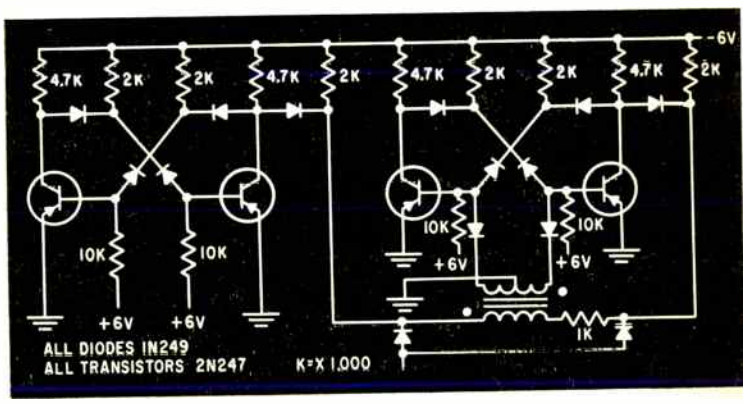


FIG. 6—Variation of counter circuit forms shift register. This circuit can be formed to shift in any direction

a series of flip-flops, the information in them can be rearranged in any arbitrary fashion, in a single pulse period.

To sum up, a series of circuit configurations has been presented which show that, when transistors are used as the amplifying device, inductance is at least as versatile a reactive parameter as is capacitance, insofar as time-measuring circuits are concerned. Every circuit described here is used in a commercial data processing device. Several thousand hours of life have been accumulated on the prototype device, and there has yet to be a component or computational failure of any kind.

Mobile Radar Pinpoints

Trailer-mounted radar system uses Foster scanner to locate enemy mortars. Unit spots positions by giving map coordinates. Dual beams of locator scan 25-degree sector alternately to get two points on mortar shell trajectory

By **M. S. YAFFEE**, Ordnance Department, General Electric Co., Pittsfield, Mass.
and **W. F. SMITH** and **J. B. SKULLY**, Heavy Military Electronics Department, General Electric Co., Syracuse, N. Y.

TODAY'S FRONTLINE INFANTRY MAN has a new tactical radar system for pinpointing the location of enemy mortars and directing more accurate counterfire to knock them out. Capable of locating enemy mortars more than six miles away, this pulsed magnetron radar system will help destroy one of the major casualty producers of recent wars.

The new mortar locator detects the mortar shell in flight and electronically computes the exact location of the enemy mortar. This data is presented in a form which minimizes the time between location and counterfire. The system has a maximum range of 10,000 meters with an accuracy of ±50 meters. The system is composed of an antenna group, a computer-indicator group and a receiver-transmitter group.

More Rapid Motar Location

As the antenna system scans the terrain where enemy mortars are located, it radiates two narrow r-f beams which have a vertical separation of two degrees. The two beams are synchronized so that they alternately scan through an azimuth angle of 25 deg as shown in Fig. 1. The system uses the information obtained when a mortar shell passes through the beams to locate the mortar position.

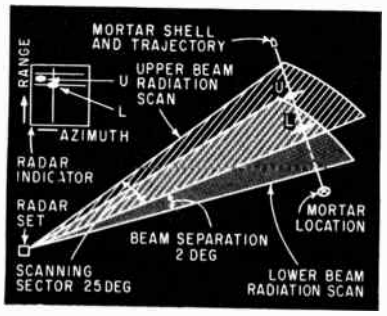


FIG. 1—Radar locates mortars using L and U as the lower and upper points of beam intersections

When the mortar shell passes through the two radar beams, two target echoes appear on the screen of the radar indicator as shown in Fig. 1. The indicator uses a B-type presentation on which azimuth angles are measured horizontally (from 12.5 deg left to 12.5 deg right of dead center), and range or distance in meters is measured vertically (0 to 10,000 meters). By moving two electronic strobe lines (one for azimuth and one for range) so that they intersect successively at the two target spots on the indicator, the range and azimuth of the two points on the shell trajectory are determined.

The azimuth and range strobe lines are moved by controls located on the computer. When the strobe lines are moved to intersect the two target echoes as shown in Fig. 1, the computer receives an analog of the range and azimuth of the two points on the shell trajectory. The range and azimuth data, lower beam elevation data and antenna azimuth data constitute sufficient information for the computer to make a straight line extrapolation through the two points in space to the ground plane.

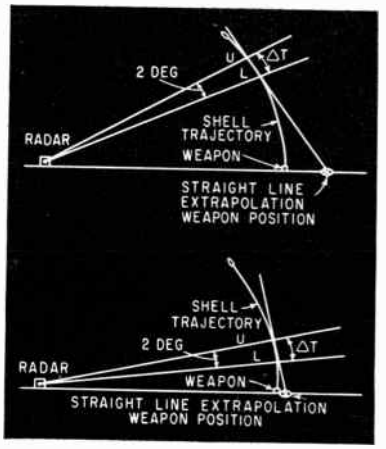
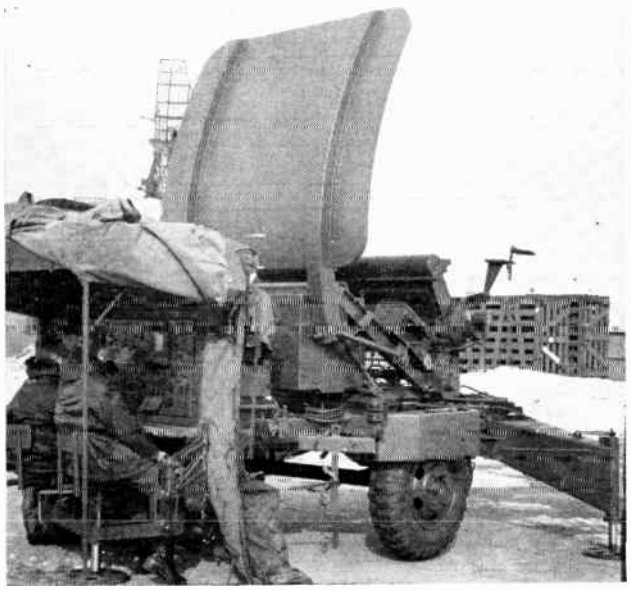


FIG. 2—Comparison of errors in straight line extrapolation method shows a large error at high elevation angles (upper diagram) but greater accuracy at lower angles (lower diagram)

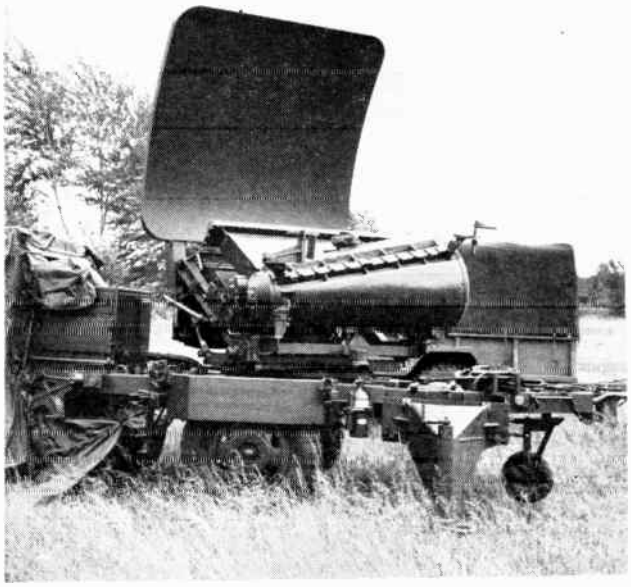
When the two intercept points are located close to the weapon position as shown in Fig. 2, the straight line extrapolation will give fairly accurate results since the actual shell trajectory will have a small curvature over this short distance. If the two intercept points are located on a portion of the shell trajectory which has a large curvature, the extrapolated weapon position will be in error by a larger amount.

To prevent the errors which are inherent in straight line extrapolation of weapon location, the elapsed time between the two target echoes is measured and manually inserted into the computer. This results in an extrapolation which is nearly parabolic and approximates the ac-

Enemy Mortar Positions



THE FRONT COVER—All controls are located on the front of the control indicator which consists of the computer, indicator, low voltage power supply and control panel



All of the radar equipment for the MPQ-4A is mounted on this trailer. Built-in leveling jacks make operation possible from almost any site. Setup time is 15 minutes

tual shell trajectory closely, thereby reducing error. The location of the radar in map coordinates is inserted in the computer and the location of the weapon is presented as map coordinates.

Antenna Group

The antenna system consists of the waveguides, feed horns, reflector, and Foster scanner. This scanner is a microwave antenna rotating around a cone at 1,000 rpm. The emitted wavefront has a shape determined by the scanner as it strikes the reflector from a constantly changing azimuth angle. For approximately 180 deg of its rotation, the scanner emits its beam from the upper feed horn. For an equal period during the remaining 180 deg of rotation, the beam is sent from the lower feed horn.

The antenna pedestal can be rotated 360 deg in azimuth and can be tilted in elevation from −5.6 deg to 11.2 deg from the horizontal. Elevation and azimuth data are accurate to within 0.056 deg. Since the Foster scanner is capable of scanning a 25-deg sector, it is not necessary for the antenna pedestal to rotate continuously in azimuth. A dual-beam Foster scanner (antenna) forms the propagated r-f energy into two beams and causes the beams to scan a 25-deg sector.

Scanner Operation

The scanner is composed of a rotor, inner and outer waveguide shells, two end bell assemblies, and two feedhorns. The r-f energy enters the scanner through a rotary joint on the large end bell and is fed to the slotted waveguide line source which is mounted on the conical scanner rotor. This signal emerges from the slotted line source as a plane wave front passing through the various wave paths of the scanner, as shown in Fig. 3. When the slotted waveguide moves from point 2 to point 1, the energy follows path *A* to the upper horn and is propagated into space by the reflector as the lower beam. When the waveguide passes point 1 and until point 2 is reached, r-f energy follows path *B* to the lower horn and is propagated into space by the reflector as the upper beam.

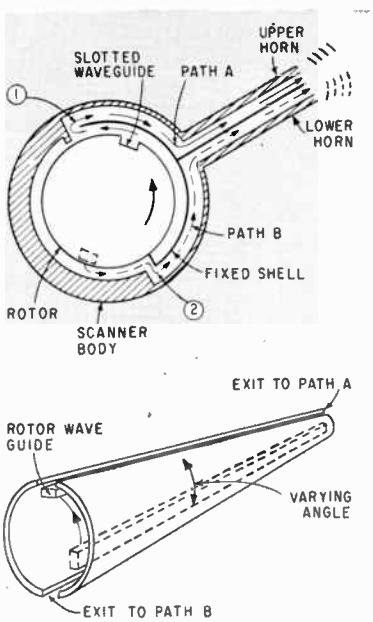


FIG. 3—Front and end views of Foster scanner show variable wave path used to obtain desired beam

Due to the conical shape of the scanner, and the rotation of the line source with the rotor, the length of the r-f path varies from one edge of a beam to the other as shown in Fig. 4. When the slotted line reaches point 3 (0 deg), the wave front of the propagated energy is tilted (wave front 3). This tilted wave front strikes the reflector at an angle which causes the r-f energy to be reflected to the right (propagated wave 3). When the slotted line reaches point 2, 90

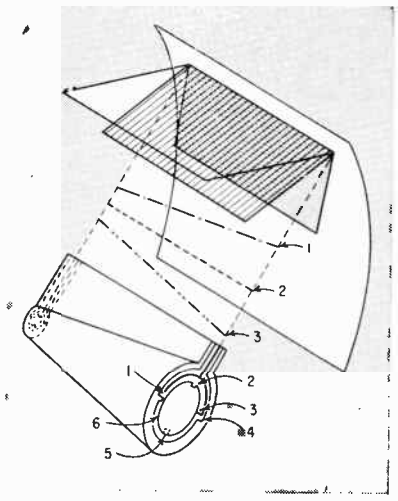


FIG. 4—Conical Foster scanner is capable of covering a 25-deg sector without rotating the pedestal

deg away, wave front 2 is perpendicular to the reflector. The propagated energy 2 is reflected from the reflector as shown. As the rotor nears the 180 deg point 1, the wave path through the scanner is such that the wave front 1 and the propagated wave 1 are again tilted. Thus, for one scan cycle, the propagated wave scans a 25-deg sector. As the rotor continues to rotate through points 6, 5 and 4, energy is propagated in the same manner through the lower feed horn.

The slotted line is a section of waveguide with slots cut into the wide side. The slots are spaced approximately a half wavelength apart and are staggered on either side of the centerline. Since each slot may be considered to be a dipole oriented perpendicular to the slot, the entire slotted line may be an array. With the half wavelength spacing, the slots would normally be excited 180 deg out of phase, but staggering them on either side of the centerline results in another 180 deg phase shift so that each slot is in phase with all of the others in the array.

The energy from each side of the slots combines with the energy radiated from the other slots to form a common wave front which is vertically polarized. If alternate slots were spaced equally on either side of the centerline, the azimuth pattern of the antenna would be strong at the edge of the beam nearest to the input to the slotted line and would fall off rapidly to nearly zero at the extreme end of the line. Since this is not the required pattern, the slots must be spaced in relation to the centerline to obtain the necessary beam shaping. Occasionally, plugging one or two slots is necessary to obtain the proper shaping. A dummy load termination at the extreme end of the slotted line absorbs the power that has not been radiated.

The speed of rotation of the scanner is 1,000 rpm which causes both the upper and lower beams to be scanned about 17 times per second. During the transition period when scanning shifts from one beam to the other, the magnetron must be blanked. This action is triggered by two coils 180 deg apart mounted on the large end bell and two adjacent magnets mounted on the large end of the rotor. When the first magnet passes a coil, a pulse is produced which is used as a trigger to blank the magnetron. When the second magnet passes the same coil, a second trigger is generated to unblank the magnetron and start another scanning cycle. The sequence is repeated 180 deg later when the pair of magnets passes the other coil.

Target Location

When a target or signal return is picked up by the antenna, the azimuth of the target relative to the antenna is known if the angle of scan in azimuth is known at the instant of sighting the target; therefore, to find the angle of scan, the angular position of the rotor must be known. To accomplish this, a movable coil is mounted on a gear on the large end bell, and a third magnet is mounted on the rotor to furnish scan angle data. The gear which holds the coil is actuated by a servo system controlled from the computer. The pulse generated by the magnet when it passes the coil triggers a strobe line which appears on the radar indicator. The servomechanism is used to move the coil which controls the strobe line displacement on the indicator. The strobe line is thus a visual presentation of the azimuth information automatically received by the computer. Antenna azimuth and data takeoff synchros furnish azimuth and elevation data to the computer.

Because slight reflection in the system can cause great azimuthal pattern deterioration, wavepath discontinuities must be avoided. Since reflections between the input to the scanner and the slotted line affect the magnetron operation, the total vswr of the system is held to a minimum. To insure proper operation over the frequency band, a longitudinal iris located in close proximity to each source of reflection in the scanner provides the required matching.

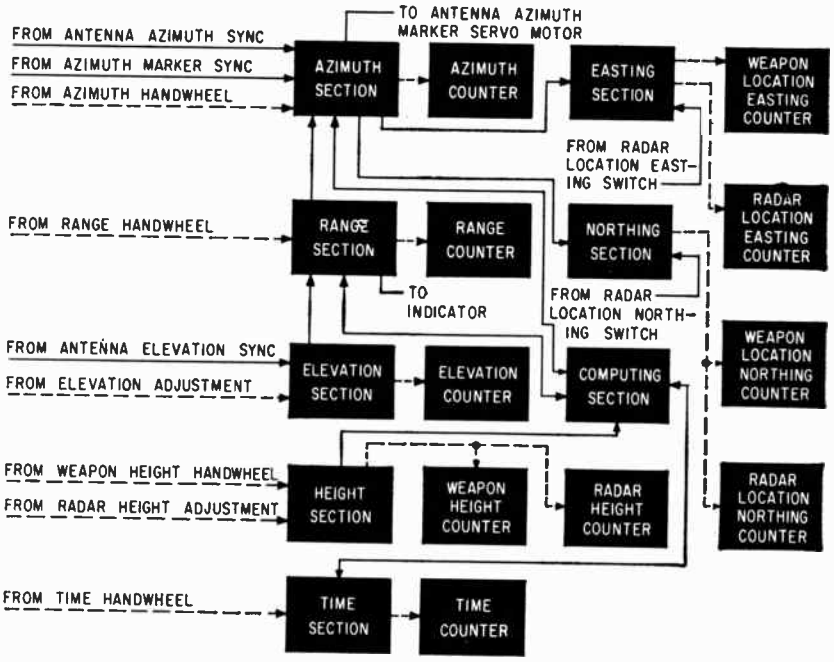


FIG. 5—Information is inserted into the computer automatically and by handwheels. Maintenance is simplified by the use of removable electronic and mechanical assemblies

The vswr of the scanner is measured using a directional coupler and tuned amplifier to monitor the klystron power. The snychro on the scanner rotor runs the chart drive on the antenna pattern recorder. With the probe removed from the slotted line, the signal from the reversed directional coupler is proportional to the voltage reflection coefficient of the scanner. This signal is fed into the pen drive of the pattern recorder. By turning the rotor, a plot of reflected signal versus rotor position is obtained. The rotor is then turned, and, as the recorder pen touches each high point of reflected signal, the probe is dropped into the slotted line to obtain an accurate measurement of the vswr.

The vswr can be separated into two parts. The first part is called the ambient because it does not vary with rotor rotation although it is variable with frequency. The ambient is composed of the reflections of all the components from the input to the scanner to the dummy load at the end of the slotted line array. The waveguide sections from the input to the scanner to the stationary half of the rotary joint and from the rotary half of the joint to the slotted line array input are conventional K_u band guides with bends. The rotary joint, which is precision cast of beryllium copper by the frozen mercury process, is tuned by circular irises in the cylindrical portion. The slotted lines are well matched and require no tuning.

The other part of the vswr is a function of rotor position. Energy reflected by discontinuities after it has left the slotted line array can only reenter the array if it is in the proper phase. This occurs when a constant phase front for the reflected wave is at a 12½-deg angle to the slotted line. The major sources of reflection occur where double 90-deg changes in propagation occur in conjunction with tooth barriers. The energy reflected by them at the ends of scan would not be of proper phase to reenter the slotted line array and would be reflected out of the scanner. Due to the double reflection, the angle of this wavefront would vary at three times the rate of the main beam. The result would be a high sidelobe traveling with the main beam. By matching these reflections with longitudinal irises, the traveling sidelobe is reduced.

Construction

The r-f energy is transmitted from the fixed waveguide section to the rotating slotted line through a rotary joint. To rotate freely, a joint must be symmetrical about the axis of rotation. Since a rectangular waveguide cannot do this, a circular section of waveguide must be used. The circular guide is broken in the middle to permit rotation and is matched to the rectangular guide at either end. Choke joints at the break in the circular guide prevent reflections. Mode rings are used in the circular sections to convert the proper wave shape and to help insure the efficient transmission through the rotating joint. Because of the timing by the addition of these mode rings, the rotating and stationary joints that make up this assembly are a matched pair and must be treated as such.

A circular polarizer is used to reduce the radar return from rain or suspended moisture which appears as clutter on the indicator screen. The circular polarizer changes the polarization of the transmitted radiation and filters the reflected wave so that reflections from smooth regular objects such as rain drops do not appear on the indicator screen. Sharp edges and angles of mortar shell fins distort reflected radio energy in such a manner that the reflected energy will be detected by the receiver. The circular polarizer is in the form of a cylindrical sector which covers the feed horns so that all radiated energy passes through it. It is constructed of thin aluminum slats, oriented at 45 deg to the incident voltage vector from the horns and spaced and supported by strips of isocynate foam. This assembly is further protected and weatherproofed by fiber glass laminate skins on both inside and outside surfaces.

Computer and Amplifier

The radar system uses an electromechanical analog computer to solve the weapon location problem. The computer is made up of eight computing sections shown in Fig. 5. Information is fed into the sections as shown, and the location of the enemy mortar is presented as map coordinates on two counters.

The receiver of the system consists of a balanced mixer, local oscillator, automatic frequency control assembly, sensitivity time control assembly, and an i-f amplifier. The receiver block diagram is shown in Fig. 6. The automatic frequency control assembly furnishes afc voltages to the local oscillator and range markers to the i-f amplifier. The sensitivity time control assembly applies a negative-going pulse to the i-f amplifier to reduce clutter from close in targets.

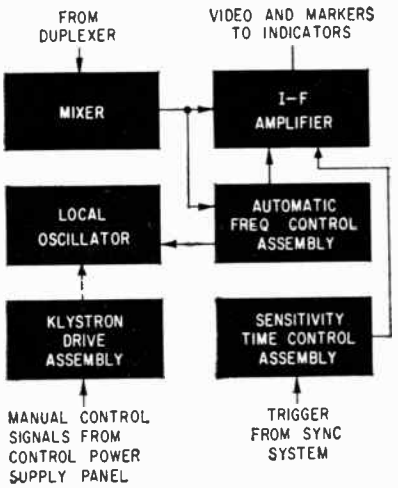


FIG. 6—Block diagram of the receiver used in system

The first five stages of the i-f amplifier operate as conventional amplifier stages with the balanced input from the mixer applied to the grid of the first stage.

The next five stages of the i-f amplifier form a linear-logarithmic amplifier circuit. This type of circuit is not as easily overloaded by a strong signal as is a conventional circuit.

All of the equipment for the unit is mounted on two two-wheel trailers. One trailer carries the primary radar equipment, while the other carries the power supply and auxiliary equipment.

All work performed on this radar set (AN/MPQ-4) was done for the United States Army Signal Research and Development Laboratory under contract DA-36039-sc-36574.

Infrared Communications

Experimental communications receiver operating at infrared frequencies may be used for future space vehicles. Circuits reject solar infrared noise

By W. E. OSBORNE,
President and Director of Engineering, Twenty-First Century Electronics, Inc., Riverside, Calif.

AS A MEANS OF COMMUNICATIONS, infrared will undoubtedly come into greater prominence over the next few years. At present at least two systems are in military use. Other IR systems, usually of a passive type, have been in use for some time. The Sidewinder missile is a good example of a simple but effective unit.

For communications purposes within the earth's atmosphere, radio scores heavily over infrared in terms of range. This situation changes rapidly with altitude and a sensitive, relatively simple infrared receiver at an altitude of 20,000 ft possesses an average range of several hundred miles in reasonably good weather. Outside the atmosphere, infrared is on equal terms with radio. Its range is virtually unlimited. Infrared also has spectrum space for literally millions of channels. The use of semiconductor detection, amplifying and oscillator components coupled with the highly directional characteristics that such short wavelengths provide are also advantageous.

An experimental fully transistorized infrared receiver is shown in Fig. 1.

Circuit

The detection elements may be a pair of matched lead sulphide (Pbs) or indium antimonide cells. The latter type require no cooling whereas the Pbs cells perform much better inside a CO_2 filled jacket. This is by no means mandatory. Cells of PbTe may be substituted but require a case cooled with liquid nitrogen.

Since the time constant of many photoconductive cells is now in the microsecond range, pulsed communication is possible. Lead sulphide cells are still relatively slow.

Cell D_2 is used as a reference while cell D_1 looks at the target or transmitter and detects any changes from the IR level of the reference cell. Selectivity is obtained by either an optical or electronic filter. The output or difference signal from the detection cell is first amplified by Q_1 and Q_2 and then passed through emitter follower Q_3 for low-impedance transmission to the main unit.

At this point the signal is electronically chopped or modulated at a frequency of approximately 1,000 cps. Chopping originates in the circuit of oscillator Q_{10}, which triggers multivibrator Q_{11} and Q_{12}. After amplification by buffer Q_{13} the square-wave from the oscillator is transformer coupled to transistors Q_{14} and Q_{15}. The synchronized rectifying action then chops the incoming IR signal at the pre-set chopping frequency. It is probable that such chopping (which allows a-c amplification at the chopping frequency) will be rendered unnecessary in the near future by the use of amplifiers which operate at the signal frequency.

The modulated component (which we assume to be a message pulse-modulated at a frequency much higher than the chopping frequency) is now applied to a tuned amplifier consisting of Q_4, Q_5, and Q_6, assisted by feedback transistor Q_7. The pass-band is narrowed to as low a point as the pulse-modulated message will allow, providing discrimination against unwanted noise frequencies. To increase the signal/noise ratio, the gated output is used. It is the electronic equivalent of former mechanical types of synchronous rectifiers used in IR receivers. In a system designed solely for communications purposes, the signal from the tuned amplifier would be boosted by Q_7, and then could be taken directly to transformer T_1. Operation of the latter is controlled by Q_9, which is in turn triggered by the multivibrators. The output of the amplifier is thus synchronized with the input. Transformer T_1 would then pass the message for discrimination and operation of a recorder or display device. These pulses would ride on the top of the waveform produced by the chopping circuitry.

Figure 1 also shows an arrangement whereby the overriding modulation or message is taken through a discriminator and thence to an audio amplifier and recorder. This then allows the unit to operate as a communications receiver.

The output signal is also fed to four diodes in a balanced output circuit which provides a rectified signal level which is indicated on a meter. This converts the receiver from a communications set to a radiation intensity measuring device.

While the transmitter used to operate this experimental receiver was of a Xenon Mercury type, solid-component power oscillators at IR frequencies are under development for military purposes. Synchronizing pulses from the transmitter (or blank periods of no transmission) will be used to hold the receiver in line, and may be adjusted in the cir-

Receiver for Space Vehicles

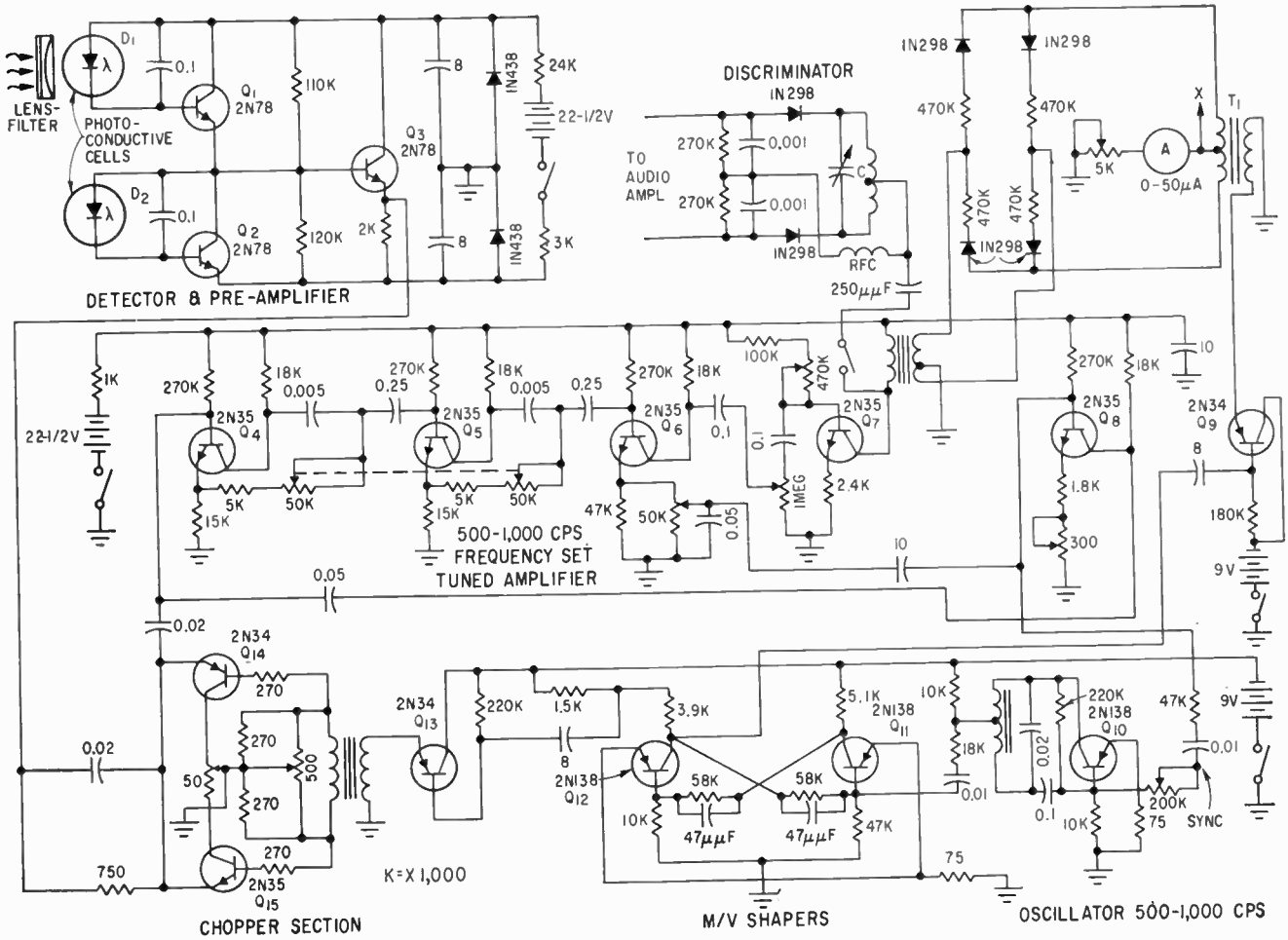


FIG. 1—Addition of four-diode bridge and circuit converts communications receiver to radiation-measuring device. Normal modulation is taken from conventional diode discriminator

cuit of oscillators Q_{10}.

Filters

Electronic filters are also under development for use in the intermediate portion of the IR spectrum (1-12μ). One of these, capable of selecting a 10-angstrom-unit portion of this spectrum, was recently tested successfully. As one micron, or 10,000 A is equivalent to three hundred thousand billion cps it is obvious that 10 A still represents an immense pass-band.

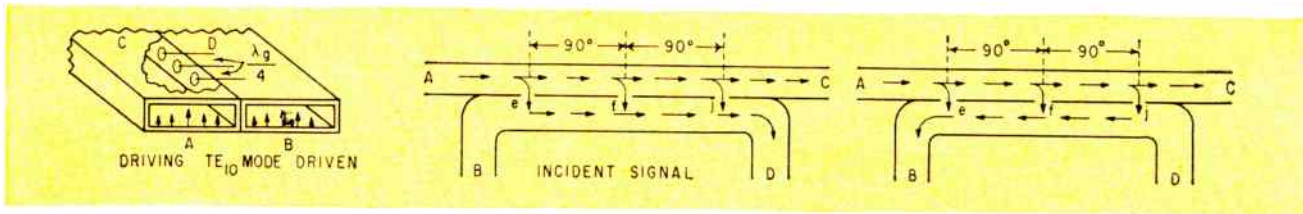
If such a communication system were used in space, it may be argued that the tremendous IR signal from the sun would completely prevent any reception. However, the receiver sync control allows it to trigger only on a modulated signal of a chosen type, and the extremely narrow angular limits of the modulated carrier combine with this to permit useful operation. In addition, the direct IR from the sun may be rejected in a great majority of cases by simple rate circuitry which measures the closing rate (in terms of emission) between sun and vehicle, and vehicle-to-vehicle. The sun's rate is infinitesimal while the vehicle-to-vehicle rate changes (relatively) rapidly and is accepted.

Radar could be used for the combined purpose of target location and simultaneous communication. However we are faced with the problem of an efficient power oscillator to replace the present magnetron or klystron.

The use of millimeter wavelengths would to some extent relieve the overcrowding problem but the time will certainly come when even this portion of the spectrum will be fully occupied.

Infrared possesses a peculiar advantage over radio. Taking the intermediate portion of the infrared spectrum, from one to 12 microns, during certain portions of the space journey no transmitter would be necessary as solar heat or the heat generated within the vessel for propulsion purposes could be used as the carrier. A modulator would be required like that of a radio or radar transmitter.

Present infrared detectors remain sensitive under direct sunlight for only a few days. This defect will eventually be eliminated and the cells may also require no cooling. Developments now under way show promising results.



Three orifices spaced one-quarter guide wavelength apart in direction of propagation. Center orifice passes 6.02 db more than either of two outside ones

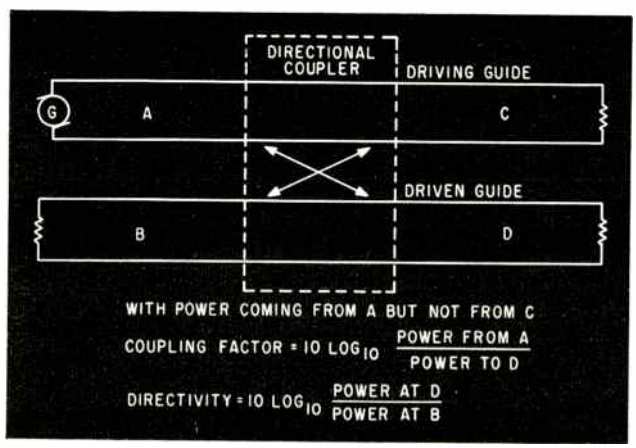
Signal through orifice e, f and j travel same path length, therefore they add directly. Signal at D is proportional to the signal at A

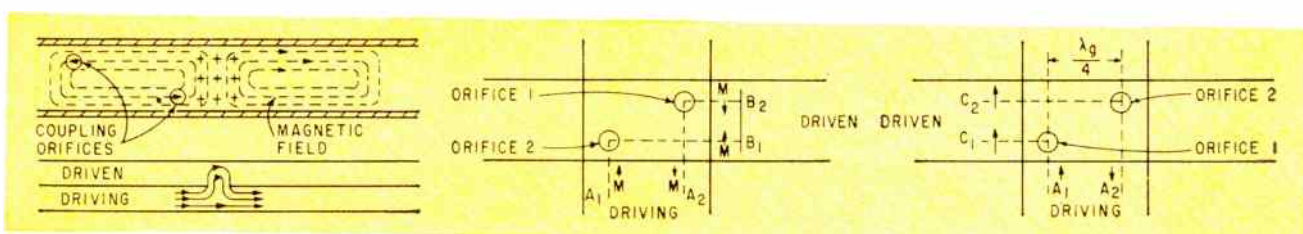
Signal through j in phase with e producing vector 6.02 db higher than either e or j alone. Resultant voltage equal to and out of phase with signal through f

TWO-ROUND-HOLE NARROW-WALL COUPLERS. Has advantages of simple construction, low cost and small space requirements. Disadvantages that coupling factor changes about 2 db for 10-percent frequency band and parallel construction requires bending. If C is not a perfect termination it will reflect power back into the coupler. A signal will appear at B proportional to the power reflected from C. The reflection coefficient of C can be measured using signals at B and D

Microwave Directional

A DIRECTIONAL COUPLER is a network between four pairs of terminals as shown at right. There is a free flow of power without reflection or attenuation between terminals A and C and the same conditions exist between terminals B and D. The upper and lower transmission lines are coupled in such a way that when B and D are terminated in their characteristic impedance with no power originating from B or D a signal appears at point D when power is flowing from A to C. Power at point B indicates that power is flowing from C to A. The ratio of the power at A to the power at D expressed in db is the coupling factor. With power coming only from terminal A, the ratio of the power at D to the power at B expressed in db is the directivity. The directional coupler is useful when only a small amount of the total power available is necessary to make a measurement.

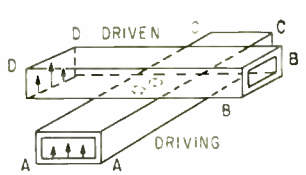




Magnetic coupling between two orifices is 180-degrees out of phase. Very little electric coupling

Wave A_1-A_2 travels down driving guide. Some magnetic field from A_1 goes through orifice 2 to B_1. Energy from A_2 goes through orifice 1 to B_2. Both path lengths are equal so no phase shift. Magnetic fields at A_1 and A_2 start 180-degrees displaced. At point B_1 and B_2 they cancel out. There is no propagation of energy in this direction and cancellation is independent of frequency

Wave A_1-A_2 travels down driving guide. Some magnetic field from A_1 goes through orifice 1 to C_1. Some energy from A_2 goes through orifice 2 to C_2. Length of A_2-C_2 path is $\lambda_g/2$ longer than path A_1-C_1. This provides phase shift which puts magnetic fields at C_1 and C_2 in phase when they are out of phase at A_1 and A_2. This produces propagation of C_1-C_2 wavefront. Phase displacement is dependent of orifice spacing and frequency of operation



With signal injected at A-A and remaining three arms matched, most signal will go to C-C. In the driven guide, a signal will appear at D-D but not at B-B

CROSS-GUIDE DIRECTIONAL COUPLERS. It has advantages of right angle relation between the two guides and eliminates the need for two bends needed with other coupler. It has high directivity and the coupling factor does not vary much with frequency

Two coupling orifices are spaced one-quarter guide wavelength apart in the direction of propagation

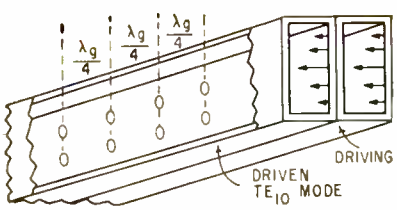
Signal through orifice e and f travel same path length, therefore add directly. Signal at D proportional to signal at A

Signal path through orifice f is twice hole spacing longer than signal through e. The vector addition is zero

COUPLERS WITH THREE ROUND HOLES IN NARROW WALL. Has advantages of lower coupling factor possible, better broad band operation (directivity) and moderate space requirements. Disadvantages that coupling factor changes about 2 db for 10-percent frequency band and parallel construction requires bending. When coupler is operated off design frequency, orifice spacing is no longer 90 degrees and vector sum is no longer zero, but is less than two-hole coupler

Couplers

By G. L. ALLERTON, Western Electric Co., Allentown, Pa.



Orifices placed one-quarter guide wavelength apart in direction of propagation

COUPLERS WITH ROUND HOLES IN THE WIDE WALL. Has advantages that wide range of coupling factors possible (3 db and up), broadband operation and high directivity. Disadvantages of large space requirements and parallel construction requires bending. Round holes are used as hole sizes may be kept to close tolerances. The proper relation between orifice radius and thickness between guides will keep the coupling factor constant over the operating frequency range. If the coupling is too high at the high-frequency end of the range, reduce wall thickness between guides and decrease orifice diameter. From Table I, the eight equal diameter orifice coupler would have each orifice 18.06 db below the desired value for the entire coupler. There are an infinite number of orifice combinations which make directional couplers. A few of these are listed in Table I.

A coupler can be made from any even number of identical orifices spaced ¼-wavelength apart along the direction of propagation. Some of these are listed under uniform arrays. One of these is the 6-orifice coupler; each orifice has 15.56-db-higher coupling loss.

Table I—Multiple Orifice Possibilities

Designation Based on Contribution (Loading)	No. of Orifices in Array	Numerical Designation Based on Orifice Size No. 1 is largest, No. 2 is next smaller, etc.	Coupler Loss in DB Below Single Hole Characteristic Loss For Each Numbered Orifice of the Array 1	2	3	4
Uniform Array	2	1,1	6.02			
	4	1,1,1,1	12.04			
	6	1,1,1,1,1,1	15.56			
	8	1,1,1,1,1,1,1,1	18.06			
	10	1,1,1,1,1,1,1,1,1,1	20.00			
	12		21.58			
	16		24.08			
	20		26.02			
	24		27.60			
	32		30.10			
	40		32.04			
	48		33.62			
Binomial Array						
1,2,1	3	2,1,2	6.02	12.04		
1,3,3,1	4	2,1,1,2	8.52	18.06		
1,4,6,4,1	5	3,2,1,2,3	8.52	12.01	21.08	
1,5,10,10,5,1	6	3,2,1,1,2,3	10.10	16.12	30.10	
1,6,15,20,15,6,1	7	4,3,2,1,2,3,4	10.10	12.60	20.56	36.12
1,7,21,35,35,21,7,1	8	4,3,2,1,1,2,3,4	11.36	15.70	25.24	42.11
1,2,1; 1,2,1	6	2,1,2; 2,1,2	12.04	18.06		
1,3,3,1; 1,3,3,1	8	2,1,1,2; 2,1,1,2	14.58	24.08		
1,2,1; 1,2,1; 1,2,1	9	2,1,2; 2,1,2; 2,1,2	15.56	21.58		
1,2,1; 1,3,3,1; 1,2,1	10	3,2,3; 3,1,1,3; 3,2,3	14.58	18.06	21.08	

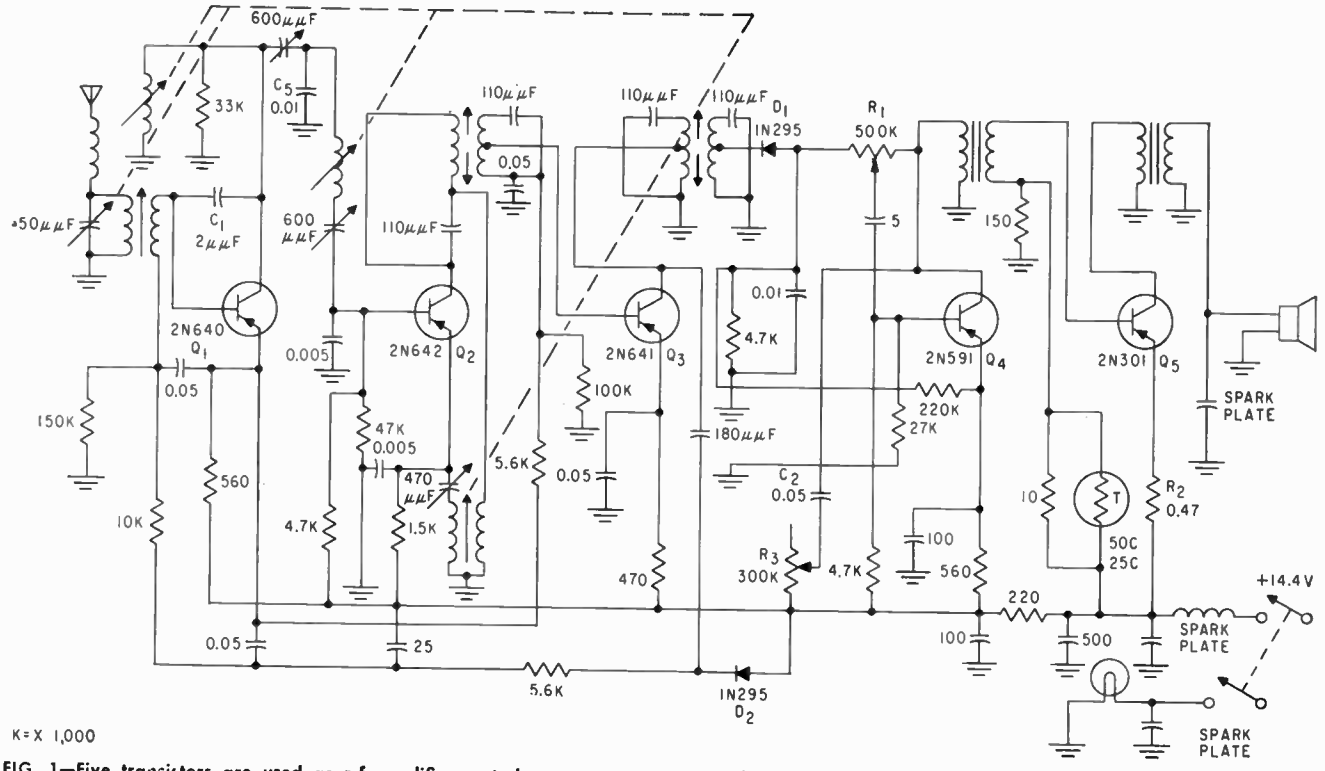


FIG. 1—Five transistors are used as r-f amplifier, autodyne converter, unneutralized 262-kc i-f amplifier, germanium-alloy audio driver and germanium power output stages

Transistorizing Automobile

Automobile receiver using drift transistors has 2-microvolt sensitivity for one watt audio output. Single-ended output delivers 4 watts at less than 10-percent total distortion

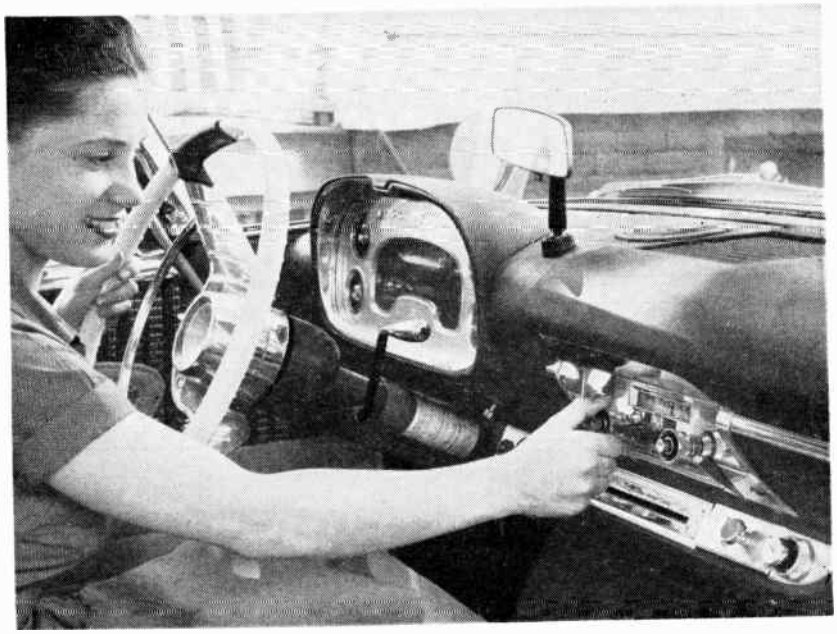
TRANSISTORIZED AUTO RADIOS usually use seven or more transistors or are hybrids using both transistors and vacuum tubes. Drift transistors which inherently have a high maximum available gain and low feedback capacitance provide good performance with a minimum number of stages.

This five transistor auto radio has a sensitivity of 2μv for 1 w of audio. The audio circuit can deliver 4 w at less than 10-percent distortion. The image rejection ratio varies from 85 db at the low end of the band to 78 db at the high end. The i-f rejection ratio varies from 89 db at the low end to 102 db at the high end. The receiver has a 60 db figure of merit using a 5,000 μv reference and a signal-to-noise ratio of 20 db at less than 5 μv. No oscillator blocking was experienced with signal levels up to 2 v. Figure 1 shows the schematic of the radio.

Antenna Circuit

The whip antenna used for automobile radios may be represented as a voltage generator having a capacitive internal impedance. Although there is also a resistive component of impedance present, the value is so low that it may be safely neglected when a 6 to 8 foot whip antenna is used over the broadcast band. Analysis shows that when the loaded Q is fixed for bandwidth purposes, the maximum power transfer is obtained when the unloaded Q is as high as possible, trimmer and other shunt capacitors are kept to a minimum, and padders and other series capacitors are kept to a maximum. In addition, the power transferred decreases with decreasing frequency. These factors must be taken into consideration to obtain a good signal-to-noise ratio.

Another consideration is that of coupling the input impedance of the r-f transistor to obtain the proper antenna loading. Although capacitive division eliminates the need for an antenna coil secondary winding, this type of coupling requires the coil to be located between the antenna and the transistor base. This connection results in poor rejection of the high field strength 60 cps (power-line) interference occasionally encountered in auto radio applications. If the low end of the antenna coil is grounded selectivity



For automobile use, radio has manual and pushbutton controls

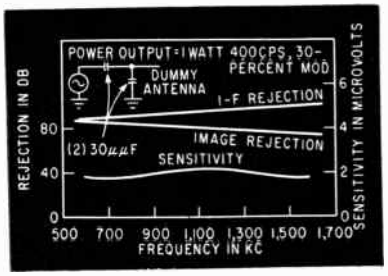


FIG. 2—Sensitivity and rejection characteristics of five-transistor receiver

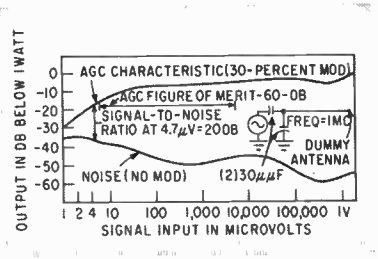


FIG. 3—Agc and noise characteristics

By R. A. SANTILLI and C. F. WHEATLEY, Semiconductor and Materials Division, RCA, Somerville, N. J.

Broadcast Receivers

falloff of 18 db/octave may be obtained. For reasons of 60-cycle rejection and of signal-to-noise ratio, an antenna coil having a secondary winding was chosen. Three r-f tuned circuits were required to obtain an image and i-f rejection in excess of 70 db across the band.

R-F Stage

To override converter noise adequately, r-f gain of the order of 15 db is required. Although neutralization may be used in a variable-frequency tuned amplifier, it was not considered necessary in this application .

Perhaps the most significant requirement for the r-f transistor is the agc requirement. The control of r-f input and output impedances and feedback capacitance is an obvious requirement. However, the range of signals encountered in an auto radio covers approximately 110 to 120 db. Consequently, the r-f transistor must provide 80 to 90 db of agc. As a result, the d-c beta (common-emitter current gain) and the I_{co} (cutoff collector current) must be controlled so that the agc system may supply sufficient power to utilize this cutoff range without amplification. This requirement becomes even more significant at higher ambient temperatures. The drift transistor is designed specifically to meet these stringent requirements.

Either top-side or bottom-side coupling may be used for the double-tuned r-f circuit, together with capacitive division on the secondary winding for impedance matching to the base of the converter transistor. The first r-f coil was designed to be tuned with a 600-$\mu\mu$f capacitor. It may be desirable to add a winding to the first coil and tune with a smaller trimmer. The value of 600 $\mu\mu$f was chosen to provide the correct collector loading as determined by dynamic stability considerations.

The r-f stage (Q_1) is operated at a collector voltage of −12 volts and a collector current of 0.7 ma and produces a power gain of 27 db at the low-frequency end and 20 db at the high-frequency end of the band. This gain is sufficiently below Q_1 maximum capabilities to assure excellent interchangeability and stability. At the low-frequency end of the band, the unloaded Q's of the first, second, and third tuned circuits are 65, 45, and 45, respectively, and the loaded Q's are 40, 30, and 50. At the high-frequency end, the unloaded Q's are 65, 65, and 65 and the loaded Q's 48, 40, and 55. The coefficient of coupling of the double-tuned circuit, which is 1.3 times the critical coefficient, provides a peak-to-valley ratio of approximately 0.2 db. This overcoupling is not sufficient to present alignment difficulties.

Converter Stage

The converter circuit is basically the autodyne type, in which emitter injection is obtained by capacitive division. The r-f signal is fed into the base of Q_2. The i-f output from the collector is fed through a double-tuned transformer to the base of i-f stage Q_3. Converter Q_2 operates at a collector voltage of −12 volts and a collector current

of 0.6 ma, and produces a conversion gain of 37 db (262-kilocycle i-f). Again, this gain is below the transistor maximum capabilities and assures excellent interchangeability and stability.

The converter stage exhibits a strong tendency toward increased injection voltage with decreasing frequency. Conversion gain increases with injection up to a maximum point, and then starts decreasing with further increase of injection voltage. For the circuit shown in Fig. 1, conversion gain is approximately independent of injection voltage between 40 and 150 millivolts and decreases with injection voltage outside this range. Because the sensitivity is greater at the low end of the band than at the high end, the injection voltage was controlled with frequency to decrease the variation of receiver gain across the band. The emitter is not as well bypassed for low-frequency r-f signals as for high-frequency r-f signals and thus provides additional flattening of the gain/r-f characteristic.

If the tickler winding is between the collector of the converter transistor and the i-f winding, the capacitance of the tickler winding to ground shunts the i-f primary and changes the coefficient of coupling. When this arrangement is used, this shunting capacitance must be considered in the design of the i-f transformer.

The major problem in the design of the converter stage was that of blocking. When a very-high-level r-f signal is applied to the base of the converter transistor, the stage operates as a clamping circuit, thereby reverse biasing the transistor and preventing oscillation. Without oscillation there is no i-f output, and therefore no agc to reduce the high-level r-f input. If the incoming signal increases gradually, the agc has a chance to build up. However, it may come on abruptly if push-button tuning is used or if the radio is turned on in the presence of a strong signal. If the turn-on condition were the only one of concern, a suitable bypass capacitor could be incorporated so that the r-f stage would gradually obtain bias (a turn-on transit could be built into the circuit). However, this arrangement is no solution for push-button blocking, or blocking caused by tuning to a strong station.

The best method to handle blocking is to determine empirically the r-f collector signal level at which blocking occurs and then limit the collector signal below this level. The d-c collector-to-emitter voltage can be chosen so that collector limiting will result. The signal level can further be reduced approximately

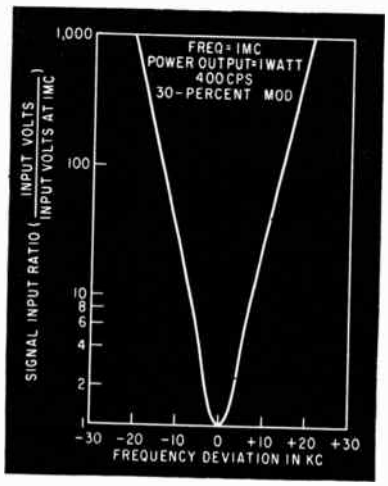


FIG. 4—Overall bandwidth of receiver at signal frequency of 1 mc

6 db by the use of a slightly backbiased diode which shunts the collector load. A much greater degree of limiting may be obtained by the use of two diodes appropriately biased in a conventional limiting arrangement.

Additional attenuation may be employed from the collector of the r-f transistor to the base of the converter transistor to eliminate blocking provided sufficient gain can be obtained elsewhere. Blocking is less severe when the converter current or injection voltage is increased.

I-F Stage

A drift transistor is used in the unneutralized 262-kilocycle i-f amplifier. Double-tuned input and output transformers are used to obtain the desired selectivity with coefficient of couplings set at 0.85 critical. Although more gain could be obtained with a higher collector load, and even more with neutralization, the i-f stage must deliver a high level of power. Consequently, the collector load is determined by large-signal class-A power amplifier criteria rather than dynamic stability alone. For the collector voltage of −12 v and the collector current of 2 ma, a collector load of 6,000 ohms is used. The i-f stage contributes 32 db of gain.

Audio detector D_1 is fed from a tap on the secondary winding of the i-f output transformer. The agc detector D_2 is fed by a capacitor from the collector of the i-f transistor. This arrangement provides a slightly wider bandwidth for the agc than for the audio, and also permits a high level of agc voltage. About 5 or 6 db of agc is obtained from the i-f stage.

AGC

The 110 to 120-db signal-handling requirement of this receiver makes agc a difficult problem. The germanium diode used for the agc detector develops approximately 2 v of agc. A tendency toward distortion at very high levels was corrected by the use of C_1 a 2 $\mu\mu$f capacitor between the base and the collector of r-f transistor Q_1. This capacitor apparently extends the agc to some extent by introducing a feedthrough current which subtracts from the normal collector signal current. These currents are normally out of phase.

Another problem encountered in the agc system was that of spurious responses at very high levels. The agc bandwidth is fixed by the i-f bandwidth and is relatively narrow. When a strong signal is present and the receiver is tuned on carrier, the performance is as expected. As the receiver is tuned off carrier however, the agc is rapidly removed. This change permits much higher levels in all stages prior to the output of the i-f stage, and shows up first as distortion of the envelope (and detected audio distortion).

Further tuning off carrier removes the agc almost completely and permits a very high r-f signal on the converter. In fact, if r-f limiting is not employed, oscillator blocking may result. The wide agc system described previously reduces this effect.

It would also be possible to obtain freedom from blocking if additional agc voltage derived from the collector of the r-f transistor were added to the normal agc

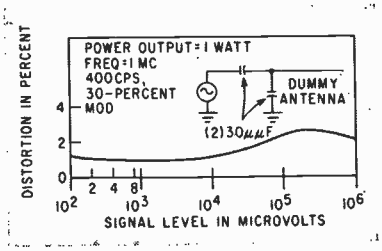


FIG. 5—Distortion of the receiver as a function of signal level

bias. This arrangement would not alter the receiver performance appreciably in normal reception areas. This arrangement was not incorporated in the receiver.

Detection

Point-contact germanium diode D_1 is used as the audio detector. For detection of small signals, maximum sensitivity is obtained by passing a certain value of forward d-c current through the diode. As the current is reduced from this value, a slight loss in sensitivity is encountered. For signals 5 or 10 db lower, however, a considerable loss of sensitivity is observed. A high degree of quieting in the absence of a signal can be obtained with only a slight reduction in normal sensitivity by utilization of this nonlinearity of the detector. This arrangement does not actually improve the signal-to-noise ratio at sensitivity, but it results in a subjective advantage similar to noise limiting. The compromise bias employed in this receiver causes a sharp curvature in the agc curve at sensitivity level. This curvature introduces detector distortion.

Maximum sensitivity is obtained when the input impedance of the audio transistor represents most of the load on the detector, that is, when the d-c load is small compared to the a-c load. Again, a high degree of distortion is introduced, particularly at high modulation levels.

For operation at sensitivity, however, the noise is sufficiently high to override the distortion. A signal-to-noise ratio of 20 db contributes as much undesired power as 10 percent distortion. At signal-to-noise ratios below 20 to 25 db distortion means little.

When the signal level is high enough to obtain a signal-to-noise ratio of 20 to 25 db (about 5 to 8 μv), the detector is fairly linear. The first 10 to 20 db of volume reduction inserts series resistance between the detector and transistor, unloading the detector to approach an a-c to d-c ratio of unity.

Audio Driver

Germanium alloy audio driver transistor Q_1 was specially designed for the high-temperature and high-voltage requirements of this application. The driver operates at a collector voltage of -12 v, a collector current of 3 ma and provides a power gain of approximately 44 db. Although the driver may contribute 3 or 4 percent distortion at very low r-f signal levels where the noise level is high, the volume control greatly reduces this distortion at normal r-f signal levels.

Volume Control

Volume control R_1 is a high-resistance potentiometer connected between the audio detector and the collector of the driver. When the variable arm (connected to the base of driver Q_1) is placed at the detector end of the potentiometer, maximum sensitivity is obtained. The resistance of the potentiometer is high enough so that appreciable collector-to-base feedback is not encountered. As the arm is moved from the detector to the transistor collector, series attenuation results, thereby unloading the audio detector. Further reduction of volume causes collector-to-base feedback, which not only reduces the driver distortion but also lowers the output impedance of the driver. When the output stage is driven by a high-impedance source, the presence of an unbypassed emitter resistor is not degenerative. Consequently, there is no loss of sensitivity although a greater dynamic range is required. When the output impedance of the driver is lowered by the feedback of the volume control, emitter resistor R_2 in output-stage Q_2 provides a significant amount of loop feedback. Further increase of the volume control setting results in additional feedback and attenuation produced by loading of the driver collector. Volume adjustment of about 100 db can be obtained by this method. For best effect, the volume control should have an S-taper with about 5-percent resistance at 35-percent rotation and 95-percent resistance at 65-percent rotation.

Audio output stage Q_2 consists of a germanium power transistor operated under class-A conditions. When this transistor is driven without regard to distortion, the power output level is 7 watts. The power transistor must be provided with an adequate heat sink to avoid exceeding a maximum junction temperature of 85 C.

Figure 2 shows the tracked sensitivity, image rejection and i-f rejection ratios as functions of frequency. With the dummy antenna shown in the insert, the sensitivity is 2 μv across the band.

The agc and noise characteristics of the receiver are shown in Fig. 3. The receiver has a 60 db figure of merit using 5,000 μv as a reference. A signal-to-noise ratio of 20 db occurs at less than 5 μv. No oscillator blocking was experienced with signal levels up to 2 v.

Figure 4 shows the overall bandwidth at a signal frequency of 1 mc, and Fig. 5 shows the distortion as a function of signal level. The crosstalk characteristic of Fig. 6 is given for signal levels of 50, 500 and 50,000 μv. This figure is a graphical presentation of antenna selectivity coupled with r-f distortion.

For a resonance frequency of 1 mc and three desired signal levels, the curves show the signal strength which an additional or interfering carrier off resonance would have to have to produce 3 percent crosstalk (1 mw of interfering audio for one watt of normal audio).

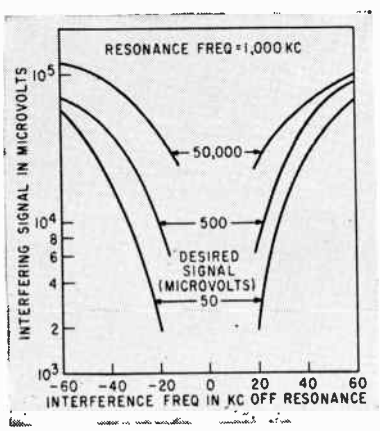


FIG. 6—Crosstalk characteristics for signal levels of 50, 500 and 50,000 microvolts

How Transistor Drives

One transistor blocking oscillator drives a cold-cathode counter tube to make a long-life decade counter having low power consumption. Waveform criteria for successful operation is discussed

By H. SADOWSKI* and M. E. CASSIDY,
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THIS AUTOMATIC RECORDING system was developed to facilitate handling of data which are obtained from several hundred radioactive samples each day. The design of this system called for a large number of compact modular decade counters capable of storing data with visual and electronic readout. These units are connected in parallel to a 10-digit bus bar system for readout at a remote station. The maximum repetition rate of the system is slightly greater than 2,000 pulses per second.

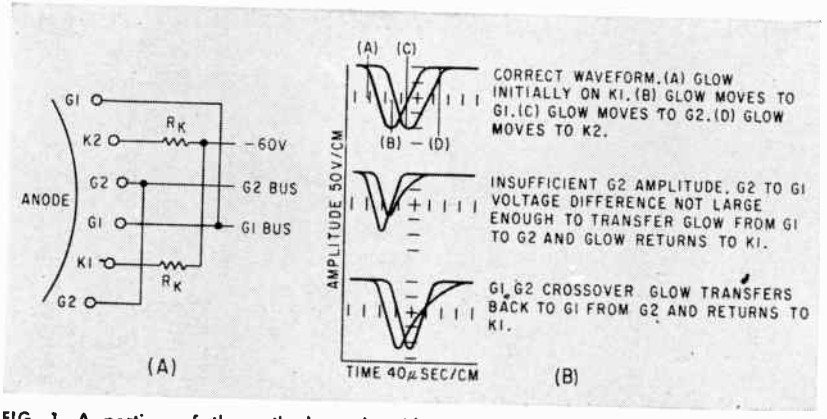

FIG. 1--A portion of the cathode and guide arrangement of the cold-cathode counter tube is shown in (A) and the waveform criteria for proper operation is shown in (B)

Decade Counter Tube

The decade counter tube, commonly referred to as a glow transfer tube, used in this unit consists of a disk (anode) surrounded by 30 electrodes (cathodes) in the form of thin rods within a gas-filled envelope. The electrodes are connected as shown in Fig. 1A. Ten of these (every third one) are called cathodes and are brought out separately at the tube base. The electrodes adjacent on the same side of each cathode are tied in common internally and a single lead is brought out through the base. This set of ten is called guide 1 (G 1). The remaining ten electrodes, on the other side of the cathodes, are connected similarly and called guide 2 (G 2). The anode connection is also made through the base of the tube.

Initially, approximately 350 v is needed to cause conduction between the anode and cathode by a gaseous discharge. The tube voltage drop under these conditions is about 190 v, while the current is limited by an anode resistor to about 0.5 ma. A positive ion sheath is formed at the current carrying cathode, resulting in a characteristic glow of the gas in this region. This gives a visible indication of the information stored in the tube. The ions in the vicinity of this cathode also serve another purpose. If all other electrodes are tied in common and a negative voltage (greater than 50 v) is applied, these ions will allow an easy transfer of the discharge to an adjacent electrode rather than to one more remotely located. This preferential ignition of adjacent electrodes is the key to the operation of the glow transfer counter tube.

To transfer this glow in a particular direction, the guides must be supplied with pulses of proper waveform (Fig. 1B). Assume that initially the discharge is at cathode 1 (K 1) and that the cathode resistor, R_K has a voltage drop across it making this cathode a few volts negative with respect to ground. A 120 v negative pulse is now applied to the guide 1 bus and the discharge transfers to the nearest guide 1. The duration of this pulse must be sufficient to allow deionization of the gas around cathode 1. As the pulse on guide 1 begins to fall in amplitude, a large negative pulse (120 v) is applied to the guide 2 bus. When the negative voltage of the adjacent 2 guide exceeds that of 1 by more than 50 v, the discharge transfers to this guide. Had the gas at cathode 1 not been deionized, the discharge might have skipped back to the 2 guide that precedes cathode 1.

The full −60 v bias appears at the cathodes because all of the anode current is now flowing into guide 2, and there is no voltage drop across any of the cathode resistors R_K. As the potential at guide 2 rises toward ground, the −60 v bias at cathode 2 causes the discharge to transfer to this cath-

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Cold-Cathode Counter

ode. The potential at cathode 2 will rise to a small negative voltage which is needed to insure a stable transfer of the discharge to this cathode. The duration of the second pulse must be sufficient to allow deionization of the gas around guide 1, to prevent skip-back to cathode 1 by this guide.

Figure 1B shows a comparison of waveforms at the guides. The top one is correct while the second illustrates insufficient amplitude of the guide 2 pulse. The discharge will not transfer but remains temporarily at guide 1 until the first pulse is over, and then returns to cathode 1. The bottom one illustrates a case where the second pulse has sufficient amplitude to transfer the discharge to guide 2 but decays more rapidly than the pulse on guide 1. Consequently, the discharge transfers back to guide 1 and finally to cathode 1.

Blocking Oscillator

The transistor blocking oscillator using emitter feedback shown in Fig. 2 was found to be a satisfactory driver. The transistor is biased near cutoff. When a negative-current pulse is applied to the base, the collector current through the primary of the transformer increases. Regeneration occurs since the tertiary winding is connected with a polarity that aids an increasing emitter current and the transistor goes rapidly into saturation. If the alpha cutoff frequency of the transistor is high enough, the rise time is determined by the primary to tertiary leakage inductance and their winding resistances in series with the tertiary shunt capacitance as well as the transformer loading. As the alpha cutoff frequency is reduced, the frequency response of the transistor ultimately limits the rise time.

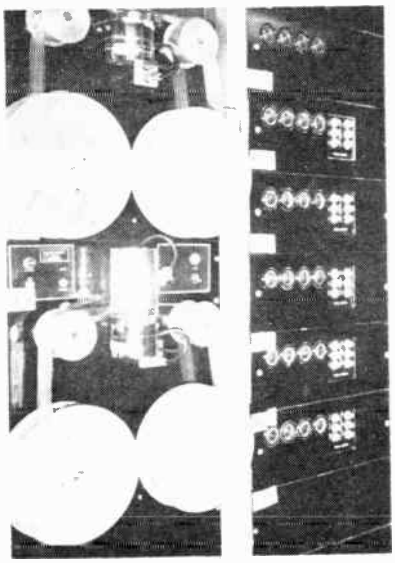
Operation

The upper waveform of Fig. 1B shows the waveform generated at the transformer secondary. The first part of the pulse charges capacitor C_1 through diode D_2 to produce a negative pulse at G_1. Because the voltage drop across D_2 is small, G_2 is held near ground potential. When the transformer reverses polarity, diode D_2 ceases to conduct and a negative pulse is applied to G_2. The voltage on capacitor C_1 adds to the transformer backswing voltage making the amplitude of the G_2 pulse comparable to that of G_1.

When capacitor C_1 discharges, diode D_1 conducts. This inhibits capacitor C_1 from charging in a reverse direction and clamps G_1 to ground. Resistor R_1 across D_2 helps discharge the circuit capacitance of G_2 when the second pulse is over.

To operate the circuit, a positive 5 v pulse of 100 μsec duration is required. Negative input signals are removed by diodes D_3 and D_4. Capacitor C_2 prevents d-c from reaching the transformer. Resistor R_2 converts the signal into a current pulse and reduces the amplitude of transients fed back to the blocking oscillator.

While receiving data, all cathodes



Typical installation shows mounting of glow decade modules

are tied to the bias line through their load resistors. The current-carrying cathode is a few volts below ground due to the voltage drop across its load resistor. Electrical readout is accomplished by placing S_1 in the read position. This grounds the cathode bias line and drives the current-carrying cathode to positive 25 v while all others are held at ground. The positive signal is fed through a diode to the appropriate digit line. To reset the glow to a particular cathode, switch S_2 disconnects the cathodes from the bias. The elements then rise to a positive 100 v. The potential difference between the elements and the zero cathode is large enough to insure transfer to the zero cathode.

Acknowledgment is given to G. B. B. Chaplin of the Atomic Energy Research Establishment, Harwell, England, and H. J. Di-Giovanni of the Del Electronics Corp.

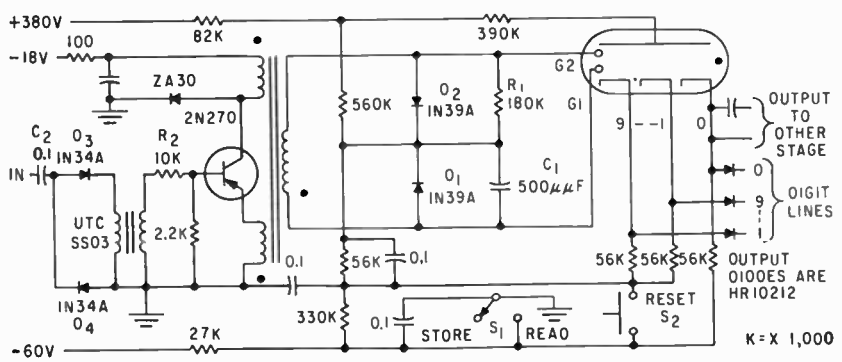


FIG. 2—A series of transistorized cold-cathode decade counters may be coupled together to increase the count range

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Circuit Design Using

Proper utilization of the voltage-variable silicon capacitor requires that the electronics designer know the limitations of this device and understand how it works. The information presented here will enable engineers to use this new component intelligently and successfully

By J. **HAMMERSLAG**, Semiconductor Division, Hughes Products, Newport Beach, Calif.

HIGHLY COMPLEX EQUIPMENT of the present day may use tens of thousands of components in one system. It is becoming increasingly vital to keep the size and weight of these components as small and as reliable as possible. To achieve this aim, it often is not sufficient merely to improve the design of existing components. It is often desirable to make radical departures in the basic design and principle of the components.

An example of such a radical departure from conventional basic design is the silicon capacitor, a device which not only fulfills the function of a conventional variable air capacitor, but does so on an entirly different and until recently unused principle.

The Device

The silicon capacitor is basically a semiconductor diode whose capacitance can be varied by varying the externally applied bias voltage.

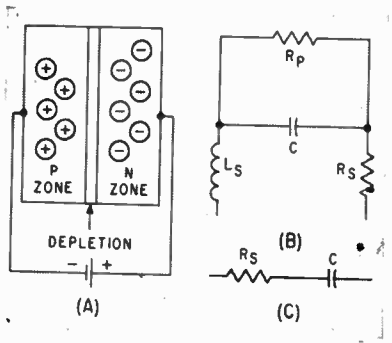


FIG. 1—Structure of silicon capacitor crystal is shown (A) along with equivalent (B) and simplified equivalent (C) circuits

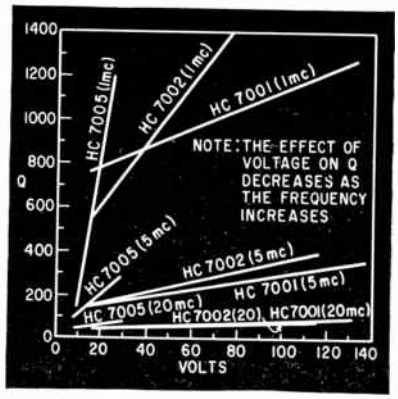


FIG. 2—Variation of Q with frequency and voltage for typical silicon capacitors is shown

A semiconductor junction can be considered as consisting of the three distinct zones shown in Fig. 1A. When the junction is used as a diode, a positive potential on the p side of the junction and a negative potential on the n side of the junction cause the carriers to bridge the depletion zone, thus forming a conducting path across the junction.

Reversal of the potential causes the depletion zone to reappear, insulating the two sides of the junction from each other. When the junction is used as a variable capacitor, the external potential is generally applied in such a manner that the depletion gap is never bridged with carriers. Looking at the junction in this manner, the device appears as a parallel plate capacitor. The p and the n zone represent the plates and the depletion zone, the dielectric.

When a potential is applied across the junction in a direction which would normally not cause conduction, this potential will cause the carriers to be pulled away from the depletion zone. The distance the carriers are pulled away from the depletion zone is a direct function of the potential applied. The larger the potential, the further the carriers are pulled away. The further conducting plates are pulled apart, the lower the capacitance of the device.

Capacitance vs Voltage

In the case of an abrupt junction (abrupt transition from the p zone to the depletion zone to the n zone) such as is in alloyed junctions, the capacitance varies with voltage according to the relation $C = K/(V_o + V)^n$, where C is

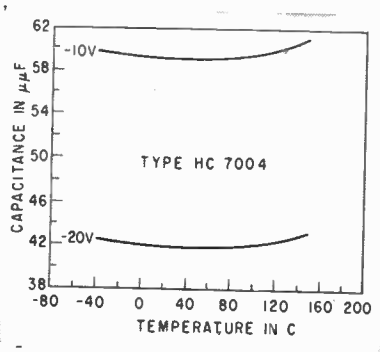


FIG. 3—Variation of capacitance with temperature is small; usually less than 200 ppm

Silicon Capacitors

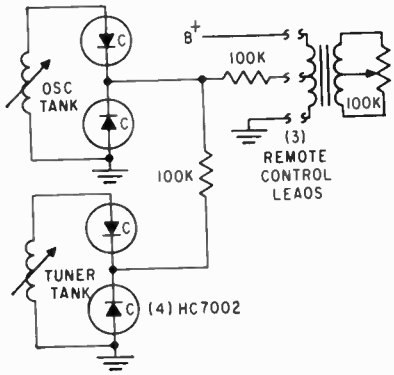


FIG. 4—Remote control is simplified by using diode capacitors

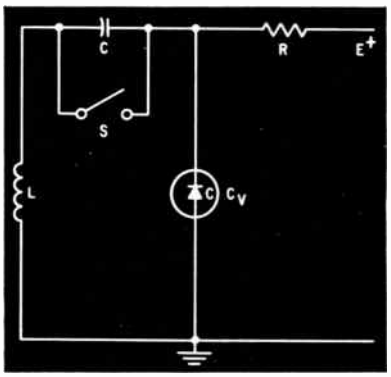


FIG. 5—Sweep circuit is controlled by opening and closing of switch

capacitance, K proportionality constant, V_o contact potential, V externally applied voltage and n characteristic exponent.

For alloyed-junction silicon capacitors V_o is approximately 0.5 v and n is approximately 0.46. The value of K varies from device to device and its value depends primarily on the resistivity of the silicon material.

Maximum to minimum capacitances ratios of as high as 35 to 1 have been obtained. Not all of this range is always usable, as will be explained later.

Equivalent Circuit

In addition to a capacitance, the device also has series and parallel resistance as well as a series inductance (Fig. 1B).

Series inductance, L_s, is usually negligible. Parallel resistanc R_p, is in the order of thousands of meghoms at room temperature (usually several megohms at 150C) and can, usually be neglected. The equivalent circuit can be simplified to the approximate equivalent circuit of Fig. 1C.

The resistance R_s has a very important effect on the usefulness of the device, because it is the determining factor of the Q of the device. It is desirable that the Q of a capacitor used in resonant circuits be as high as possible. At present, the Q of available silicon capacitors is low. Therefore it is important that the design engineer using the device be well acquainted with the various external factors affecting the Q. Then, he can design the circuit to create conditions for maximum Q.

Since $Q = 1/2\pi fCR_s$, frequency and capacitance affect Q. As capacitance is dependent on applied voltage, voltage affects Q. Also, since R_s is essentially the physical resistance of the conducting portion of the silicon crystal, and this conducting portion becomes thinner as the applied voltage is increased, the applied voltage has an effect on R_s and therefore on Q. Figure 2 shows the variation of Q with frequency and voltage.

Stability

The capacitance of the device is extremely stable. Capacitance does change somewhat with temperature, probably because of variation of contact potential with temperature. Figure 3 shows typical C vs temperature curves. As can be seen, the variation of C with temperature is quite small.

Although the absolute capacitance at a given voltage varies from device to device, the rate of variation of capacitance with voltage is constant, provided reasonable care is taken in the formation of the junction. The term n in the relation $C = K/(V_o + V)^n$ remains fixed from device to device. In some commercial units n varies less than 1 percent from unit to unit. A constant value of n is essential to obtain good tracking in tuned circuits.

Applications

It is advantageous to use a silicon capacitor when one or more of the following are needed: variation of reactance (capacitive or inductive) electrically, small size and weight, resistance to severe environmental conditions, and automated assembly.

There will generally be two parts to the circuit employing silicon capacitor. The controlled circuit is the circuit, usually a signal circuit, that is affected by a change in capacitance of the silicon capacitor. The controlling circuit is the circuit that changes the bias across the silicon capacitor in order to change capacitance.

Design considerations for the controlled circuits are Q, capacitance range and parasitic change of capacitance due to the signal it-

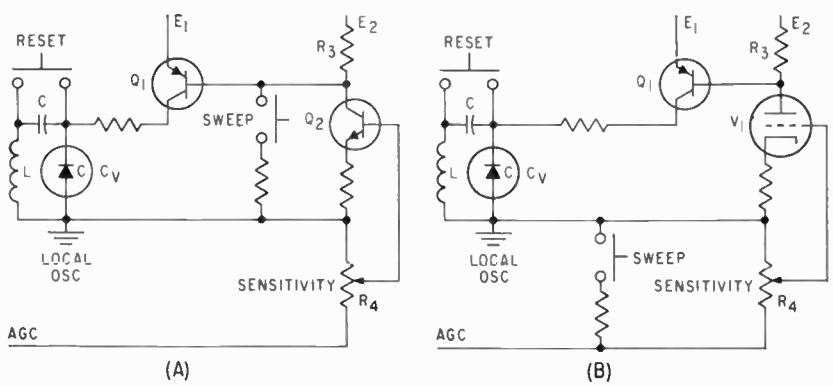


FIG. 6—Typical sweeping circuits use either a transistor (A) or a vacuum tube (B) to control tuning

self. The highest Q will be obtained with the highest bias voltage. This will limit the capacitance range, since most of the capacitance change takes place at low bias voltages. A compromise is usually necessary to obtain maximum Q with suitable capacitance range.

Much of the distortion resulting from parasitic change of capacitance due to the signal can be eliminated by keeping the bias high compared to the signal voltage. Again, a compromise has to be made to reach acceptable capacitance variation without excessive distortion.

The controlling circuit must create the bias change necessary to obtain the desired capacitance change without interfering with the normal function of the controlled circuits. Usually the controlling circuit is designed to produce just the voltage variation needed to obtain the required capacitance change and a resistor of several megohms is inserted between the controlling and controlled circuits. The only current flowing through this resistor is usually the leakage current of the silicon capacitor, seldom more than a microampere.

Typical Circuits

Figure 4 shows a method of obtaining remote control of broadcast receivers. The resonant frequency of both the oscillator tank and tuner tank are tunable over the broadcast band by turning the 100,000 ohm potentiometer. Tracking is achieved by adjusting the cores in the coils.

The principle of automatic sweep[1] is revealed in Fig. 5. Here C_v and L are the tuned-circuit elements. Capacitor C is a d-c blocking capacitor whose value is large compared to that of C_v while R is an isolating resistor.

When S is opened, C charges exponentially toward E at a rate determined by time constant CR and control voltage E. During the charging cycle, the circuit sweeps through a frequency band defined by L, C_v, and E. Upon completion of the charging process, closing S will reset the circuit to the initial condition. Opening and closing of S can be made automatic by replacing the switch with a device that fires at a certain voltage.

Figure 6 illustrates two circuits that use agc in a feedback system to control the charging current. Operation of each is identical although transistor Q_2 of Fig. 6A is replaced by a vacuum tube in Fig. 6B, because of the higher impedance levels encountered.

Assume that the reset and sweep switches of Fig. 6A are open and that the agc is below the threshold level set by R_1. Transistor Q_2 will be fully conducting. If the voltage drop across R_3 is greater than the difference between voltages E_1 and E_2, transistor Q_1 will present a low resistance path for the charging current of C.

As the sweep frequency approaches a station, the agc voltage becomes more negative and tends to cut off Q_2. This action changes Q_1 from a low- to a high-resistance state. Therefore, the circuit stays tuned to the station.

Any frequency drift due to the discharge of C through the finite circuit resistance results in a decrease of agc voltage, with subsequent resistance changes of controlling element Q_1, permitting more charging current to flow until an equillibrium position is reached.

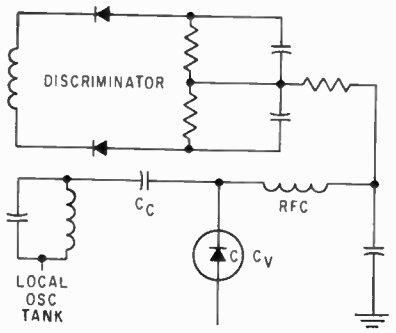


FIG. 7—Silicon capacitor replaces reactance tube in afc circuit

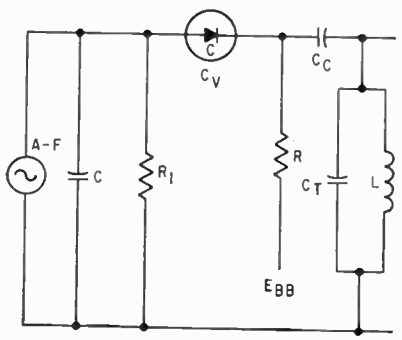


FIG. 8—Center frequency of f-m circuit is set by d-c bios voltage

Temporary closure of the sweep switch in Fig. 6A or B allows continuation of the sweep until the next station is reached. After reaching the top of the band, the circuit can be reset by closing the reset switch. The sensitivity control permits selection of stations on the basis of signal strength.

Automatic Frequency Control

In automatic frequency controls, the silicon capacitor replaces a reactance tube. In Fig. 7, the output voltage from the discriminator varies the voltage on the C_v and hence the local oscillator frequency so as to correct for any frequency drift due to extraneous causes.

The circuit in Fig. 8 demonstrates how silicon capacitors can be utilized in frequency modulation. The audio voltage appearing across R_1 varies the capacitance of C_v and the tank circuit. The d-c bias voltage E_{BB}, applied through isolating resistor R, controls the center frequency. Capacitor C acts as an r-f bypass, while C_c blocks the d-c.

Possible Applications

Recently several companies have announced microminiature construction techniques. Such construction has made it possible to decrease the component density to millions of components per cu ft.

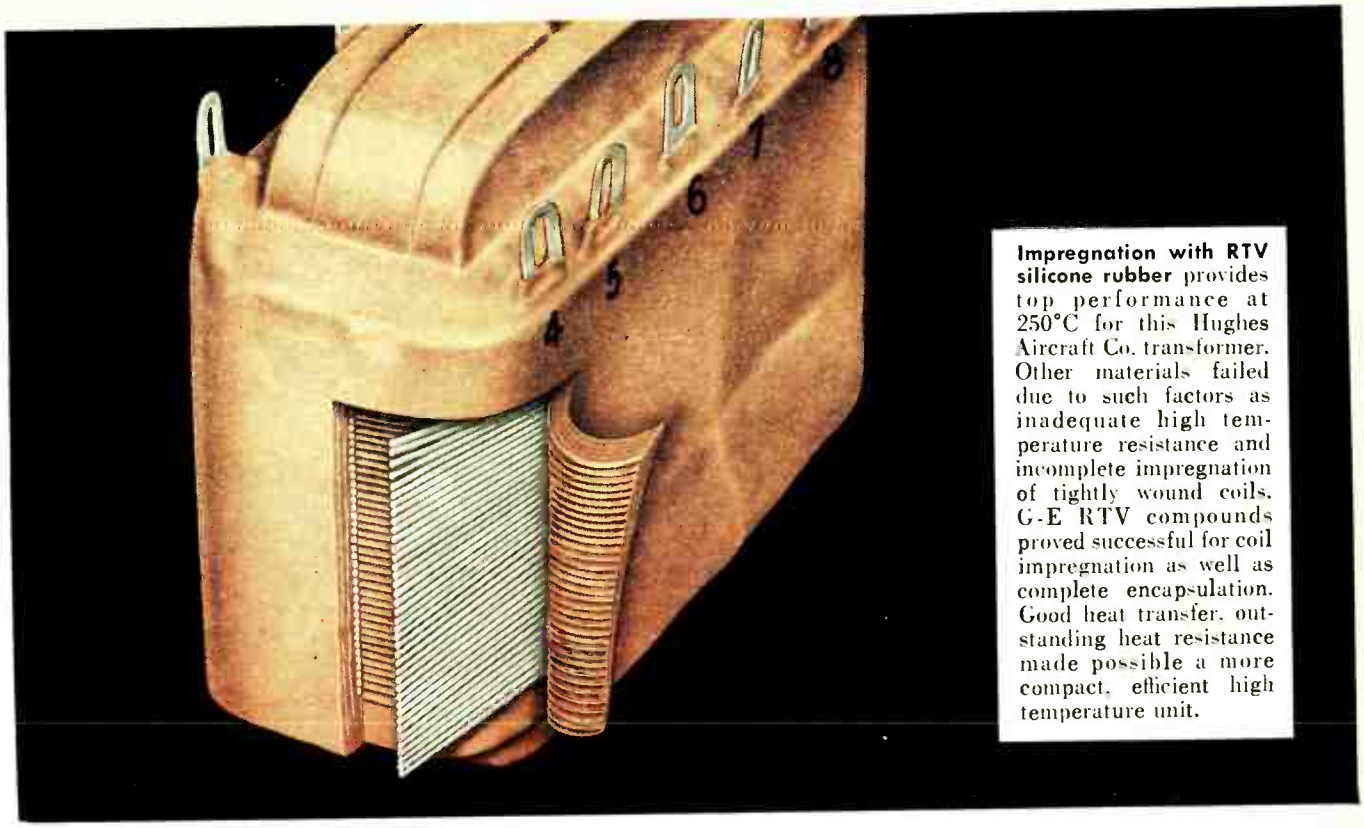
The one component that has not been included in this type of construction is the variable capacitor. This obstacle may be overcome with the silicon capacitor.

It is usually easier to change the voltage than effect mechanical changes by telemetering techniques. The use of silicon capacitors in missile and satellite transmitters and receivers may make tuning from the ground more practical.

A signal-seeking and frequency-correcting receiver which uses silicon capacitors has been built. This receiver latches on and locks-in to a transmitter frequency over an entire band. This afc technique makes possible transmitter-receiver combinations requiring less frequency stability.

REFERENCE

(1) Jan Black, Hughes Bulletin SP8-HM-LP-8/58, Aug. 15, 1958.



Impregnation with RTV silicone rubber provides top performance at 250°C for this Hughes Aircraft Co. transformer. Other materials failed due to such factors as inadequate high temperature resistance and incomplete impregnation of tightly wound coils. G-E RTV compounds proved successful for coil impregnation as well as complete encapsulation. Good heat transfer, outstanding heat resistance made possible a more compact, efficient high temperature unit.

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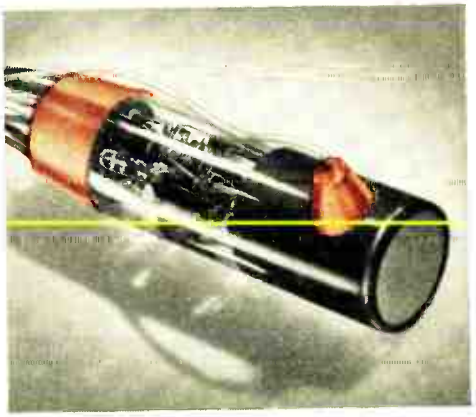
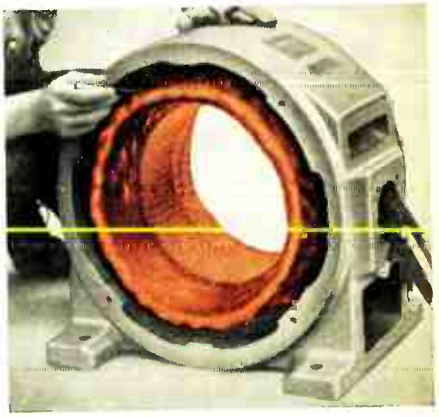


Protection from high altitude arc-over and corona is provided for this cathode ray tube by encapsulating all lead wires with RTV (room temperature vulcanizing) silicone rubber. Designed for airborne operation and installed in a non-pressurized section of the aircraft, tube is protected from arc-over and corona at altitudes up to 70,000 feet.



Extended service life for motors through RTV encapsulation of stator windings, introduced by General Electric motor departments. RTV's resistance to moisture and other contaminants enables these dripproof motors to meet certain applications formerly requiring totally enclosed units. RTV has low viscosity, rapid cure.

For application data and samples of General Electric RTV silicone rubber, write General Electric Company, Silicone Products Department, Section N98, Waterford, New York

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Silicone Products Department, Waterford, New York

Chart Finds Loaded Q

Loaded Q of a capacitor-shortened, quarter-wave transmission line of uniform impedance is found quickly using this nomograph

By ROY A. HENDERSON, Design Engineer, Radio Corporation of America, Camden, N. J.

WHEN TRANSMISSION LINES are used as tuning elements for amplifier tubes, the loaded Q (Q_L) of the line is important. Computation of Q_L can be very lengthy if the line contains a number of small sections, each having a different impedance.

Approximation

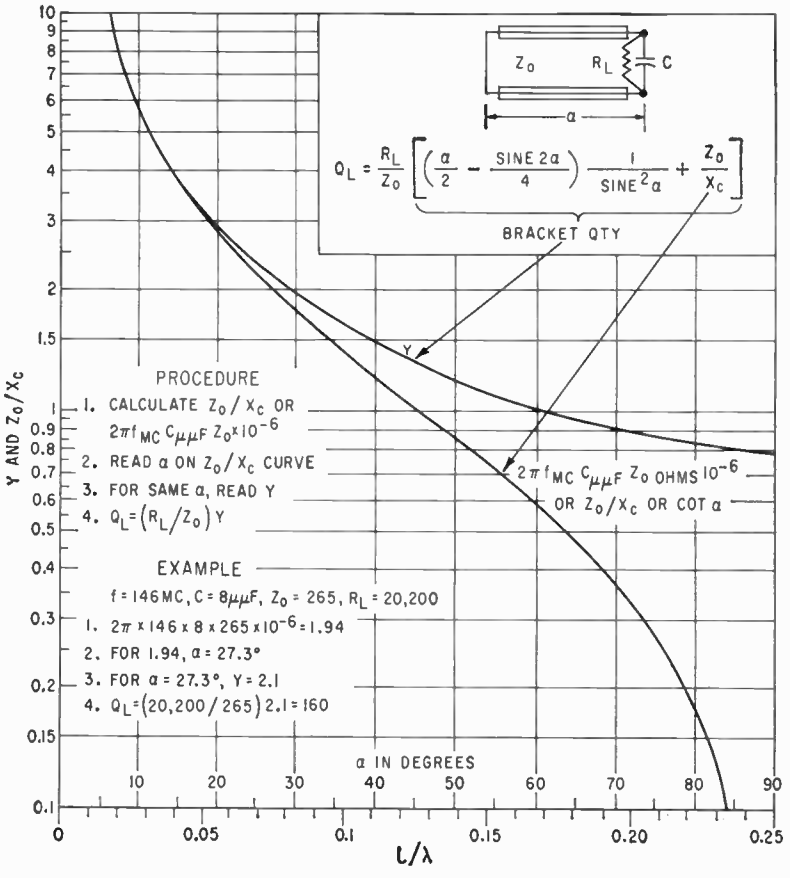
In many cases the line has a long uniform impedance section with a shorting slider for tuning to various frequencies. If this uniform impedance section is long compared to the other sections, the entire line can be approximated at the lowest frequency by the uniform impedance line with only a small error.

This approximation makes it possible to determine Q_L as a function of tube capacitance and line and load impedances using the curve shown. Although use is limited to the lowest frequencies in the band, the curve helps to determine what line impedances are required for an acceptable Q. Thus it can be used in the initial design stages.

Example

The equation for Q_L is given on the curve. The term within the bracket is plotted as the Y curve. The lower curve is a plot of Z_o/X_c.

The example and procedure show how to find Q_L when f, C, Z_o and R_L are given. Where α is known, Q_L can be found by starting with step 3 of the procedure given.



The procedure and example shown are for a shortened quarter-wave line. In calculating Q_L for lines which include several quarter-wave sections, the bracket term (Y) must be increased by 0.785 for each additional section.

The alternate abscissa (showing the amount of line shortening) is the ratio of line length, l, to the wave length, λ. It should be noted that in the uhf range the tube capacitance is usually less than listed in tube data sheets because of different voltage distribution.

Bibliography

L. L. Koros, A Novel UHF Power Amplifier System, *RCA Review*, June 1955.

W. C. Hollis, Design of Transmission Line Tank Circuits, ELECTRONICS, 20, May 1947.

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Microwave Antenna Saves Space

By JAMES O. PULLMAN*, Naval Research Laboratory, Washington, D. C.

PHYSICAL DIMENSIONS, weight and mechanical properties of conventional microwave antennas have led to new types, including endfire radiators. Thus in a missile, where frontal area needed for a forward-looking beam may be unavailable, an endfire antenna of sufficient length along the missile frame may be used.

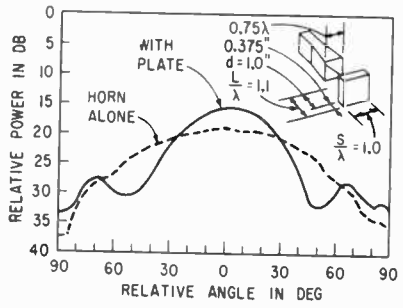


FIG. 1—Addition of dielectric plate improves gain and beamwidth

A new configuration, the dielectric plate array, has been investigated[1] at the Naval Research Laboratory. It can use both available aperture area and endfire length, using available space more efficiently than most conventional antennas. It is also easy to produce.

Basic Antenna

The simplest form, Fig. 1, has a Plexiglas plate one wavelength square placed about one wavelength in front and along the axis of a small X-band horn. Plate thickness is one-half wavelength, so reflections from front and back surfaces cancel. Half-power beamwidth has been narrowed from over 70 to 42 deg, and on-axis gain has increased 3.0 db. The only space penalty is about 1.1 wavelengths in front of the existing aperture.

Radiation patterns in Fig. 2 (displaced to coincide at zero deg) for various positions of the plate are shown. Pattern 1 is that of the horn alone. As the plate is moved out, gain and beamwidth rapidly improve.

The pattern in Fig. 1 represents optimum gain improvement with this plate. As the plate is moved further from the feed, sidelobes rise eventually merging with the main beam to yield the feed pattern again. Plates up to two wavelengths square give higher gains but also higher sidelobes. Plates as small as one-half wavelength square were used to advantage. Experiments were performed with feed horns up to about ten wavelengths square. In all cases, a plate of about the same size as the feed aperture produced results similar to those illustrated. Vswr was generally low.

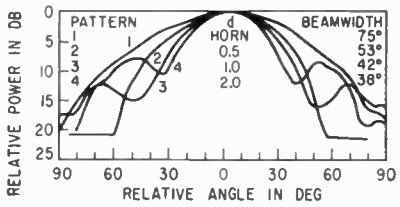


FIG. 2—As plate is moved away from horn, gain and beamwidth improve

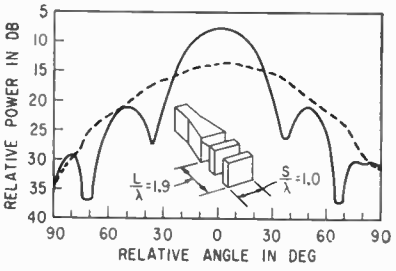


FIG. 3—Use of two plates reduces beamwidth from 75 to 36 deg

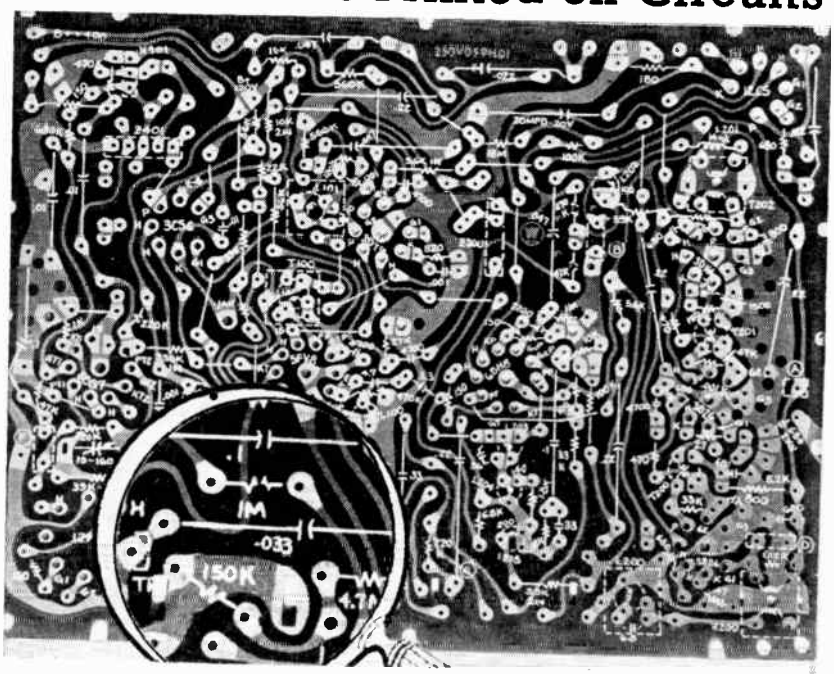
Single-plate configurations can be dramatically improved by adding a second plate between the first and the horn. Radiation pattern in Fig. 3 represents optimum gain using two one-wavelength square plates. Beamwidth has been reduced from 75 to 36 deg; improvement in on-axis gain over the horn is 5.8 db. This gain added to that of the horn gives an absolute gain just under 13 db.

Sidelobe levels lower than those in Fig. 3 may be obtained at some sacrifice of gain and beamwidth. Plate spacing of half that shown yielded a tent-shaped beam of 45 deg half-power width and containing no sidelobes within 33 db of the on-axis level.

Antennas with more than two plates are difficult to evaluate em-

* Presently with Department of Physics, Duke University, Durham, N. C.

Service Data Is Printed on Circuits



Printed circuit boards of new Westinghouse tv sets have wiring diagram silkscreened on back. Service data includes component values and key voltages

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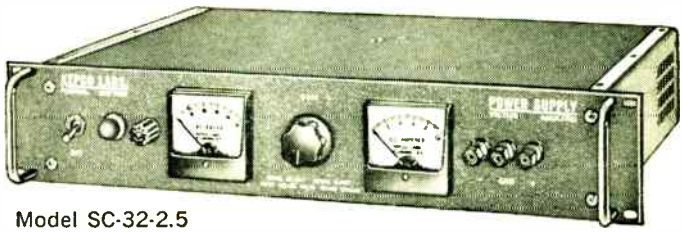

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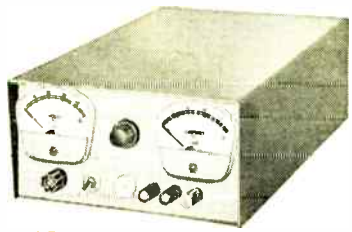
DUAL OUTPUT	0-32	0-1.5
SC-32-2.5	0-32	0-2.5
SC-32-5	0-32	0-5
SC-32-10	0-32	0-10
SC-32-15	0-32	0-15
SC-60-2	0-60	0-2
SC-60-5	0-60	0-5
2SC-100-0.2	0-100	0-0.2
DUAL OUTPUT	0-100	0-0.2
SC-150-1	0-150	0-1
SC-300-1	0-300	0-1



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SC-18-4	0-18	0-4
SC-36-0.5	0-36	0-0.5
SC-36-1	0-36	0-1
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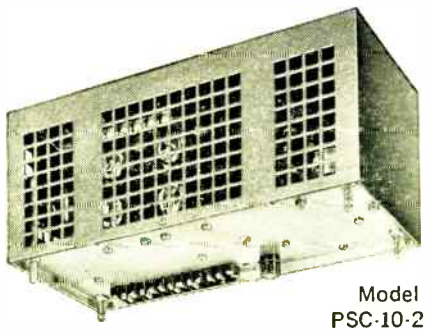

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PSC-28-1	22.5-32.5	1
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pirically. Beamwidth of one of the better three-plate antennas is 35 deg. Sidelobes are 22 db down and absolute gain is about 11.5 db.

Dielectrics

Some of the experiments were repeated with plates of a ceramic material of four times the dielectric constant of Plexiglas. Gain improved or sidelobe level was lowered for a given gain. The plates were lighter and thinner than those of Plexiglas.

At X band, the dielectric plate antenna is light. At S band and longer wavelengths, however, the plastic slabs begin to assume massive proportions. Therefore, the above antennas were successfully simulated at S band using an almost arbitrarily light artificial dielectric composed of metal posts. Results in general approached those above.

To demonstrate practical use, an effort was made to improve radiation pattern of a broadside array. A waveguide slot array 20 wavelengths long was used. The slots radiated into a short parallel-plate region flared to half-wavelength width at the mouth. The beam was nearly broadside, the peak occurring at 85 deg with the line of the array. Horizontal beamwidth was 3.1 deg and vertical beamwidth about 77 deg.

Plexiglas plates, one wavelength wide and one-half dielectric wavelength thick, were placed in front of the slots. A single plate less than one wavelength from the array raised gain 3 db and narrowed vertical beam to 40 deg. A second plate increased gain more than 4 db and narrowed vertical beamwidth to 30 deg. Neither beamwidth nor sidelobe level in the horizontal (narrow) plane was affected.

REFERENCE

(1) J. O. Pullman, Naval Research Report 5068, Jan. 24, 1958.

Solar Cells Aid Photosynthesis Study

METHOD for decomposing water into its basic elements by a beam of light has been discovered by two New York University scientists. The work apparently confirms certain theories dealing with photosynthesis in plants and may be useful in future studies concerning solar energy applications.

The method was developed in the course of basic research into the electrical properties of organic crystals. Equipment used is similar to a solar battery, but artificial ultraviolet light is used rather than sunlight. Organic crystal used is anthracene, an inexpensive chemical related to naphthalene.

A flat circular crystal, 0.0005 in. thick and 0.02 sq in. in area, is mounted in an electrical cell. Each face is bathed in a separate dilute salt solution. This is accomplished by mounting the crystal in a small window of a plastic divider that separates the solutions.

When ultraviolet light is directed on one face, the crystal becomes a battery developing a potential of 0.2 v. Resulting current is measured through two silver wires, one in each salt solution.

Power developed by the crystal is in the order of microwatts.

Current flowing through the cell indicates that water is being decomposed, with hydrogen forming on one face and oxygen on the other. This result may be significant in the study of photosynthesis, the process by which plants use solar energy to transfer carbon dioxide and water into carbohydrates.

One explanation of photosynthesis places chlorophyll in the role of a photovoltaic generator that becomes an electric battery under the influence of light. This battery causes water to decompose.

Project was supported by Office of Naval Research and Air Force Cambridge Research Center.

Cryogenic Tests For Countermeasures

Absolute zero within 1 deg F is achieved by Sperry Gyroscope Co. scientist in tests of components for countermeasures systems. Equipment is being tested in bath of liquid helium

can be extended to more than three units; it also can be closed to a ring. Thus counters of different degrees of complexity can be achieved.

Four-Stage Ring Counter

In Fig. 1B, it is apparent that in such a sequential arrangement the interconnections between stages have to be made from n-type to n-type material and from p-type to p-type material. That is why, at least for the stepping application, an integrated structure can be made readily. Fig. 2 is a top view photograph of the four-stage ring counter before leads are attached. The various regions are visible since they have been produced by diffusion techniques which resulted in silicon dioxide layers of various thicknesses on the different regions. The four quadrants correspond to the uppermost p regions in Fig. 1B. In each of these quadrants there are two "paddles" which are the location of two n-type regions corresponding to the small n-type region in Fig. 1B. Only one each will be contacted, the second one being introduced for symmetry reasons only. The remainder of the picture shows the center n-type

40-ft Shock Tube

Small size version of a nose cone, used to study missile entry into the atmosphere of Venus, is inserted into end of 40-foot-long shock tube by K. K. Chan and R. W. Rutowski at Lockheed Missiles and Space division's Scientific Research Laboratory in Palo Alto, California. They are collecting experimental data on missile entry into neighboring planets. The entry problem for Venus is about 50 percent greater than for earth

region penetrating to the surface. The entire back surface forms the lowest *p*-type region in Fig. 1B.

After removal of the silicon dioxide layer, contacts will be made to every second "paddle" and to the back surface. Thus the four-stage ring counter requires a total of only five external contacts. It also should be noted that the actual unit is just 1 mm in diameter.

The current level at which these devices are operated can be designed within the range of 1 to 100 ma with supply voltages of 10 to 100 volts. They have been operated at speeds up to one million pulses per second. With improved design, it is expected that they will operate even faster.

These types of devices have potential applications to digital computers and telephone switching.

REFERENCE

(1) L. A. D'Asaro, A Stepping Transistor Element, paper presented at Western Electronic Show and Convention, August 18, 1959, at San Francisco, and published in 1959 *IRE Wescon Convention Record*, Part 3, p 37.

Magnetic Modulator Of Photocell Current

A SENSITIVE microphotometer, developed by G. Striker of the Technical College, Budapest, uses the known principle of magnetic modulation of photocell current. The method of modulation is applied to the photoelectron multiplier, thus utilizing to the full the high sensitivity of these tubes, by enabling the use of high-stability a-c electronic amplifiers without any mechanical vibrating of the light beam.

Magnetic coils in the immediate vicinity of the tube produce an alternating magnetic field at right angles to the electron paths. The alternating component of the photocell current produced in this way is passed on to the indicating or registering instrument over an alternating voltage amplifier with an input sensitivity of about $3\mu v$.

The light sensitivity of the new instrument lies in the magnitude of 10^{-12} lumen. At such low levels the quantum nature of light is already quite noticeable. By using the Naray method, the dark current of the multiplier tube is substantially suppressed.

How to Detect Contaminant Traces

By D. O. FEDER and D. E. KOONTZ, Bell Telephone Laboratories, Inc., Murray Hill, N. J.

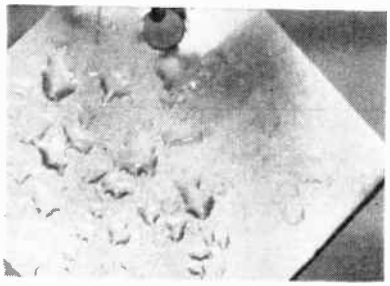
WETTABILITY TESTS provide simple, nondestructive methods of detecting hydrophobic contaminants on electronic device parts. Among contaminants detected are machine lubricants, coolants and cutting oils, human fatty materials, greasy airborne dust and organic residues from plating and polishing baths.

Even a single molecular layer of contaminants can seriously affect component performance. Experiments at these laboratories show that cathode activity of a travelling wave tube can be improved 53 percent on the average by removing extraneous materials. In addition, brazing and welding of tube components become more reliable.

The tests described depend on the ability of water to wet metallic and inorganic surfaces, but not to wet oily or greasy surfaces. Until recently, there have been almost no practical applications of this in electron device production.

Atomizer test of clean nickel surface (2X)

Atomizer test of nickel surface covered with hydrophobic contaminant (2X)

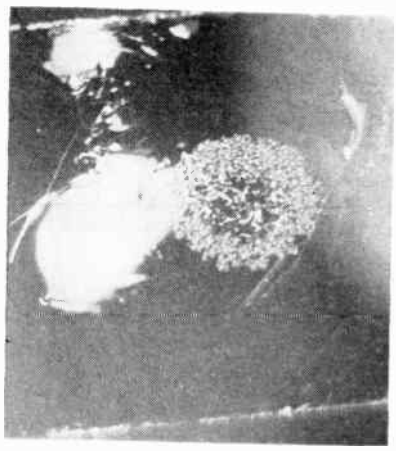


Atomizer test of partially contaminated nickel specimen (2X)

Atomizer test of nickel with traces of hydrophobic contamination (2X)

Test Procedures

A water break test is performed by immersing and withdrawing the surface being tested from a beaker of overflowing water free of organic contaminants. An uncontaminated surface exhibits a thin uniform film of water over the surface until evaporation sets in or interference colors are observed. A contaminated surface shows breaks in the surface immediately (when grossly contaminated) or upon 30 to 60 seconds draining.



Test pattern showing proper performance of the atomizer. The white areas are delaminations of the mica test blank

An atomizer test consists of spraying the dry surface with contaminant-free water in a fine spray. The surface is sprayed 3 to 30 seconds with the atomizer held 18 to 24 inches from the surface. The droplets form a thin continuous film over a clean surface or remain as fine droplets on a completely contaminated surface. Droplets also form on contaminated areas of clean surfaces. When only traces of contaminants are present, slight discontinuities appear in the water film.

The tests can be interpreted rapidly and reproducibly by referring to a series of photographs showing the water film condition on surfaces with known amounts of contaminants. The photos serve as go-no-go standards.

Checks can be made on freshly cleaved mica to insure that contaminants are not being introduced from the test equipment. A freshly cleaved mica surface has no detectable hydrophobic contaminants. A drop of a fatty acid-acetone solution is placed on the mica and allowed to evaporate. The test will show only the deliberately contaminated area if the equipment is clean. If the mica is flooded and the spot does not appear, the atomizer is supplying too much water.

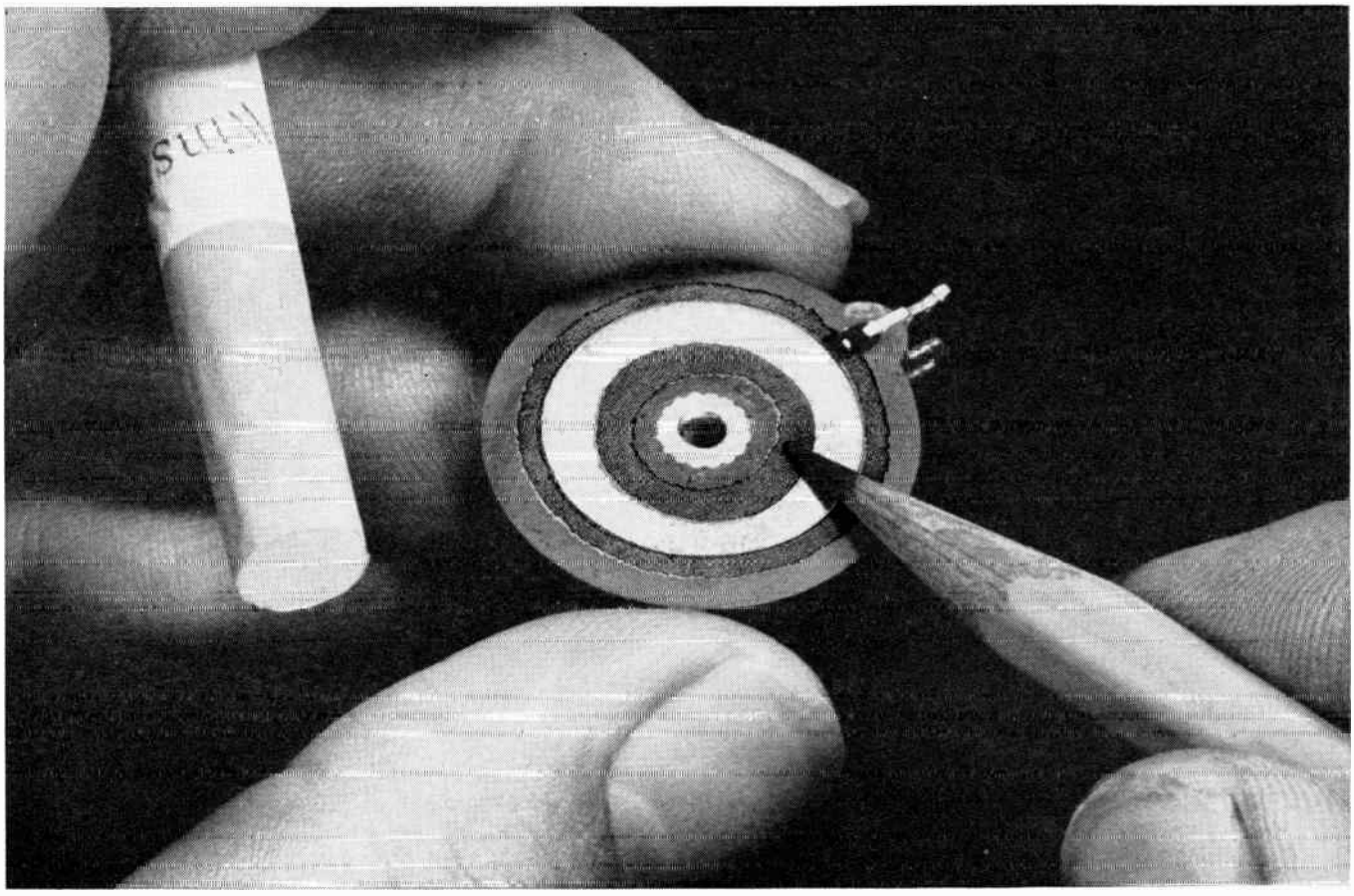
Other investigations have demonstrated that both tests will detect less than 1 molecular layer of polar soils. The atomizer test will detect a small fraction of a monolayer or as little as 0.16×10^{-7} g/cm^2.

Fine Wire Tests

Parts with plane surfaces as small as $\frac{1}{4}$ inch and wires as fine as 0.015 inch diameter are being routinely tested in these laboratories at magnifications of 5 to 40. More minute parts may be examined at 40 to 400 magnification after droplets are formed from steam or by chilling the part below the ambient dewpoint.

The tests are also well suited to tracing contaminants to their source in solvents, rinse water, storage containers and protective atmospheres. A cleaved mica sheet is exposed to the suspected source and then subjected to the tests.

Common methods of cleaning electron device parts were surveyed



If it hasn't got it HERE it hasn't got it!

The long term performance of any toroidal coil is tied directly to the quality of its manufacture. Reliability under environmental extremes means everything. Throughout the industry, C-A-C's MP (molded plastic) coils have developed a reputation for performance and dependability. Periodic quality control tests of C-A-C coils consistently display temperature co-efficients of less than 30 PPM per degree C. Since C-A-C pioneered the MP coil, production techniques have been developed which *guarantee* the highest quality and competitive price structures. *You get more quality/ performance when you specify C-A-C.*

Consider these advantages...

1. Center bushing, threaded or unthreaded, provides easy, durable mounting . . . may be "stacked." Saves money.

2. Simple wiring procedures; frequently replaces a terminal board. Terrific resistance to shock, vibration.

3. Quality, internal construction dictates the parameter you'll measure at the terminals. Consistent performance is assured.

4. Quality appearance . . . adds that "expensive" look to your equipment without extra cost.

5. Low prices . . . because of C-A-C's fast, quality-controlled-all-the-way production techniques.

Other Components—quality and precision built by C-A-C

Toroidal COILS, sub-miniature, conventional; MP (molded plastic); HS (hermetically sealed); uncased, plastic dipped. Power TRANSFORMERS, Filter REACTORS: Filament TRANSFORMERS, DC to DC converter TRANSFORMERS, Class "T" TRANSFORMERS and REACTORS. Low pass FILTERS, Band Pass FILTERS, Special FILTERS, Telegraph Tone FILTERS, Telemeter Channel FILTERS, Aircraft Navigation FILTERS. Special MAGNETIC AMPLIFIER Devices.

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with the test. The results show that many of them will not remove the last traces of organic contaminants.

Performance of Cleaners

Samples cleaned by solvent extraction methods failed to pass both tests. Parts cleaned by acid etching passed the water break tests. Parts cleaned by mixed concentrated acetic, nitric and hydrochloric acids passed the atomizer test, but this is a dangerous medium. Parts cleaned by electrolytic sulfuric acid and by mixed hydrochloric acid and hydrogen peroxide failed the atomizer test.

Storage Vessel	Days[a]
New Polyethylene Bag	1
19/38 Standard Taper Ground Glass Joint	
—Greased	1
—Ungreased	30
Glass Petri Dish	5
Screw Cap Bottle with Teflon Gasket	15
Sealed Glass Tube	[b]

(a) Inspected after 1, 2, 3, 5, 7, 10, 15, 30 and 60 days storage (b) No hydrophobic contamination after 60 days

FIG. 1—Effectiveness of clean storage vessels in preventing hydrophobic recontamination of clean test specimens

Parts cleaned by alkaline cleaners all passed the water break test. Parts cleaned by solutions of carbonate-silicate passed the atomizer test, but hydroxide-carbonate and hydroxide-phosphate solution failed to clean the parts. A few lengthy heat treatments in dry or wet hydrogen passed the water break test, but all cycles in dry nitrogen and dry or wet hydrogen failed the atomizer test. Sequential oxidation-hydrogen reduction heat treatments passed both tests.

Abrasive cleaning (liquid honing) passed the water break test, but failed the atomizer test. Aqueous oxidation in 3 percent hydrogen peroxide passed both tests when parts were held 20 minutes in baths of 90-100 C temperature and pH

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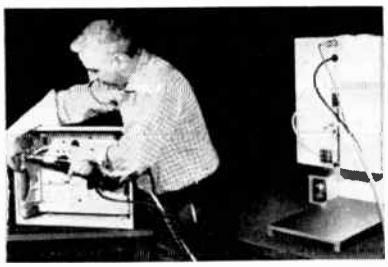
above 5. Ultrasonic cleaning in a continuously flowing system failed both tests when the cleaning medium was a detergent solution, carbon tetrachloride or carbon tetrachloride with 180 mesh silicon-carbide. Ultrasonic cleaning in alkaline silicate for 30 minutes at 60 C passed both tests.

Cleaned parts must be protected against contamination. Several simple storage systems were evaluated. Fig. 1 indicates that effective storage may be achieved for periods up to two months in clean vessels containing room air. Length of effective storage appears to depend on container seals.
(From a paper by the authors in "Symposium on Cleaning Electronic Device Components and Materials," ASTM STP 246, American Society for Testing Materials, Philadelphia, 1959.)

Pneumatic Tube Shoots Screws to Gun Driver



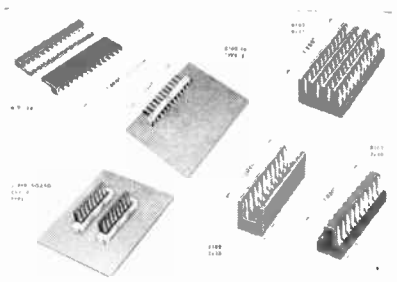
Sets screws are transported from table-top selector to gun via tube

GUN-TYPE automatic feeder-driver for set screws, recently announced by The Bristol Co., Waterbury, Conn., permits screws to be driven 15 feet or more from the machine. The machine is also portable.

Screws are fed from a rotary hopper to a selector which orients the screw by feeling for its socket. The screw is then carried by air pressure through a flexible tube to the air gun driver. The gun can be mounted on the machine for stationary use.

Models will handle screws in three size ranges, numbers 4-8, number 10 through ¼ inch diameter and ⅜-½ inch diameter. Changeover takes about 20 minutes. Rate is up to 2,000 an hour, depending on torque setting, screw depth, operator proficiency and fixturing.

On The Market



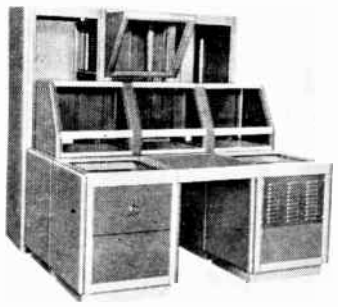
Connectors
microminiature

ELCO CORP., M St. below Erie Ave., Philadelphia 24, Pa. Series 8100 Varicon connectors are for applications where highest contact density and reliability are a necessity. Contacts are of the forklike mating Varicon principle, assuring lowest contact resistance at all typical environmental conditions. Current rating is 3 amperes; withstanding voltage at sea level, 1,000 v a-c rms; at 3.4 in. Hg, 500 v a-c rms; contact resistance, 0.005 max.; insulation resistance 1,000 megohms, min.; insulation material, diallyl phthalate, glass-filled.

CIRCLE 200 ON READER SERVICE CARD

Console Cabinets
for modular systems

PREMIER METAL PRODUCTS CO., 337 Manida St., New York 59, N. Y. A new line of Prem-O-Rak console cabinets are designed for modular console systems. The two-tone cabinets can be assembled in a wide variety of arrangements. System



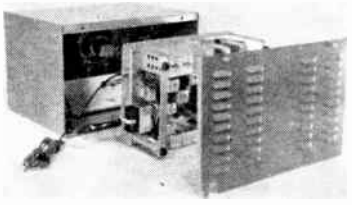
consists of sloping cabinets, pedestal frames, work tops, writing shelves, turrets and sliding drawers. They are also designed, the manufacturer says, to be used with Premier heavy duty transmitter racks (PR series) as well as the Prem-O-Rak desk cabinet racks (POR series).

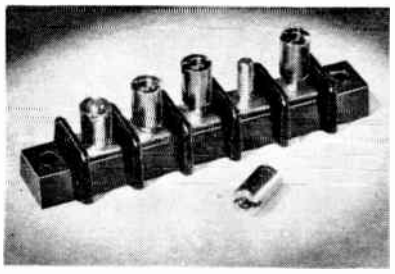
CIRCLE 201 ON READER SERVICE CARD

Base Stations
for mobile vhf/f-m

COMMUNICATIONS CO., INC., 300 Greco Ave., Coral Gables, Florida. Series 580/582 Fleetcom series combines its transistorized power supply with the combination speaker/control unit. Thus the transmitter/receiver unit is reduced in size (9 by 12.25 by 5.5 in. in height). Transmitter provides 35-40 w output, 25-54 mc, or 25-30 w, 144-174 mc. Base station price is in the $400 class.

CIRCLE 202 ON READER SERVICE CARD





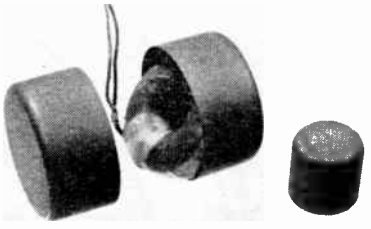
Terminal Blocks
stud-type

KULKA ELECTRIC CORP., 633 So. Fulton Ave., Mt. Vernon, N. Y. A stud-type molded-barrier terminal block is available in various sizes accommodating from 1 to 26 stud posts, and in current-handling ratings from ma to 90 amperes. Screw studs are separated by molded barriers for minimized electrical leakage and shorts. Molded thermosetting plastics are used, with high tensile strength bakelite for general commercial use, and in CFG, MFE, MA1-60, MME and MDG to meet MIL-M-14 specs.

CIRCLE 203 ON READER SERVICE CARD

Magnetic Shielding
for toroids

MAGNETIC SHIELD DIVISION, PERFECTION MICA CO., 1322 No. Elston Ave., Chicago 22, Ill. Lightweight Netic and Co-Netic foils provide shielding at minimum cost where



circuitry and spacing demand shielding of toroids. Foils lend themselves to encapsulation, are non-shock sensitive, non-retentive and require no periodic annealing. The foils help the designer achieve high density packaging.

CIRCLE 204 ON READER SERVICE CARD

Recording Heads
all-metal

GENERAL TRANSISTOR WESTERN CORP., 6110 Venice Blvd., Los Angeles 34, Calif. All-metal, 20-channel universal head records 20 channels of audio or digital information on 1-in. tape. All-metal construction adds life and prevents

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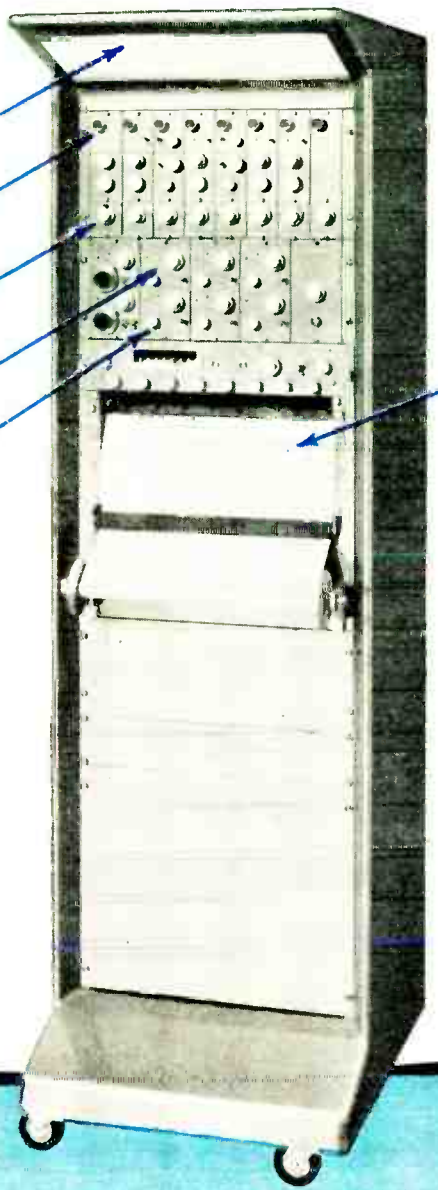

Illuminated canopy

Type 9800 series input couplers provide all input, control and balance functions. Input available both front and rear.

Type 481 Preamplifier provides sensitivities from one microvolt to 5 volts per mm.

Type 482 power amplifiers—may be used without preamplifiers for up to 10 mv/cm sensitivity

Zero suppression control

504-A paper drive—speeds from 1 to 250 mm/sec. Electrical speed shift 1 to 250 mm per minute available. Zero weave high precision drive, 850 ft. capacity (heat or electric) 1500 ft. (ink). Front loading, with full unobstructed record visible from front.

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- *stable d-c sensitivity of one microvolt per mm*
- *true differential input*
- *high input impedance*
- *response to beyond 150 cps.*
- *reluctance, differential transformer, strain gage with a-c or d-c excitation, thermocouples, etc., used with all preamplifiers*
- *deflection time less than 1.5 milliseconds (2.5 ms with preamplifiers)*
- *fixed precision calibration*
- *instant warm-up*
- *precision source for d-c and 400 cycle excitation, self-contained*
- *zero suppression, twenty times full scale, both directions*

Thanks for your patience in awaiting deliveries of the Type R. Schedules were temporarily disrupted by the large volume of orders received for this radically new instrument. We are now in our new plant, with 300% more space, and are rapidly increasing production capacity. Deliveries will soon be on a current basis.

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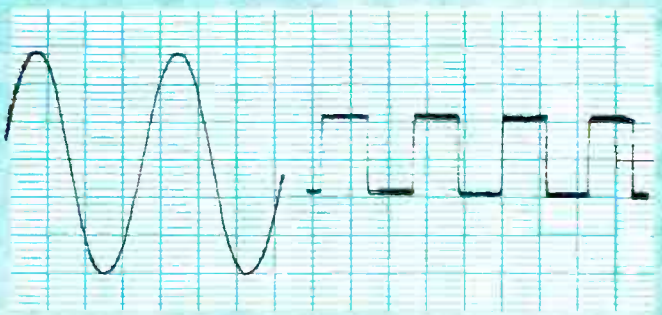

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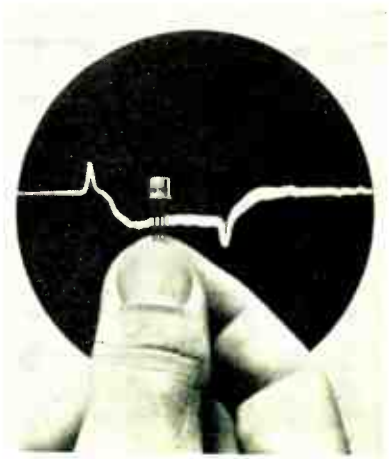
tape oxide buildup. Unit incorporates high efficiency design, precision lapped gap and full shielding between channels.

CIRCLE 205 ON READER SERVICE CARD

Power Supply transistorized

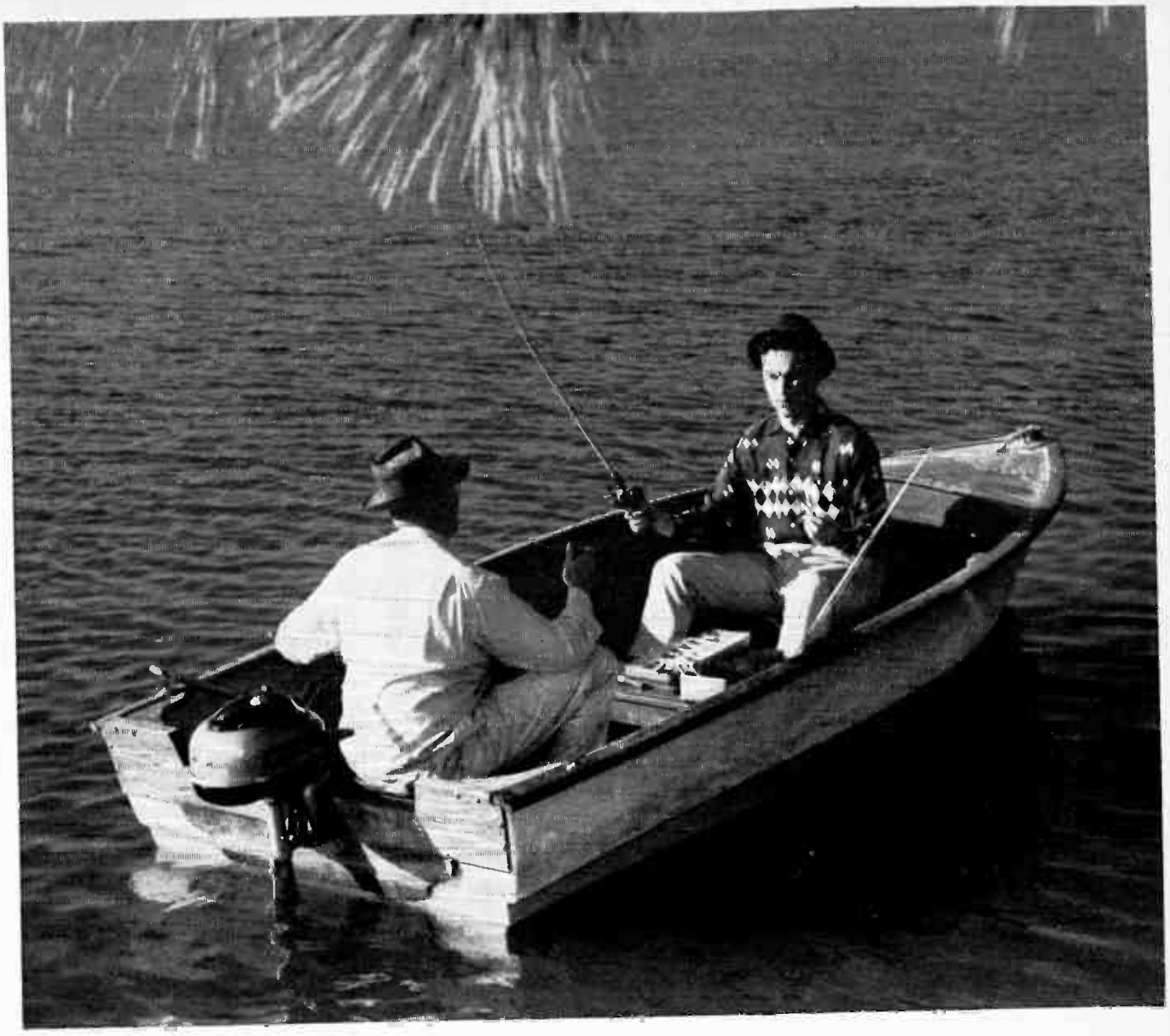
SOUTHWESTERN INDUSTRIAL ELECTRONICS CO., 10201 Westheimer Rd., Houston, Texas. Model PS-25 airborne power supply has five regulated outputs protected from overload and short circuit to prevent component damage. Outputs are 17½ v d-c, positive and negative, 5 percent regulated; 110 v d-c, positive and negative, 1 percent regulated; and 6.3 v a-c, 5 percent regulated. All voltages have final potentiometer adjustment.

CIRCLE 206 ON READER SERVICE CARD



Silicon Transistor diffused-base

TEXAS INSTRUMENTS INC., P. O. Box 312, Dallas, Texas. The 2N702 subminiature 25-millimicrosecond silicon "mesa" switching transistor dissipates 150 mw at 100 deg in free air. It provides a guaranteed d-c beta spread of 15 to 45 and a



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Clark P. Spellman, Mgr., Area Development, Electric Bldg., Richmond 9, Va., MI 9-1411

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maximum collector cutoff current of 0.5 μa. Minimum breakdown voltage is 20 v and maximum saturation voltage is 0.6 v. Unit is packaged in the subminiature JEDEC-outline TO-18 case which meets the E3-58 base-dimension requirements.

CIRCLE 207 ON READER SERVICE CARD

Logic Module Tester
automatic

ATRONIC PRODUCTS, INC., One Bala Ave., Bala-Cynwyd, Pa. Machine measures logic circuitry printed on cards under operational conditions. Performs several types of static and dynamic tests on "go" or "no go" basis. Speed, degree of response and continuity of circuitry are measured. Tester provides its own power supplies, pulse generators and voltage sources. Adapters are provided for setting up sequences and limits of tests performed on transistor cards.

CIRCLE 208 ON READER SERVICE CARD

Tuned Amplifier
sub-audio

AD-YU ELECTRONICS LAB., INC., 249 Terhune Ave., Passaic, N. J. Type 301 sub-audio tuned amplifier consists of a high gain, direct coupled cascode amplifier, two cathode fol-

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lowers and a tuned RC twin-T network. It is suitable for filtering distortion and noise from the waveforms at the output of transducers or pickup devices. Amplification at center frequency is approximately unity; frequency range, 0.3 to 3,000 cps, continuously adjustable, with attenuation of second harmonic above 35 db, third harmonic above 45 db, and 50 db for higher harmonics.

CIRCLE 209 ON READER SERVICE CARD

X-Y Recorder
high writing speed

SANBORN CO., 175 Wyman St., Waltham 54, Mass. Model 670 X-Y recorder uses optical galvanometers, a light beam trace and immediate-developing direct print paper charts. It makes possible fast, accurate recording of families of transistor curves, or of rapid mechanical displacement, velocity and acceleration. Writing speeds in excess of 2500 in./sec may be attained. Overall frequency response is 3 db down at 130 cps and is independent of amplitude. Linearity is 1 percent of full scale; sensitivity, as high as 62.5 μv/in.

CIRCLE 210 ON READER SERVICE CARD

Voltage Regulators
militarized

SORENSEN & CO., South Norwalk, Conn. Models 500 MIL and 1500 MIL regulators are suited for all land-based military requirements.

(Continued on p 76)

In this brochure—complete facts on DIALCO's

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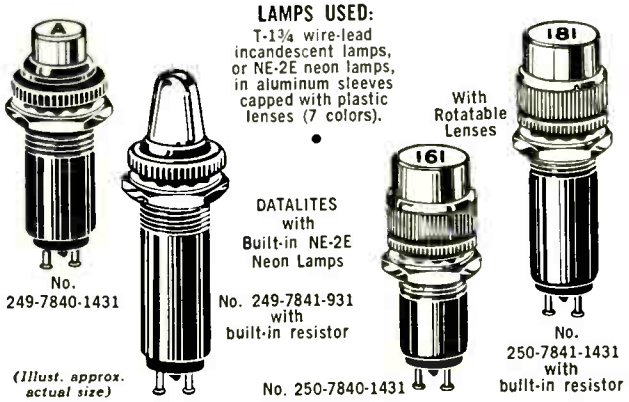
For the Computer-Automation Industries

DATALITES by DIALCO are ultra-miniature Indicator Lights specially designed to meet the critical requirements of the computer-automation fields. Made in 2 basic styles: *Lamp Holders with* DIALCO'S own *replaceable Lamp Cartridges* (see above); or integrated DATALITES *with Built-in Neon Lamps* which are *not replaceable* (see below). Ultra-compact, single units mount in ⅜" clearance hole; the twin-lamp assembly mounts in ¾" clearance hole.



DATALITES have fully insulated terminals and conform to all applicable military specifications. Integrated units are available *with* or *without built-in resistors*. The cylindrical lenses can be hot-stamped with digits, letters, etc. Complete details in *Brochure L-160*. Send for it now.

SAMPLES ON REQUEST—AT ONCE—NO CHARGE

Foremost Manufacturer of Pilot Lights

DIALIGHT CORPORATION

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WIDEBAND RF AMPLIFIERS

40 to 1500 mcps

Low noise figure • Low power drain

Minimum size and weight • High gain

TYPE HFW AMPLIFIERS are now available for operation in the 600-1500 mcps range, with bandwidths of 100 to more than 400 mcps in the upper ranges. These augment the extant Applied Research amplifiers, which provide for operation in the 40-600 mcps region.

ARI Amplifiers are used as part of receiving systems in antenna preamplifiers, multicouplers, and high frequency IF amplifiers, where faithful reproduction of signals and amplification over a wide band of frequencies are required. The low noise characteristics of these equipments result in a dynamic range of greater than 60 db.

TYPICAL PERFORMANCE CHARACTERISTICS

Model	HFW-5070-3	HFW-77100-3
Frequency range	500-775 mcps	775-1000 mcps
Gain	Greater than 30 db	Greater than 30 db
Noise figure	6 to 8.5 db	8.0 to 9.5 db
Peak to valley ratio	Less than 1 db	Less than 1 db
Zin — Zout	50 ohms	50 ohms
VSWR Input	Less than 1.5	Less than 1.5
VSWR Output	Less than 1.75	Less than 1.75
Anode drain	200V at 60 ma	200V at 60 ma
Filament drain	6.3V at 2.1 amps.	6.3V at 2.1 amps.

Write for further information

Applied Research inc.

76 South Bayles Avenue, Port Washington, N. Y.

CIRCLE 75 ON READER SERVICE CARD

They supply 500 or 1,500 va, respectively, at nominal 115 v a-c. Output voltage regulation is ±0.5 percent against variations in input line voltage, load, and power factor changes. Less than 5 percent harmonic distortion is introduced.

CIRCLE 211 ON READER SERVICE CARD

Magnetic Trigger
half-wave

AVION DIVISION, ACF Industries, Inc., 11 Park Place, Paramus, N. J. The 408 series half-wave magnetic triggers are designed specifically for use with C35 or equivalent series of silicon controlled rectifiers. Operating range is from 50 through 400 cps. Output presents a steep wavefront to the gate circuit of the scr, allowing precise determination of firing angle. Control signal is integrated over each half cycle, so that a high signal-to-noise ratio is achieved. Volume is less than 11.6 cu in., weight less than 15 oz.

CIRCLE 212 ON READER SERVICE CARD

Rectifier
ceramic base

TRANSITRON ELECTRONIC CORP., 168 Albion St., Wakefield, Mass. All power rectifiers in ⅛ in. hex base series can now be supplied with mounting base electrically insulated from rectifying junction. High

USE ELECTRONIC COUNTERS AS DIGITAL VOLTMETERS

with SYSTRON'S NEW MODEL 1230 VOLTAGE to TIME CONVERTER

FEATURES:
- All-Electronic System
- 10 Millisecond Conversion
- .05% Accuracy

PROVIDES:
- Automatic Polarity
- ±Microvolts to 1000 Volts
- 1 Megohm Input Impedance

The development of Systron's new Model 1230 now makes it possible to convert any existing period or time counter into a precision high speed digital voltmeter. Connects directly to Systron Models 1010, 1040, 1043 and 1031 to provide an IN-LINE readout (±10,000) of DC voltages.

Systron manufactures IN-LINE Counters for laboratory, military and industrial applications, as well as complete Data Processing and Control Systems tailored to meet individual specifications.

Write today for complete specifications of Model 1230 and your free copy of our new Short Form Catalog . . .

SPECIFICATIONS
MODEL 1230

Input Voltage Ranges:
0 to ±1, ±10 and ±100v DC
Option A - ±10 and ±100 millivolts full scale
Option B - ±1000 volts

Indication: NIXIE IN-LINE, ±10,000 (on Model 1031)

Conversion Time: .010 seconds (Time between pulses)
Option C .100 seconds (100KC counters)

Errors:
Conversion - ±0.05% of full scale

Input Impedance:
1 Megohm (standard ranges)
Option A - 100,000 ohms

Polarity: Automatic polarity sensing

Price:

Model 1230	$1095.00
Option A	895.00
Option B	180.00
Option C	100.00

SYSTRON CORPORATION
1050 GALINDO STREET • CONCORD, CALIFORNIA

Representatives in Principal Cities

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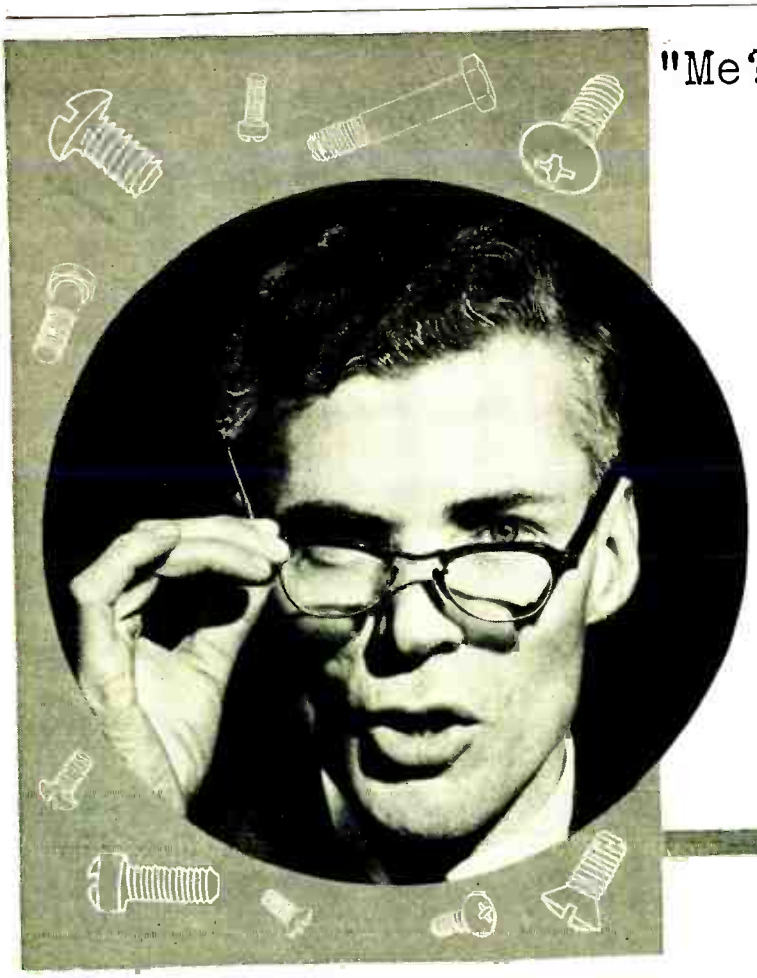

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MIDWEST DIVISION: 6424 WEST BELMONT AVE. • CHICAGO 34, ILLINOIS
TWX CG 3185 PHONE: AVENUE 2-3232, 3, 4

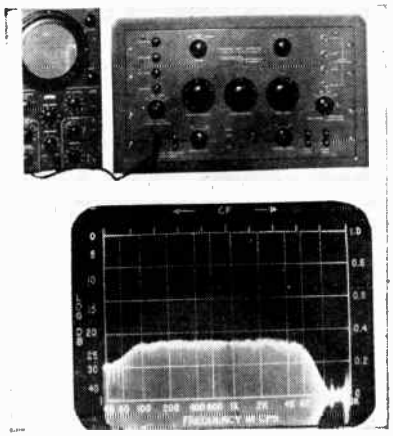
WEST COAST DIVISION: 5822 WEST WASHINGTON BLVD. • CULVER CITY, CALIF.
TWX LA 1472 PHONE: WEBSTER 3-9595

CIRCLE 77 ON READER SERVICE CARD

alumina ceramic disk provides low thermal resistance, typically 1.5 C/w, and high electrical insulation.

Configuration needs no mounting hardware and simplifies bridge assemblies.

CIRCLE 213 ON READER SERVICE CARD



Sweep Generator for rapid analysis

PANORAMIC RADIO PRODUCTS, INC., 514 S. Fulton Ave., Mt. Vernon, N. Y. Model SG-1R gives rapid analysis of tape and disk recorder and pickup frequency responses replacing tedious point by point methods. Amplitude vs frequency is displayed automatically on specially calibrated crt screen of companion oscilloscope. Unit combines the swept signal output with a synchronizing pulse for making of test records. Upon playback, the oscilloscope sweep is triggered by pulse from test record at 1 cps. Test record is normally made using repetitive log sweeps from 40 cps—20 kc or 400 cps-200 kc. Linear and 40 db log amplitude scales are furnished.

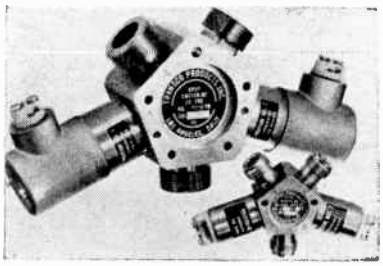
CIRCLE 214 ON READER SERVICE CARD

Oscillator 10 cps to 5 mc

THE GERBER SCIENTIFIC INSTRUMENT CO., 89 Spruce St., Hartford

1, Conn. Model GO-20F oscillator is a wide-frequency range unit covering the band 10 cps to 5 mc. It features a 50 ohm output impedance, a Wien bridge stabilized oscillator, excellent frequency stability, low distortion, and continuous control of the output voltage level. Some of its applications include circuit development, generating signals which may be directly coupled to coaxial cables, providing a stable low impedance source for loads whose impedance varies, and for alignment.

CIRCLE 215 ON READER SERVICE CARD



Coaxial Switch
large size

TRANSCO PRODUCTS, INC., 12210 Nebraska Ave., Los Angeles 25, Calif. New large "YL" type coaxial switch for use with RG117/U and similar cables is shown contrasted with regular "Y" type coaxial switch. Both are manufactured by the company.

CIRCLE 216 ON READER SERVICE CARD

Solid-State Switch
for automation use

PARAMETRICS, P. O. Box 629, Costa Mesa, Calif. The Proxor is a solid-state switch triggered by metal in the proximity of a sensing coil. Only ¾ in. in diameter and 4 in. long, it is completely self-contained. The sensing coils, the bridge, transistor oscillator, two-stage transistor

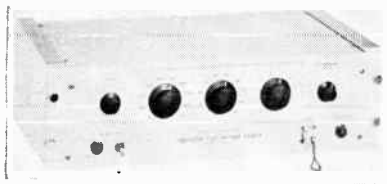
switch, and a miniature printed circuit board are all encapsulated in the chrome-plated case. Some features are: Proxor can distinguish between magnetic and other metals; it will furnish voltage steps at ultra-low rates down to standstill; no electrical contact need be made between Proxor and workpieces.

CIRCLE 217 ON READER SERVICE CARD

Power Transistors *npn* type

CBS-ELECTRONICS, Parker St., Newburyport, Mass. Line of *npn* power transistors for complementary push-pull and cascade circuits. For resistive loads, 2N326, LT-5163, LT-5164 and LT-5165; for inductive loads, LT-5163L, LT-5164L and LT-5165L. They feature collector voltages to 80 v, maximum collector current of 2 amperes, minimum cutoff frequency of 150 kc and they meet the MIL-19500A specification.

CIRCLE 218 ON READER SERVICE CARD



Regulated Supply 0-1,000 v

KEITHLEY INSTRUMENTS, INC., 12415 Euclid Ave., Cleveland 6, Ohio. Model 240 regulated h-v supply selects d-c voltages for the laboratory. It can be used to test insulation, supply potentials for diode and capacitance leakage resistance measurements, excite ion chambers and photocells, or to calibrate meters and check d-c amplifier gains.

CIRCLE 219 ON READER SERVICE CARD

MINIATURIZATION

We are far into new areas with miniaturized and microminiaturized electromagnetic devices used in the Inertial Guidance systems we build. Our staff openings in miniaturization are for men who think big. Write to Mr. C. T. Petrie, Manager, Research & Engineering Staff.

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Beverly Hills, California

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NEW HEAVY DUTY 2 & 3 DIMENSIONAL ENGRAVER

FOR
Engraving Nameplates
Fine Routing Work
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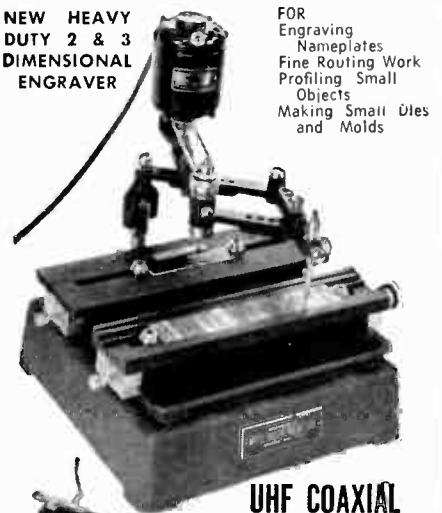

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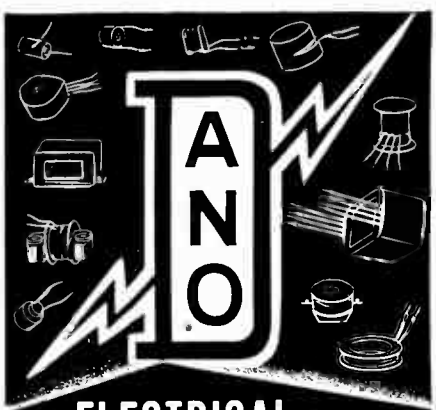
77 Trowbridge St. Cambridge 38, Mass.

CIRCLE 105 ON READER SERVICE CARD



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With our greater variety and greater volume of the precision components listed below, we have become the "supermarket" of the industry. We feature fast delivery and mass-production economy—plus the highest precision quality.

400-CYCLE SYNCHROS
(Frame sizes: 8, 10, 11, 15, 22)
Control Transformers
Differentials • Receivers
Resolvers • Transmitters

GYROS
Directional, Free, Rate, Roll and Vertical Gyro Transmitters • Stable Platforms

MOTORS AND GENERATORS
• Low-Inertia Servo Motors • Motor Generators • Precision Induction Tachometer Generators • Rate Generators

PACKAGED COMPONENTS
Analog-Digital Converters • Azimuth Counters • Cam Compensators • Clutched Synchros • Dual-Speed Synchros • External Slip-Ring Synchros • Follow-Up Mechanisms • Miniature Differential Gear Assemblies • Servo Assemblies

RADAR DEVICES
Airborne Radar Antennae • Ground Antenna Pedestals

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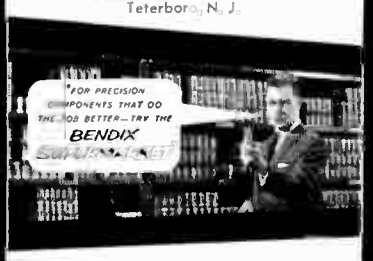
Eclipse-Pioneer Division

Bendix
AVIATION CORPORATION

Teterboro, N. J.



CIRCLE 83 ON READER SERVICE CARD

Literature of

MATERIALS

Flameproof Plastics. Mesa Plastics Co., 12270 Nebraska Ave., Los Angeles 25, Calif. Seven new flame-proofed and heat resistant diallyl phthalate plastic molding compounds for electronic and electrical use are featured in a 4-page specification sheet.

CIRCLE 250 ON READER SERVICE CARD

COMPONENTS

Delay Lines. Microsecond Electronics, Inc., 3213½ E. Washington, Phoenix, Ariz. A technical article discusses delay lines, defines parameters, and describes methods of measuring the electrical characteristics of delay lines using both pulse and c-w techniques.

CIRCLE 251 ON READER SERVICE CARD

P-C Terminal. Litton Industries, 13536 Saticoy St., Van Nuys, Calif. A data sheet describes a "floating" printed circuit terminal which prevents lifting of conductor lines during the swaging operation even under continued application of heat due to soldering.

CIRCLE 252 ON READER SERVICE CARD

Subminiature Resistors. Eastern Precision Resistor Corp., 675 Barbey St., Brooklyn 7, N. Y. The "Min-Istor" brochure details a line of subminiature wire wound resistors. A handy temperature conversion chart is included.

CIRCLE 253 ON READER SERVICE CARD

EQUIPMENT

Shaft Position Encoders. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif. Bulletin No. 300-5 is a four-page summary of standard Datex shaft position encoders.

CIRCLE 254 ON READER SERVICE CARD

Analog Computing Instruments. George A. Philbrick Researches, Inc., 285 Columbus Ave., Boston 16, Mass. A 4-page short form

catalog on various lines of analog computing instruments is available.

CIRCLE 255 ON READER SERVICE CARD

H-V D-C Supplies. Sorensen & Co., Inc., Richards Ave., South Norwalk, Conn. Sixty-three h-v d-c power supply models are described along with tabular specifications in a new product data sheet.

CIRCLE 256 ON READER SERVICE CARD

Video Amplifier. Kay Electric Co., 16 Maple Ave., Pine Brook, N. J. A mailing card illustrates, gives features and specifications of the Transifier, a wide-band, plug-in, transistorized video amplifier.

CIRCLE 257 ON READER SERVICE CARD

Half-Inch Panel Meters. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. An illustrated technical bulletin gives specifications, outline drawing and general information on the series SC-030 panel meters.

CIRCLE 258 ON READER SERVICE CARD

FACILITIES

Field Services. Hoffman Electronics Corp., 3740 S. Grand Ave., Los Angeles 7, Calif. An 8-page, illustrated brochure describes the field service capabilities of the company's Laboratories Division.

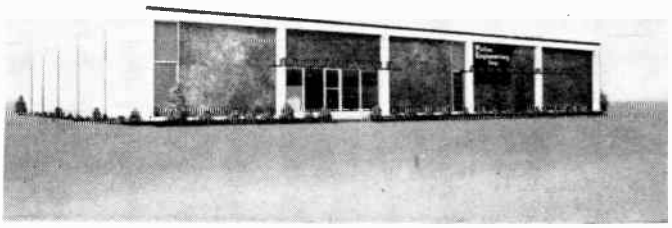
CIRCLE 259 ON READER SERVICE CARD

Facilities Brochure. Computer Equipment Corp., 1931 Pontius Ave., Los Angeles 25, Calif. A two-color brochure describes the company's capabilities and facilities.

CIRCLE 260 ON READER SERVICE CARD

Welded Assemblies. Raytheon Co., 55 Chapel St., Newton 58, Mass,. has available a brochure describing its welded assembly technique for high density packaging of electronic components.

CIRCLE 261 ON READER SERVICE CARD



PEI Opens New Building

PULSE ENGINEERING, INC., manufacturer of magnetic components, has completed a new building in Santa Clara, Calif., adding 12,000 sq ft to its administration, engineering and production facilities. This more than doubles the firm's production capacity, according to president Hugh Fleming.

With its added facilities, the company plans to hire more employees and install advanced manufacturing methods and equipment. Pulse Engineering is currently faced with its largest backlog since operations began four years ago.

The new building is situated on a 1½-acre plot. Space is available for another 12,000-ft plant planned by the company.

Pulse Engineering makes components for missiles, aircraft and business computers. Parts are used in Terrier, Bomarc, Atlas, Jupiter, Polaris missiles, as well as in many aircraft fire control and radar systems. Civilian activity is centered around the scientific, business and automatic control computer.

At present, the company's sales volume exceeds $1 million annually.

Name Goodman Vice-President

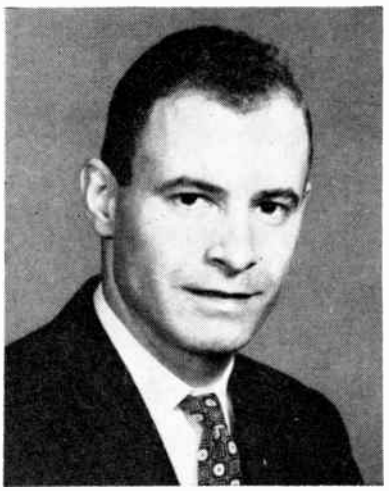
JACK GOODMAN was recently appointed vice-president in charge of the electronic components division of JFD Electronics Corp., Brooklyn, N. Y. He has been manager of the division since 1949.

The division manufactures a wide range of military and industrial electronic equipment, including variable trimmer capacitors, delay lines, L-C tuners, multiplexes, and pulse forming networks.

GE Advances James Pitman

JAMES E. PITMAN has been named manager of product planning for point-to-point communication equipment in General Electric's communication products department at Lynchburg, Va.

Previously a commercial engineer in microwave product planning, Pitman will now be responsible for long-range development on microwave relay, power line carrier, and terminal communication products.



Dibling Moves To Midwest

CARL W. DIBLING has been named field engineer for the midwest region by CBS Electronics, Danvers, Mass. In addition to receiving tube applications, he will specialize in the use of semiconductor devices for the entertainment market. He was previously a field engineer in the eastern region.

Prior to his association with CBS Electronics, Dibling was test department supervisor and later a project engineer and a quality control engineer with Video Products, Inc., Red Bank, N. J. Following that, he was chief inspector and quality control manager for Trad Electronics.

MAECON Sets Up '59 Program

THIS year's Mid-America Electronics Conference will be held in Municipal Auditorium and Hotel Muehlebach, Kansas City, Mo., on Nov. 3-5. The conference is sponsored by the Kansas City Section of IRE.

Sixteen sessions will feature the presentation of a total of 46 papers

rugged, non-metallic

ALITE® to SAPPHIRE SEALS

Ideal for critical infrared and microwave applications

Looking for ways to improve infrared or microwave systems designs? The unique advantages offered by these Alite-Sapphire assemblies may be just what you want!

Up to now, synthetic sapphire window units of this type required difficult, and often unreliable, metallizing methods. We've developed a high temperature *non-metallic* bonding technique that simplifies design problems, while assuring a high strength, vacuum-tight seal capable of withstanding extreme environmental conditions.

The similarity of the Alite body to sapphire (both are essentially aluminum oxide) offers distinct advantages. Since Alite and sapphire are nearly identical in composition, they have virtually the same dielectric constant, loss factor, coefficient of expansion, mechanical strength, and other superior characteristics. Excellent design flexibility is achieved with Alite, too. For in addition to the Alite-Sapphire bond, if desired the Alite body can be metallized and brazed to metal components to make hermetic assemblies with integral feed-throughs. Likewise, sapphire-to-metal seals can be provided where required.

Possible applications include infrared domes for missiles, infrared spectrometry, fire detection equipment, microwave windows, ultraviolet devices. We offer our technical assistance on any applications where Alite-Sapphire assemblies may prove of value. Write for details.

OUR 100th YEAR

ALITE DIVISION

381F

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by engineers and educators. Principal address at the opening session, "Radio Engineer of the Future", will be delivered by Ernst Weber, national president of IRE and president of Polytechnic Institute of Brooklyn.

Plant Briefs

The **Langevin Division** of **The W. L. Maxson Corp.** has moved from its Long Island City location. Headquarters for engineering, sales and administration are at 475 Tenth Ave., New York 18, N. Y. Production facilities are located at the corporation's plant in Old Forge, Pa.

The **Thompson-Ramo-Wooldridge Products Co.**, Los Angeles, Calif., has established an Atlantic City, N. J., systems engineering office.

A components division has been established at **Telemeter Magnetics, Inc.**, as an autonomous operation within the company responsible for sales, engineering, and production of ferrite cores, core arrays, memory stacks, and new component products as they are developed. New division will occupy approximately 13,000 sq ft in both the headquarters plant in West Los Angeles and in the company's Santa Monica facilities.

Executive and administrative personnel of the administrative staff of **Aeronutronic**, a division of Ford Motor Co., recently moved from facilities in Glendale to offices in the division's new computer-electronics building on a 200-acre site at Newport Beach, Calif.

News of Reps

Frank Tylinski of Queens, N. Y., was recently appointed a sales rep for Ohio Semiconductors, Inc., Columbus, Ohio. He will cover metropolitan New York and northern New Jersey.

Leonard G. Evans of South Hadley Falls, Mass., has joined **Henry Lavin Associates**, manufacturers' reps of Meriden, Conn., as sales engineer. He was formerly con-

TRANSISTORIZED PROPORTIONAL CONTROL OVEN for CRYSTALS and COMPONENTS . . .

The Bliley type BPCO-1 proportional control oven for crystals and components provides temperature stability of ±.02°C. over an ambient range of +10°C. to +50°C. This control is accomplished by compact transistorized circuitry and a Dewar flask insulated heat chamber. Operating on a 26 volt supply, the oven can be furnished with operating temperatures, as specified, in range +70°C. to +85°C. It will accept Bliley Series BG6 and BG7 crystal units. Request Bulletin #518.

BLILEY
TYPE BPCO-1

Bliley

BLILEY ELECTRIC COMPANY
UNION STATION BUILDING
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ACID-RESISTANT
STATIC-FREE
100% DYNEL
Industrial Apparel

Perfected work clothing with proved less static than cotton... and remaining static-free for the life of the garment.

- Solves the static hazard in your plant or laboratory.
- Resists damage from acids and caustics up to 50 times longer than ordinary apparel.
- More comfortable; will not cling; no clammy feel.
- Far safer; no flash burning of fabric.

FOR SUPER-CLEAN CONDITIONS

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LINT-FREE
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Ideal when lint-free conditions are essential. Savings are many times the original low cost of the garment. You get increased wear . . . and you benefit from decreased product damage caused by dust, lint and dirt.

- Resists damage from acids and caustics up to 50 times longer than ordinary apparel.
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- More durable; shape-retaining; neater looking; easy to launder.

FREE!

Mail coupon for latest Worklon industrial apparel catalog plus supplement. No cost, no obligation, of course!

*—DuPont Dacron polyester fiber.

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☐ Kindly send latest Worklon information book
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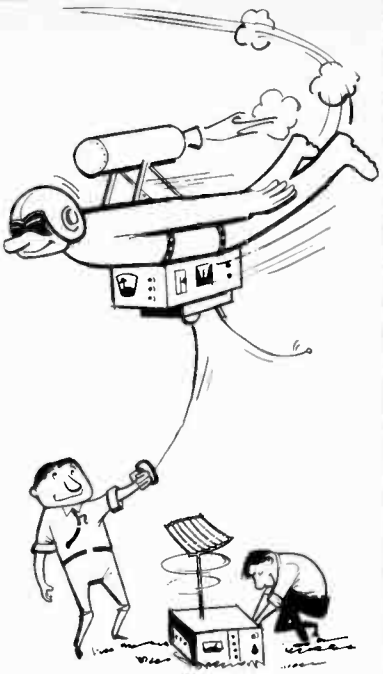

It's a new automatic flight control system.

This one isn't operational yet, but maybe you could lend us a hand in exchange for things like salary and

LRCP*

General Electric's **ARMAMENT AND CONTROL SECTION** in Johnson City (Binghamton) New York, has 14 openings for men with degrees and/or experience in mechanical engineering, electrical (electronics) engineering—also in mathematics and physics.

Some of the product areas include airborne defense systems, automatic flight control systems (not in any way similar to the cartoon), inertial navigation systems, analog and digital computers, gyros, fluid controls, servo controls and many more.

General Electric has the right combination for developing your career potential. ***Long Range Career Potential.**

Let's trade facts. Tell us about your education, experience and interests. We'll send you details about where you'll fit into the Armament and Control Section.

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ARMAMENT AND CONTROL SECTION
GENERAL ELECTRIC
JOHNSON CITY, NEW YORK

nected with the special weapons project of the Air Force, and with Sandia Laboratories of Albuquerque, N. M.

Larson Instrument Co., Tarrytown, N. Y., announces appointment of the following sales reps:

McCarthy Associates of Pasadena, Calif., for California, Arizona and Nevada; **Tesco Associates** of Syracuse, N. Y., for upstate New York; **Tex-O-Koma Sales Co.** of Grand Prairie, Texas, for Texas, Oklahoma, Kansas and New Mexico; **Electro-Mec Associates** of Warren, Mich., for Michigan; and **RMC Associates** of New York City, for greater New York and northern New Jersey.

Waters Mfg., Inc., Wayland, Mass., appoints **Farwest Agencies** of Seattle, Wash., as rep for the sales of potentiometers, components and instruments in Washington and Oregon.

G. E. Moxon Sales is appointed to represent Arnoux Corp., Los Angeles, Calif., in California, Nevada and Arizona.

The Instrument and Equipment Division of Epsco, Inc., Cambridge, Mass., names **Robert L. Lang Associates** of Chicago, Ill., as manufacturer's rep in Indiana and Illinois.

The Birtcher Corp. has named **The Heimann Co.** of Minneapolis, Minn., sales reps for its line of tube, transistor and component cooling and retaining devices. Territory to be covered includes Minnesota, Iowa, North and South Dakota, Nebraska, Missouri and Kansas.

Avco Research and Advanced Development Division, Wilmington, Mass., announces appointment of the following reps for its line of hypervelocity instrumentation:

Instruments for Measurements, Hollywood, Calif.; **General Measurement Co.,** Newton Highlands, Mass.; **Kemco Inc.,** Irving, Texas; **V. A. Snyder,** Union, N. J.; **Anger Associates,** Dearborn, Mich.; **Concor International Corp.,** Long Beach, N. Y.

VALUABLE 64 PAGE REFERENCE SECTION

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Prepared especially by the 25-man editorial staff of *electronics*, this 64-page section is designed to assist the buyer by providing him with market data, electronics applications, market distribution, market reports and books, industry organizations and services.

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Associate Editor, electronics
MARKET RESEARCH EXPERT

A graduate of Oberlin, BA, and Harvard Business School, MBA, Ed DeJongh is the researcher and analyst who is responsible for "Market Research", "Figures of the Week", sales estimates, sales forecasts, marketing news, and developments in marketing. Ed is constantly preparing for a year-end statistical issue and forecast for the following year. If you're not a subscriber, if your subscription is expiring, if you need market data in your work, fill in box on Reader Service Card. Easy to use. Postage free.

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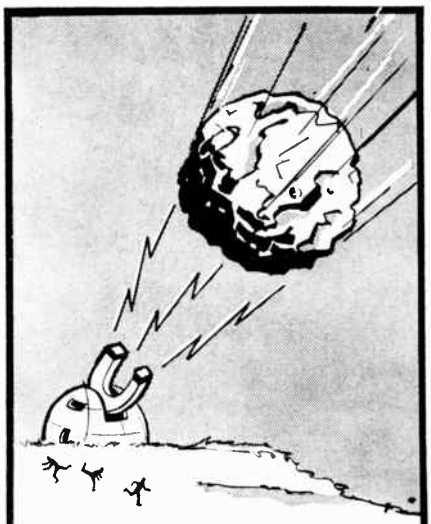

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COMMENT

Security Policy

I wish to commend you and your associate editor Janis for the article "New Security Policy Coming?" (p 34, July 31). It is temperate, fair and without prejudice.

Having seen only one other article on the same subject, I presume that you at McGraw-Hill are not asleep at the switch. My regard for your publishing firm has gone up several notches.

My own opinions may be obtuse, but I consider the plant security processes as being a little bit of totalitarianism. I have seen these processes used to vent personal dislikes. They have also cost the taxpayers untold thousands of wasted dollars.

As a human factor, it is a sad and dreary instance of misappropriated energy. Had security officials based their premises on basic personal honesty, which is scarcely considered as those things go, the whole weeding-out process would be greatly simplified.

Again, let me thank you for a forthright reporting of the situation—one which I have found many defense workers are not aware of because of the (probably) deliberate playing down by our Southern California kept press.

LESLIE BAIRD
PASADENA, CALIF.

More on Terms

Commenting rather belatedly on this subject, does not your rejoinder to Mr. Greatorex of BBC (Comment, p 84, June 26) rather overlook the point that, by accepted usage, capital letters are applied to multiples and lower-case letters are usually taken to apply to submultiples?

It is true, of course, that there is compounded confusion over the letter *M*, which is taken to mean 1,000 in commerce and 1,000,000 in engineering; while, again, the lower-case *m* means 10^{-3} in engineering and not 10^{-6} as one would in the circumstances have a right to expect. Yet again, in capacitor measurements *m* changes once more, since for convenience it is often used for 10^{-6} in place of μ.

This brings to mind the merits of the term *picofarad* (abbreviation *pf*) used in Europe for 10^{-12} in capacitor measurement in place of $\mu\mu$f. The abbreviation, useful in text and in circuit diagrams, is of especially great value in eliminating redundancy in speech. The term *pf* has already been adopted by one American capacitor manufacturer, and on reading a recent publication by General Radio Co., I learned that it is now used by the U. S. National Bureau of Standards, so I am encouraged to advance the hope that it may gradually receive generalized acceptance in the U. S.

Of course, multiples of a small unit are always more convenient than decimal fractions of a large unit, and in Britain the trend is to use *pf* for all values at least up to 0.01 μf (10,000 pf).

F. D. HARRIS
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Reader Harris has documented the confusion that exists, omitting the growing acceptance of "nano-" for 10^{-9}, as in "nanosecond" to replace the awkward "millimicrosecond." (We know of several people who would disagree loudly with his last paragraph, however).

We can add only this: the degree of agreement is small, and we feel free to adopt our own style or standard in the interests of clarity and succinctness, and in the absence of any IRE standards. Our use of small "m" for megacycle is justifiable—to our thinking—as long as it is not capable of confusion. Since "kc" can stand for nothing but "kilocycle" in its normal context in this magazine, and since there is no millicycle or microcycle term in common usage, we don't think anyone can become confused by "kc" and "mc."

Transistor Limits

In our paper "Determining Transistor High-Frequency Limits" (p 31, Aug. 21), we found that on p 32, Fig. 2 and Fig. 3 are interchanged. The captions are right; apparently the two circuit drawings have been interchanged.

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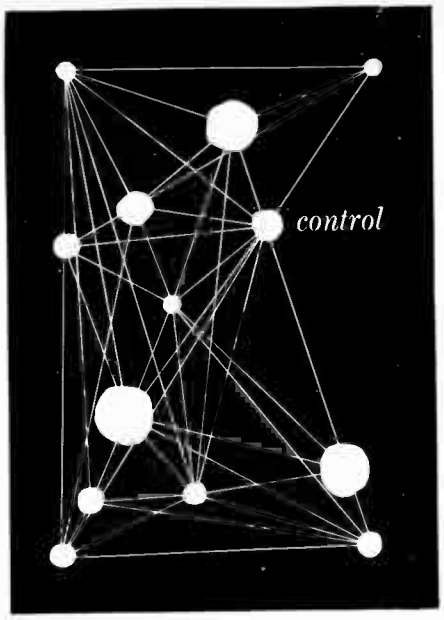

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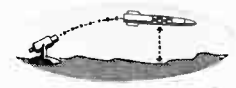
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