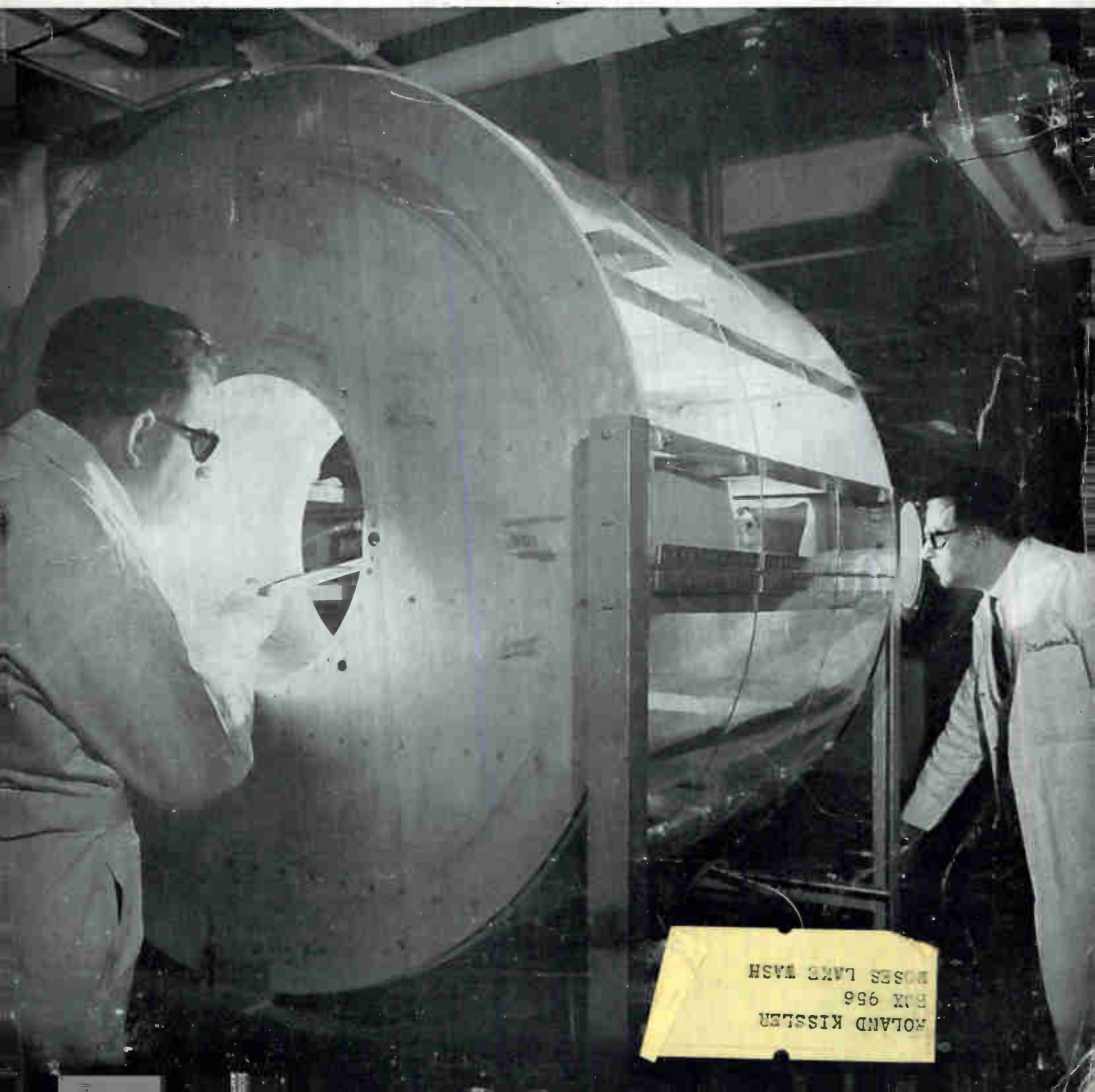
June 10, 1960

electronics

Magnetic pinch plasma engine may steer moon probes and propel interplanetary space vehicles. Creating and investigating plasmas require unique instrumentation for data acquisition. *See p 66*

A McGraw-Hill Publication 75 Cents



A *Versatile* PULSE SOURCE FOR TRANSISTOR TESTING . . .

Turn-On Time, Rise Time, Fall Time . . . three of the more important transistor characteristics measured at Philco's Lansdale Division with the aid of a General Radio 1391-B Pulse, Sweep, and Time-Delay Generator — a *complete* pulse system. To make repetitive measurements of the various transistor types faster and with minimum resetting of their test console, Lansdale's engineers have designed a circuit jig (shown on the work table) for each transistor type. Type 1219-A Pulse Amplifier (shown under Type 1391-B) provides additional pulse amplification.

Features of the Pulse Generator that are particularly useful in Lansdale's quality control program include: excellent rise and decay time characteristics (0.015 μsec); the extremely wide range of pulse durations; lack of duty ratio restrictions; variable output impedance; the ability to put the pulse's zero reference level above ground level; and in general, the wide variety of useful waveforms that the generator can produce.

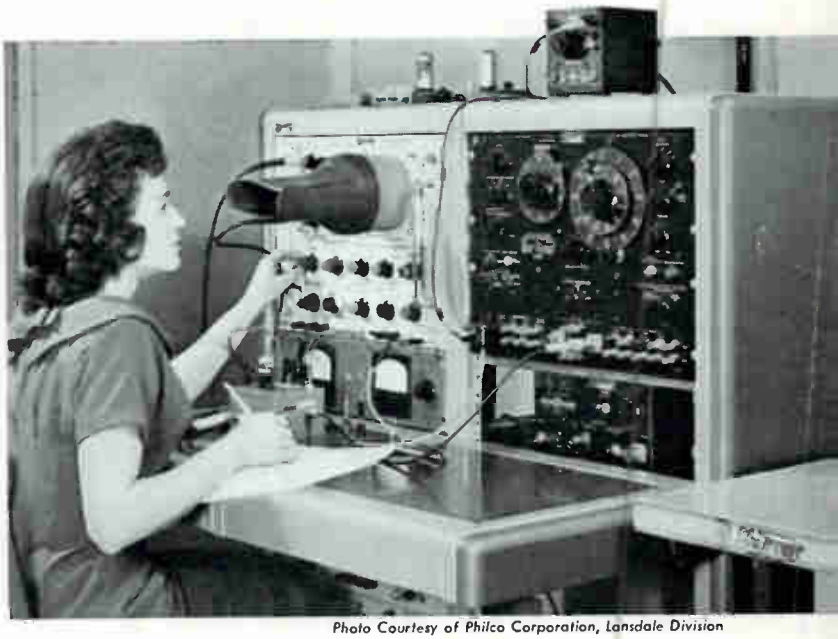
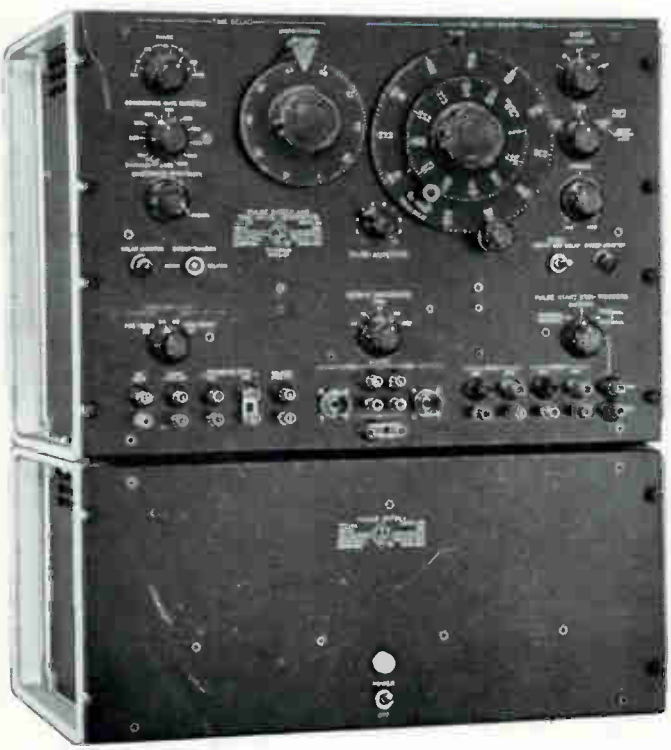


Photo Courtesy of Philco Corporation, Lansdale Division

. . . A *Versatile* PULSE SOURCE FOR MANY OTHER MEASUREMENTS



Echo Ranging, Telemetering, Computer Research, Television, Radio Navigation

- ★ Rise and Decay Times Better Than 0.015 μsec
- ★ Pulse Durations From 0.025 μsec to 1.1 sec
- ★ Time Delays From 1 μsec to 1.1 sec

Type 1391-B Pulse, Sweep, and Time-Delay Generator . . . $2025

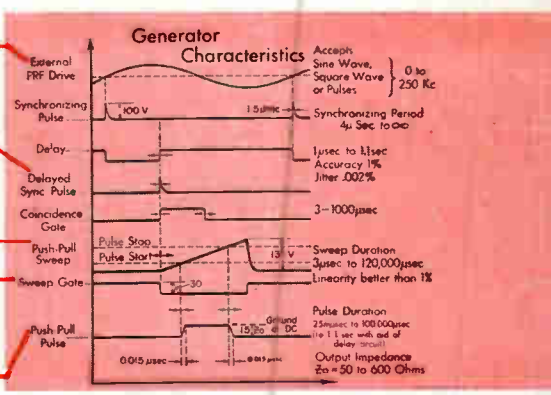
Direct synchronizing pulse timed by the input signal.

Delayed synchronizing pulse accurately adjustable in time by delay generator. Built-in coincidence circuit for timing the delayed synchronizing pulse by externally generated pulses fed into the instrument.

Push-pull sawtooth voltage of sufficient amplitude to be applied to the deflection plates of oscilloscope for examining the generator's output pulses, or for use in driving auxiliary equipment.

Push-pull gating pulses with same duration as the sweep.

Positive or negative pulses with excellent shape characteristics, continuously adjustable in duration, amplitude, impedance level, and delay with respect to (a) the direct sync pulse and (b) the sweep.



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June 10, 1960

electronics

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BUSINESS

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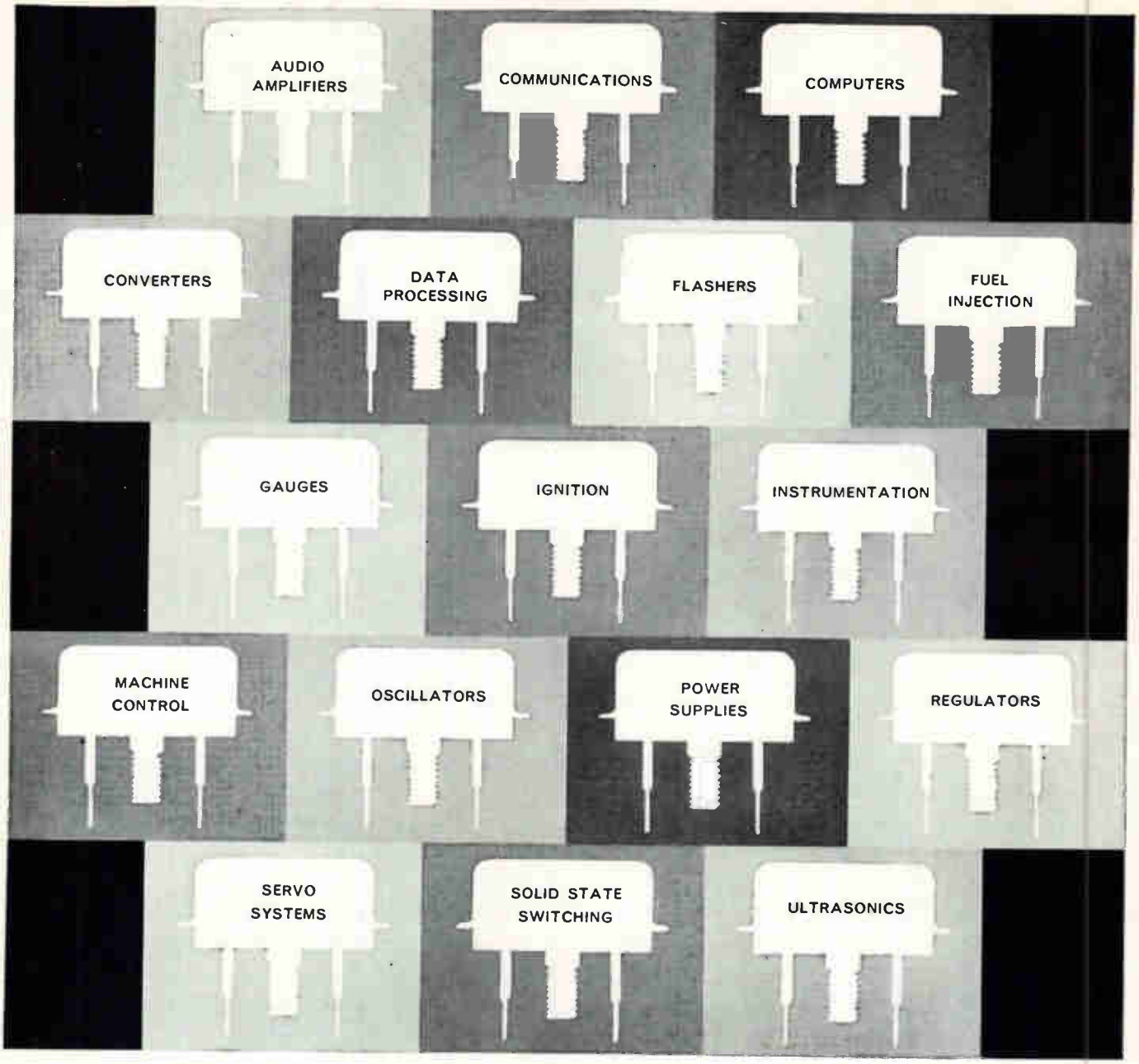
DEPARTMENTS



ONE TRANSISTOR— HUNDREDS OF USES

DELCO RADIO'S VERSATILE 2N174 For top performance in a wide, wide range of applications, depend on Delco Radio's 2N174.

■ This multi-purpose PNP germanium transistor is designed for general use with 28-volt power supplies, and for use with 12-volt power supplies where high reliability is desired despite the presence of voltage transients. ■ It has a high maximum emitter current of 15 amperes, a maximum collector diode rating of 80 volts and a thermal resistance below .8°C per watt. The maximum power dissipation at 71°C mounting base temperature is 30 watts. Low saturation resistance gives high efficiency in switching operations. ■ The 2N174 is versatile, rugged, reliable, stable and low priced. For more details or applications assistance on the 2N174 or other highly reliable Delco transistors, contact your nearest Delco Radio sales office.

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DESIGN WITH ARNOLD 6T CORES . . .

SAME-DAY SHIPMENT OF STANDARD DELTAMAX CORE SIZES

Arnold 6T tape cores (aluminum-cased and hermetically-sealed) offer you three very important design advantages. *One:* Maximum compactness, comparable to or exceeding that previously offered only by plastic-cased cores. *Two:* Maximum built-in protection against environmental hazards. *Three:* Require no supplementary insulation prior to winding and can be vacuum impregnated after winding.

Now we've added a fourth vital advantage: Maximum availability. An initial stock of approximately 20,000 Deltamax 1, 2 and 4-mil tape cores in the proposed EIA standard sizes (See AIEE Publication No. 430) is ready on warehouse shelves for your convenience. From this revolving stock, you can get immediate shipment (*the same day order is received*) on cores in quantities from prototype lots to regular production requirements.

Use Arnold 6T cores in your designs for improved performance and reduced cost. They're guaranteed against 1000-volt breakdown . . . guaranteed to meet military test specifications for resistance to vibration and shock . . . guaranteed also to meet military specifications for operating temperatures. The 6T hermetic casing method is extra rigid to protect against strains.

Let us supply *your* requirements. Full data (Bulletin TC-101A and Supplements) on request. • Write *The Arnold Engineering Company, Main Office and Plant, Marengo, Ill.*

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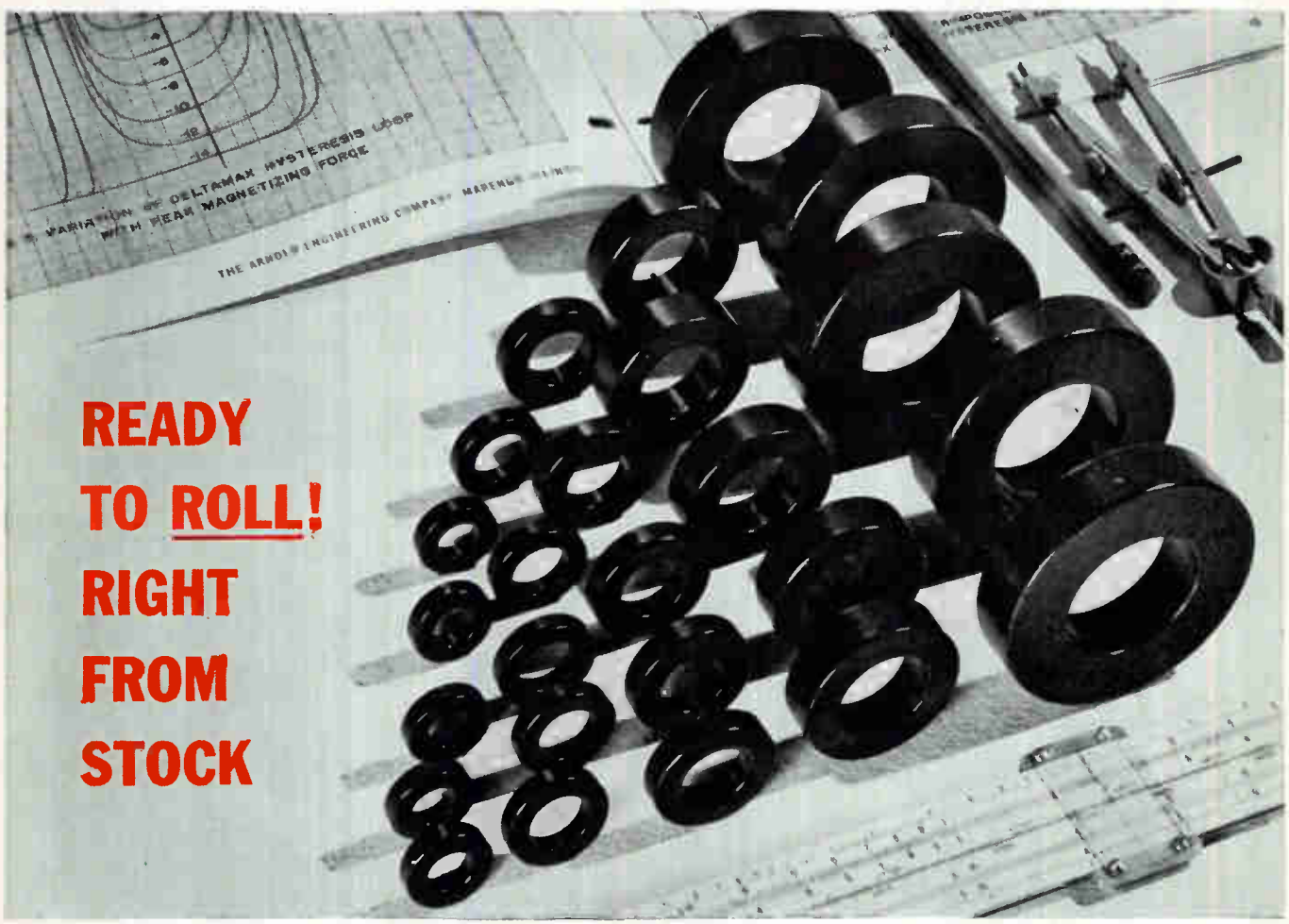
1539



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June 10, 1960 Vol. 33, No. 24

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CROSSTALK

KLYSTRON AMPLIFIERS. Use of reflex klystrons in regenerative amplifier circuits presents certain disadvantages because the amplifiers are one-port devices. In this issue (p 64), long-time ELECTRONICS contributor K. Ishii of the University of Minnesota presents a novel method of overcoming some of the limitations. According to Ishii, hybrid-T coupling gives a substantial increase in directivity and allows higher input signals.

This is Ishii's fourth article in ELECTRONICS. He is an assistant professor in Minnesota's electrical engineering department. His previous articles have dealt with reflex klystrons in X-band receiving amplifiers (p 202, April, 1955, and p 56, Jan. 8, 1960) and in M-band amplifiers (p 71, Mar. 18, 1960).

MORE RELIABILITY. The increasing search for reliability in components and systems is worldwide. And while the reliability hunt itself is as old as the first electron tube, the intensity and broadness of the hunt reaches new proportions almost every week. Recently in Britain, for example, a one-day symposium titled "Electronic Equipment Reliability" was held. The attendance wasn't 200 or 300. It was 1,000. And the people present weren't just electronics engineers. They were Britain's top design engineers—all seeking more information on reliability. Derek Barlow, of McGraw-Hill's World News bureau in London, was there, too. His story appears on p 34.

Coming In Our June 17 Issue

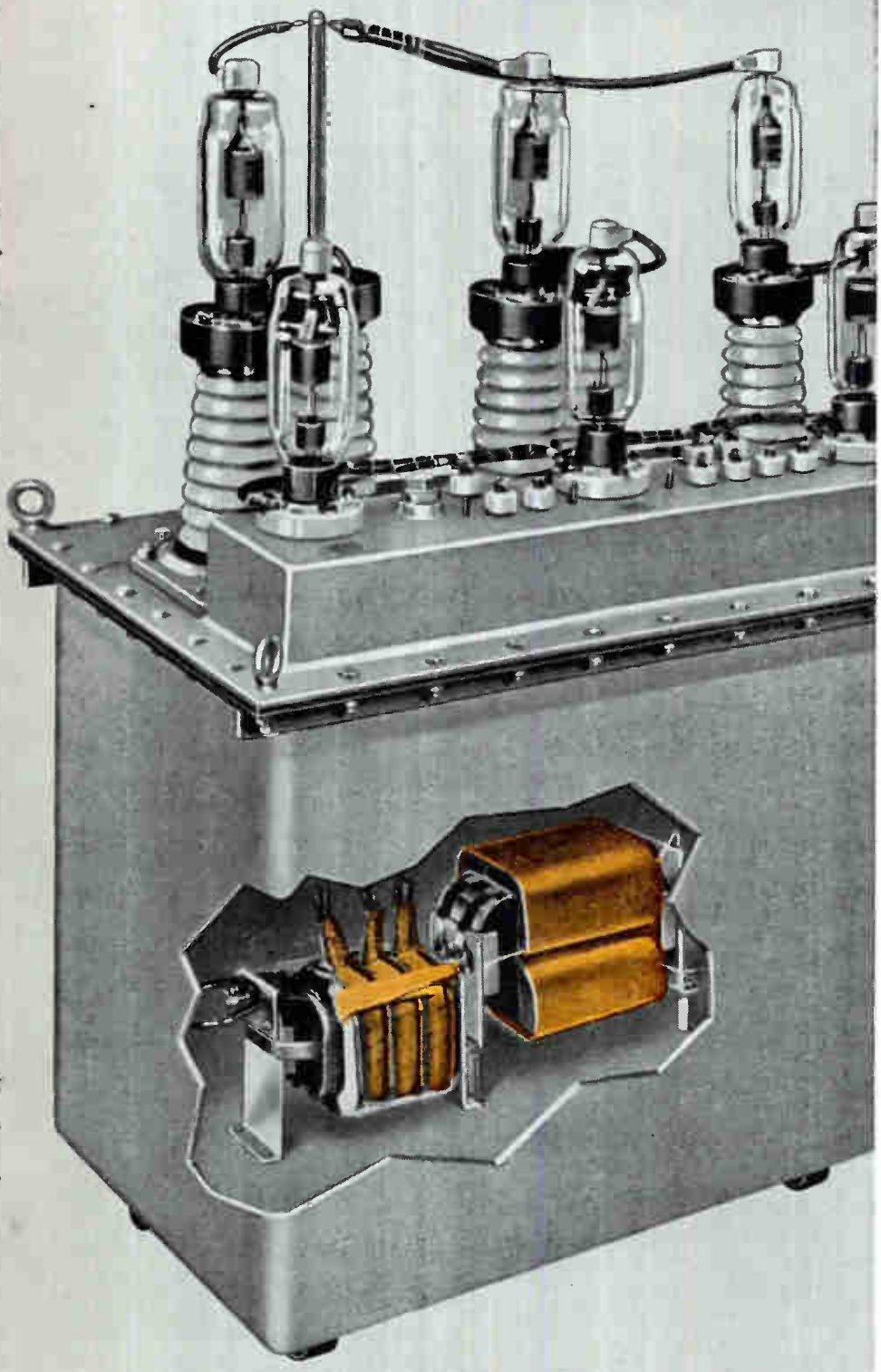
STRATOSCOPE I TV. High-altitude solar photography conducted in the Stratoscope I program was made possible by using a slow-scan tv chain. The chain consists of a balloon-borne camera and transmitter and a ground receiving station.

For our next issue, four members of the technical staff at RCA Laboratories in Princeton, N. J., have teamed up to describe this special-purpose tv system. L. E. Flory, G. W. Gray, J. M. Morgan and W. S. Pike provide an informative article which, in addition to presenting some unconventional electronics, is a significant example of how our industry is assisting astronomers and other scientists in studying man's environment.

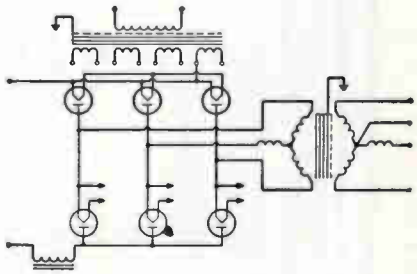
SOUND LEVEL METER. A transistorized sound level meter has been developed to provide direct readings of sound level from 24 db to 140 db. Next week, W. V. Richings and B. J. White of Dawe Instruments Ltd. in London describe this instrument, which employs a crystal microphone feeding into a specially-developed high impedance circuit.

FURTHERMORE. A variety of other interesting feature material to appear next week includes: an automatic surveying system for measuring runway roughness by R. S. Brown of Midwest Research Institute; a novel design peak voltmeter by R. P. MacKenzie of Philco Corp.; a built-in test system for automatic fault location by D. H. Breslow of Raytheon Co.; a reference sheet that can be used to obtain graphical solutions for twin-T networks, and a discussion of broadband log-periodic antennas by R. Bell of Granger Associates.

Raytheon Transformer Talk



Applying the unit construction technique to high voltage power supplies



The trend to unitization of power supply construction is not limited to low voltage supplies. The unit at left was designed and built by Raytheon for the main power supply of the FAA Vortac System—the guidance system for aircraft throughout the United States.

This is a complete high-voltage rectifier, including plate transformer, filament transformer and filter reactor in one compact housing with integral mounting of rectifier tubes (circuit diagram above). All magnetic components are capable of withstanding 51 KV RMS hi-pot test. Oil-filled high voltage terminals are corona-free. Input = 3 phase, 208 volts ± 15% 60 cycle ± 10%. Output at nominal line voltage is 24,000 volts DC ± 2% at 200 MA.

Write for complete data on Raytheon magnetic components.

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Magnetics Operations
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CIRCLE 5 ON READER SERVICE CARD

Solving critical transformer design problems for key missile, radar and communications system contracts has been an important Raytheon activity for over 20 years.

Recent expansion in production facilities now makes many of these advanced designs available in quantity, with prompt delivery.

COMMENT

In This Corner

This is just a brief note to let you know that I am in your corner in your controversy with reader Carroll (Comment, p 6, May 20). Seemingly, Mr. Carroll does not know that both government and industry spend vast amounts of money for the sole purpose of obtaining information from abroad. Unfortunately, as Mr. Carroll's letter indicates, the problem is not always so much that of what information is available, but what certain individuals are willing to read.

Keep up the good work. . . .

EUGENE MITTELMANN
CHICAGO

Up and Down

I was fascinated to read in my favorite magazine (p 92, May 13) that "synchronous pumping ups noise figure."

I always thought it cuts noise figure.

Never suspected your journal of such cutups. . . .

ROBERT ADLER
ZENITH RADIO CORP.
CHICAGO

Problem wasn't cutups but cutdowns. One editor wrote the headline with the word "improves"—a pretty accurate word but too long for the page. In the press of closing the page, another editor had to cut the headline down to size, and, without looking into the article, interpreted "improves" as "ups."

Charactron

We have noted your article entitled "Air Traffic Data Center Tests Begin" (p 28, Apr. 8). In that article, *Charactron*, which is a registered trademark of the Stromberg-Carlson division of General Dynamics Corp. was misused in several respects.

In column 2 of p 29, it is stated that "the computer . . . generates a Hughes Charactron display of simulated aircraft movements . . ." Naturally, we are upset at this inadvertence and were wondering whether you would be kind enough

Two completely new, transistorized, differential Data Amplifiers, Types 491 and 492, by Offner Electronics Inc. Their high precision makes possible an accuracy and simplification of data reduction previously impossible. Sixteen channels of data reduction (Type 492) requires only 8¾" of rack space. Power supply occupies only 5¼". The combination of accuracy, stability, fast response, and size is unmatched.

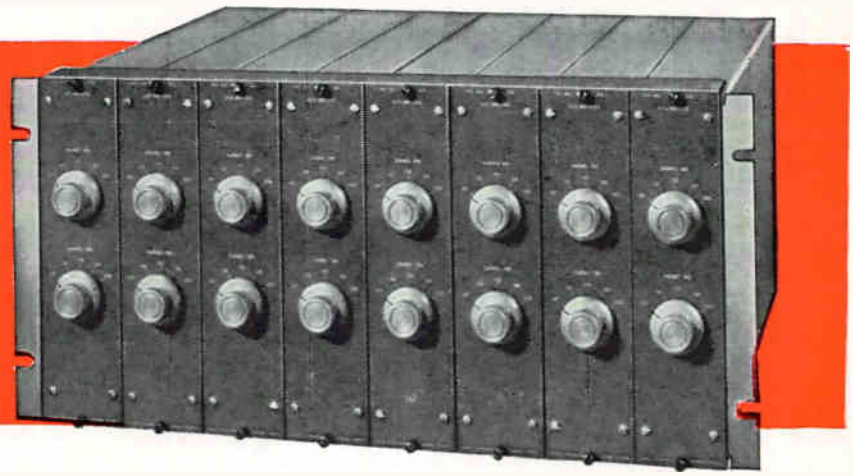
1/100% accuracy

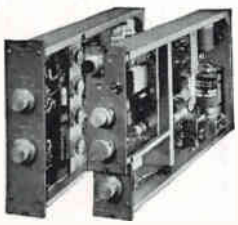
1/100% gain stability

1/100% linearity

OFFNER

Type 491 and 492 *Differential* Data Amplifiers





Type 492 Amplifier (left) provides 2 channels of precision amplification per unit. The Type 491 (right) is a single channel unit, with input coupler for added versatility.

featuring

1/100% accuracy

1/100% gain stability—for 1,000 hours at normal ambients
1/100% linearity—for full output
All-transistor construction
1/400th second response—to step input
Very low output impedance—less than 0.1 ohm
Infinite rejection—of common d-c signals
120db rejection—at 60 cps
16 channels in 8¾ inches of rack space (Type 492)
Versatile input couplers (Type 491)

OFFNER ELECTRONICS INC.
3906 River Road, Schiller Park, Ill. (Suburb of Chicago)

to print a correction in ELECTRONICS in the near future stating that *Charactron* is a registered trademark of General Dynamics Corp. . . .

ROBERT L. NATHANS
STROMBERG-CARLSON
ROCHESTER, N. Y.

The Disappearance

(Re: "Tiros I Tracked from Horizon to Horizon," p 96, May 13). . . .

At the bottom of p 96, I presume Tiros I disappeared over the horizon?

JACK R. CRADDOCK
BOULDER, COLO.

It seems that way; the page ends in midsentence, and the next page begins a new article. But pages 95 and 96 are out of order; reader Craddock will find that Tiros landed, not over the horizon, but on p 95.

On the Market

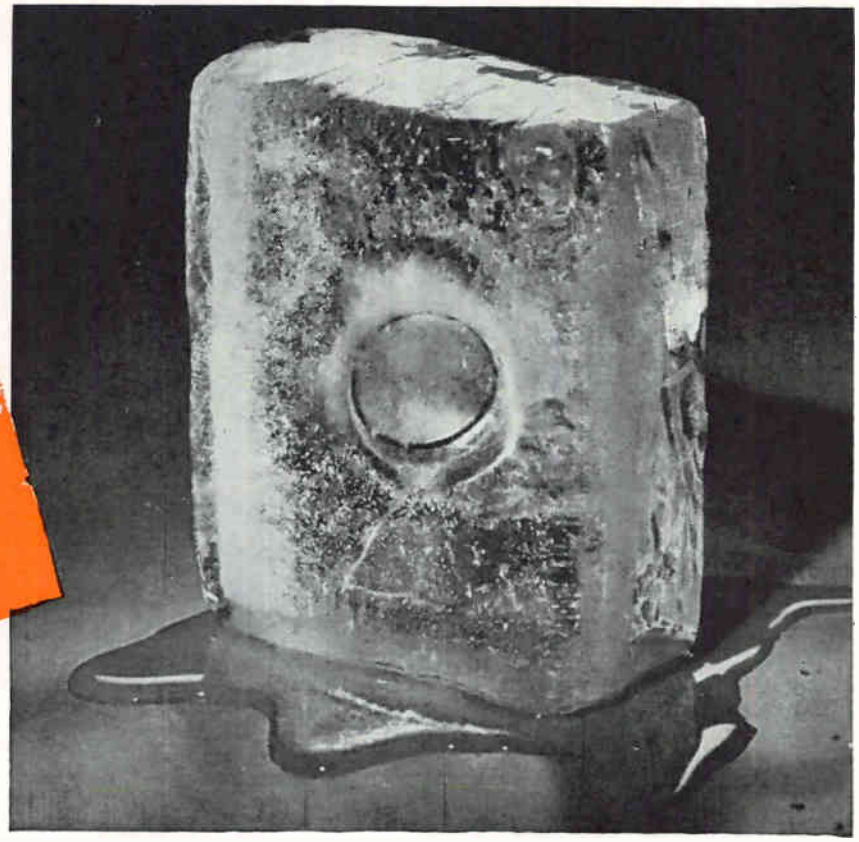
. . . We are unceasingly continuing research in many specialized laboratories to develop new products in the field of electronics, including radio, television, communications and components.

We should be grateful if you would accept our new products as material for On The Market. Although being afraid of taking too much of your valuable time, we anxiously await information on your editorial policies, in order to select the material in the best way to cooperate with your staff. . . .

TAKASHI HIRANO
MATSUSHITA ELECTRIC
INDUSTRIAL CO.
OSAKA, JAPAN

Reader Hirano and other international readers who may not be familiar with our policy might like to know that we are always interested in finding out about new electronic devices wherever they are produced. Naturally, we don't publish them all; there are probably well over 10,000 new products developed in the U. S. alone every year. In selecting material, we follow the same rules as with all other editorial material—we select the best and most interesting, in our judgment, consistent with available space.

Frozen solid and still full of life!



Freezing temperatures hold no threat for this hardy battery! The performance of Mallory's new low-temperature, wound anode mercury cell far surpasses that of conventional pressed powder anode cells at temperatures around 32°F. This improved performance yields increased capacity per unit volume for all-weather uses, such as navigational buoys, emergency beacons, air-sea rescue transceivers, survival kits, marker lights, warning devices, and many other applications.

The ribbon wound zinc anode of this new mercury cell has a large surface area in contact with the electrolyte. The interleaved absorbent retains the electrolyte and facilitates ionic transfer over the entire anode surface area. This lowers the temperature sensitive anode impedance in the freezing temperature zones.

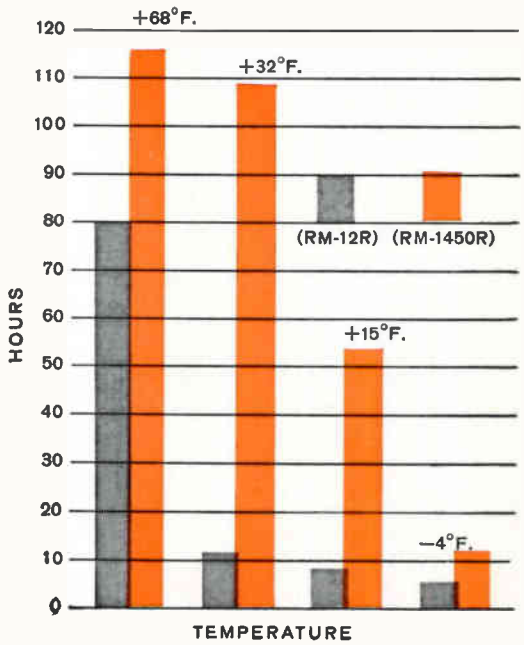
Wound anode construction also increases cell efficiency. At drains up to 100 ma, 90% of available room temperature capacity is attained. Cell units can be packaged to yield up to 45 watt hours per pound.

Write for complete engineering data, including sizes available, suggested applications, characteristics curves and tables. Detailed information on current military uses is available to authorized companies.

HOURS LIFE VS. TEMPERATURE OPERATION

Wound Anode (RM-1450R) vs. Pressed Powder (RM-12R)

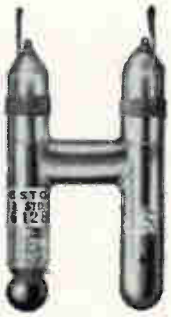
Data shows hours life to .9v cut-off on typical transceiver duty 10ma rec. 5 min. 75ma trans. 5 min. continuous cycle.



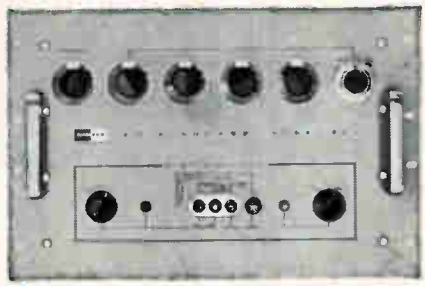
Mallory Battery Co., Cleveland, Ohio
a division of

P.R. MALLORY & CO. Inc.
MALLORY

In Canada, Mallory Battery Company of Canada Ltd., Toronto 4, Ontario



This is a DC standard cell



This is a KIN TEL 601A AC voltage standard, the nearest AC equivalent

The 601A produces 1 to 501 volts, at 60, 400 or 1000 cps. Voltage accuracy is ± 0.1%. Frequency accuracy is ± 1.0%. Harmonic distortion is less than 0.3%. Power output capability is 5 amps up to 5 volts and 25 watts above. The output is completely floating and isolated from AC line and chassis ground.

If you calibrate high-accuracy AC measuring instruments, or design servo or gyro equipment, or evaluate magnetic properties, you probably need this new kind of voltage standard.

For more information call or write us direct, or call your nearest KIN TEL representative.

5725 Kearny Villa Road, San Diego 11, California, Phone: BRowning 7-6700

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ELECTRONICS, INC.

KIN TEL manufactures electronic instruments for measurement and control, and closed circuit TV. Representatives in all major cities. Write for detailed literature or demonstration.

ELECTRONICS NEWSLETTER

Automatic Print Reader Aids Machine Translation

MACHINE that reads Russian is being built by Baird-Atomic to work with the electronic translator developed by IBM and recently unveiled by the Air Force (ELECTRONICS, p 11, May 20). The print reader will be able to recognize 1,000 Russian characters a second, compared with typists' speed of about 40 words a minute.

At the present time, a typist copies *Pravda* and *Izvestia* on a Flexwriter, converting the Russian letters into punched-tape code for the translating computer.

The optical-electronic reader scans a film copy of the original page. Reader memory consists of photographic masks or optical apertures. Light passes through the unknown character (transparent on film copy), through an array of apertures and on to an array of photodetectors, one behind each aperture. The decision-making function is carried out electronically by threshold circuits at the photodetector outputs. The reader will be tested in September.

Instrument Fault Causes Soviet Spaceship "Backfire"

SOVIET SCIENTISTS attempted to bring back Sputnik IV's cabin capsule and failed. According to Tass, Soviet news agency, the order was sent to the ship four days after launch to switch on the braking system in order to depress the orbit and detach the cabin. "As a result of a fault . . . in one of the instruments in the space ship's orientation system," the retro rocket fired in the wrong direction.

The satellite was fragmented into several pieces (seven have been identified by the National Space Surveillance Control Center) and the apogee of its orbit expanded from 222 miles to 412. Its transmitter is still working.

After winnowing the chaff out of a host of reports in the Soviet press, it appears that while the rocket's propulsion system was undoubtedly a powerful and advanced one, the electronics systems were unexceptional. Automatic regulatory systems for temperature and other environmental conditions were powered with zinc-alkali batteries. Solar cells—used on the "interplanetary automatic station" that photographed the backside of the moon—were apparently not used.

A Soviet academician, commenting on the space ship, claimed among other things that the first manned space flight "is not far off." Another added "as soon as technical aspects of spaceship flight control and reentry problems are solved, we shall be ready to send a man into space."

System Supervises Gas Transmission

SOLID-STATE circuitry is employed in an automatic control and supervisory system installed by Colorado Interstate Gas Co., Colorado Springs. The system was built by Southwestern Industrial Co. of Houston, Tex., to control and supervise CIG's compressor station at Springfield, Colo., 160 miles southeast of the gas transmission company's headquarters.

Gas dispatcher at the headquarters communications center telemeters discharge-pressure figures (known as set-point controls) to the compressor station over microwave link. Automatic controls at the station keep discharge pressures at the set point, monitor for off-limit conditions, call in protective devices when necessary, keep a log on equipment operations.

Radio, Tv Production Rises in Austria

GENERAL SLACKENING of electrical-appliance production in Austria is countered in part by rises chalked up in three areas: radio-tv, light bulbs and insulated wire. Government statistics indicate that curtailed government buying and slowdown in construction are behind the slack appliance market, give no hint as to why radio-tv is rising while other appliances slide.

Average monthly radio production in 1959 was 30,947; this year it is running about 33,300. Television production figure for 1959 averaged 5,997, and is topping 7,000 monthly so far this year.

Information Agency Calls for Engineers

VOICE OF AMERICA's big shortwave facility, going up in Greenville, N.C., will use six 250-Kw General Electric transmitters as part of its overall 4-million-watt strength. The first two GE sets are slated to go on test in July. When completed, the station will be the most powerful shortwave transmitter in the world. It will consolidate four obsolescent stations now operating along the eastern seaboard, send broadcasts to relay stations in Europe and beam directly to South America, the Middle East and North Africa.

U.S. Information Agency tells ELECTRONICS it needs engineers to keep the facility on schedule. The propaganda agency needs electrical and electronics engineers with a minimum of three years' professional experience. Preparation for the 6,100-acre installation began last February; it is scheduled for completion in 1962.

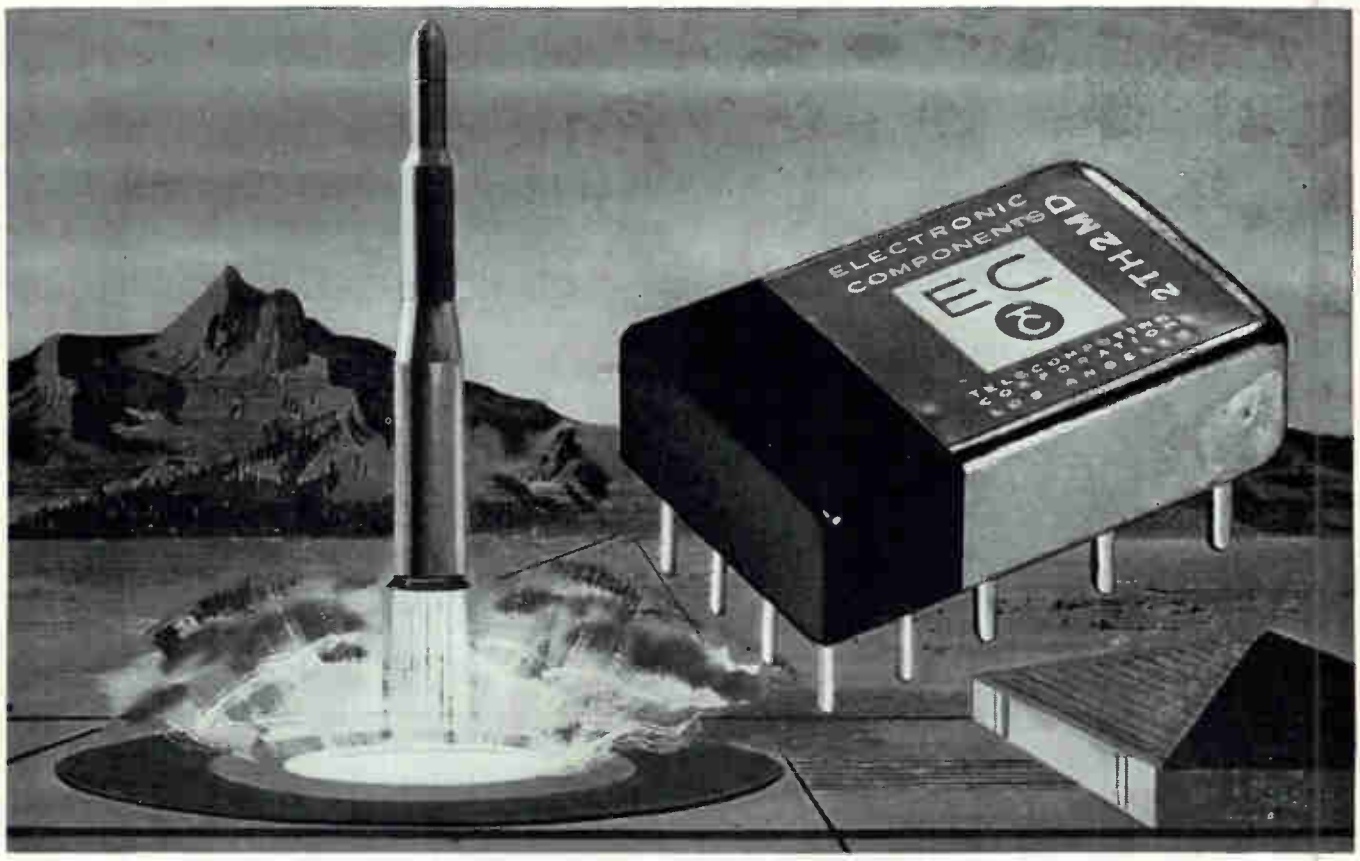
Changemaking Machine Senses Magnetic Signals

CHANGEMAKER developed by Rescon Electronics, Boston, can recognize bills in $1, $2, $5 and $20 denominations, make proper change either for face value or after subtracting price of a product. Called Optrovend, the machine measures color and density of the inks on the bill in terms of magnetic response.

American-made A-m/F-m Transistor Portable Out

AMERICAN-MADE all-transistor a-m/f-m portable radio is being test-marketed in parts of New England through Northeastern Distributors, Cambridge, Mass. Developed by Zenith Radio, the battery-powered set is equipped with afc for drift-free tuning in primary signal areas.

DOW | THERMOSETTING RESINS



Relay terminal connections, potted with Dow epoxy novolac, help keep the Minuteman missile ready to go!

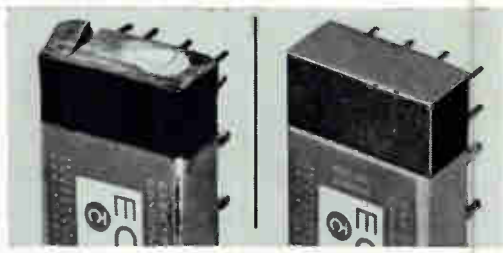
"Our micro-miniature relay rejects dropped from 25% to . . .
NO REJECTIONS SINCE WE SWITCHED TO DOW EPOXY NOVOLAC!"

"Our customers, the Autonetics Division of North American Aviation, Inc., specified 100,000 ohms insulation resistance for a relay in the guidance system of the Minuteman missile," states H. E. Wardein, Customer Relations Manager of the Electronics Components Division, Telecomputing Corporation. "Our micro-miniature relay had to measure up to this standard. Since the relay is designed as a plug-in unit, it is potted to give the connector mechanical stability, and to assure electrical insulation.

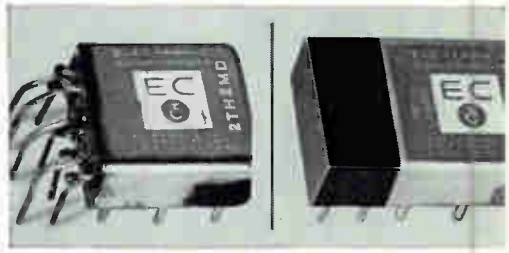
"Using our regular potting materials, we found it necessary to rework about 25% of our production. But with Dow epoxy novolac resin (D.E.N. 438) potting compounds, we have built many thousands of relays and have not experienced a single rejection due to low insulation resistance!"

Dow epoxy novolac resins are preferred by component manufacturers like Telecomputing Corporation for their superior ability to adhere to metal parts; for their heat and chemical resistance—far above that of ordinary epoxy materials; and for their ability to surpass the heat distortion point of ordinary epoxies—even when room-cured rather than oven-cured!

If you are potting, molding, encapsulating, or laminating electronic components, or require an epoxy resin for an application where performance is critical, consider D.E.N. 438 for that extra measure of physical and chemical stability! Call your nearest Dow sales office. Or write: THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Merchandising Department 1968JG6-10.



In heat-resistance tests, ordinary epoxy resin compound (left) cracked. Dow epoxy novolac (right) was unharmed!

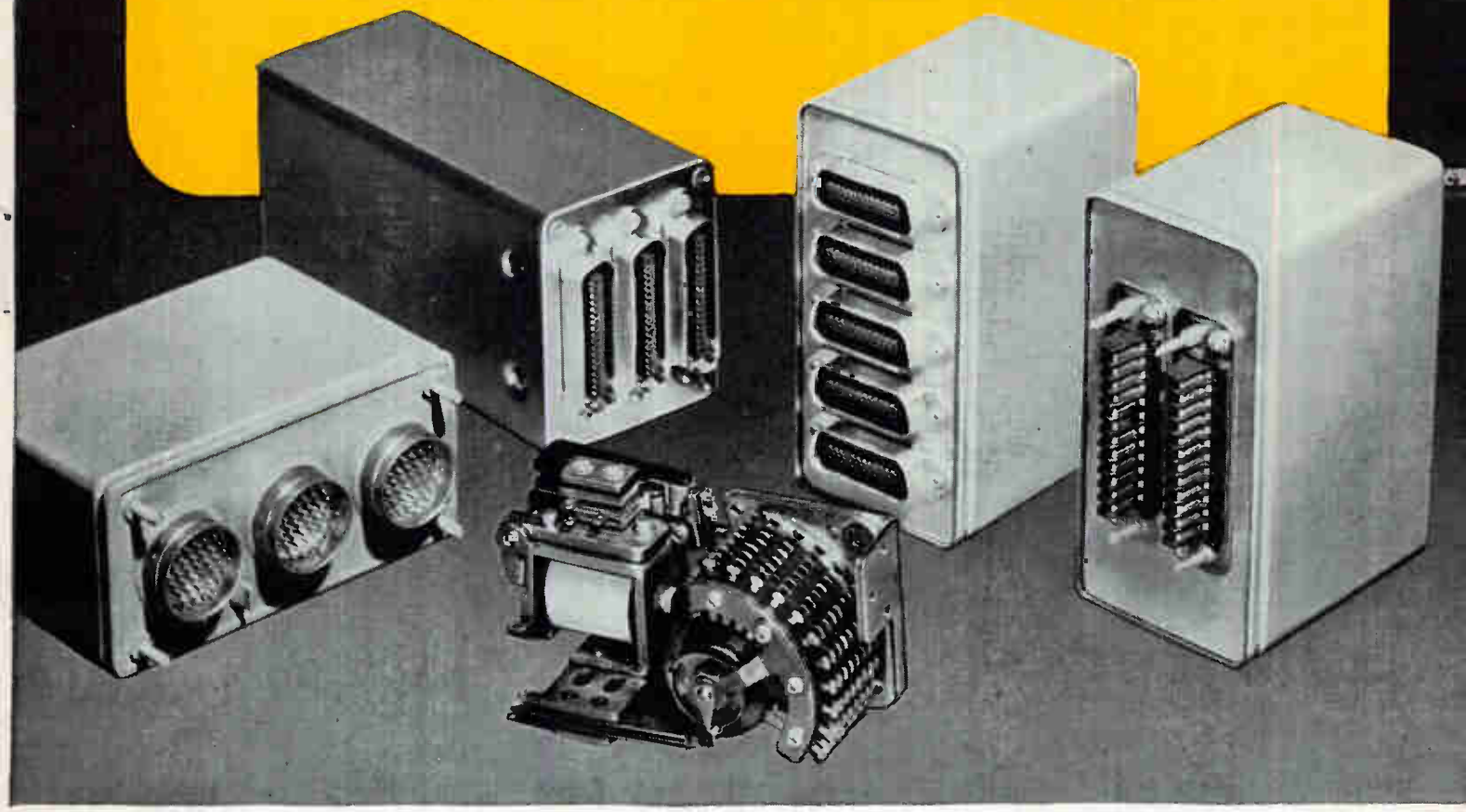


Soaked in an epoxy stripper, ordinary epoxy resin potting (left) dissolved. Dow epoxy novolac (right) showed no change after two weeks' immersion!

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

NOW... from CLARE...

a new 10-Point Stepping Switch



for long life digital operation

Small, lightweight and capable of a minimum of over 100,000,000 operations,* the new CLARE Type 210 Stepping Switch is specially designed for digital operation. It is ideally suited as a component for sequence control, totalizing, sampling or single point selection. It transfers from Position 10 to Position 1 without special circuitry.

This new switch has all the improved features which have made the Type 211 an ideal component for complex switching requirements—long life, excellent capacity and freedom from maintenance. A wide variety of hermetically sealed and dust cover enclosures are available with terminals or connectors to suit the application.

Send for Bulletin CPC-6 for complete information. Address C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois; In Canada: C. P. Clare Canada Ltd., P. O. Box 134, Downsview, Ontario. Cable Address: CLARELAY.

*with twelve 10-point levels . . . 300,000,000 operations with four 30-point levels (properly lubricated and adjusted).

CLARE

Relays and Related Control Components

ELECTRICAL DATA

OPERATING SPEEDS—Self-interrupt speed: 60 sps at 25°C on nominal voltage. Remote impulse speed: 30 sps at 25°C on nominal voltage with 66% make impulse.

OPERATE & RELEASE TIME—Operate time: 20 ms at 25°C on nominal voltage. Release time: 10 ms at 25°C on nominal voltage.

OPERATE & RELEASE VOLTAGE—Maximum pull-in at 25°C is 75% of nominal voltage. Minimum dropout at 25°C is 3% of nominal voltage.

BREAKDOWN TEST—1000v, rms, 60 cps, is standard.

COILS—Coil resistances for typical voltages are shown below:

VOLTAGE Vdc	1-8 LEVELS OHMS	9-12 LEVELS OHMS
6	1.5	1.5
12	6	6
24	24	20
48	100	70
60	150	100
110	600	400

MECHANICAL DATA

OVERALL DIMENSIONS—Length (maximum)—4-5/16 in. Height (1C interrupter, 1C O.N.S.)—2¾ in. Width—from 1-5/16 in. for 3 levels to 2-13/16 in. for 12 levels.

NET WEIGHT—From one pound for 3 levels to 1½ pounds for 12 levels.

BANK CONTACT—Standard is phosphor bronze. Also available are coin silver or gold plated phosphor bronze.

MAXIMUM BANK LEVELS & PILEUPS

Type of operation (points)	10	30
Bank levels maximum (electrical)	12	4
Interrupter springs	6	6
Off-normal springs	6	6
Number of ratchet teeth	30	30

WIPERS—Standard wipers are non-bridging phosphor bronze with coin silver and gold-plated phosphor bronze available in either non-bridging or bridging models.

WASHINGTON OUTLOOK

THE AIR FORCE is making a monumental policy change which will affect management of future ballistic missile and space development projects.

From here on out, systems engineering and technical director functions will be assigned to production prime contractors through competition. For the past six years, Thompson Ramo Wooldridge's Space Technology Laboratories has been the Air Force's technical and managerial director on the ICBM and early satellite systems.

STL is also being eased out of its Air Force staff role in charge of advanced planning and evaluation of new systems. In STL's place, a nonprofit corporation will be set up along the lines of the Rand Corp. It will be housed in STL's $25-million El Segundo, Calif., R&D complex, and will be staffed—the Air Force hopes—with personnel recruited from STL. A contract spelling this out is expected to be ready in about two weeks.

The contract will also define STL's role in existing projects. STL will remain as system engineer and technical director for ICBMs through "the essential development stage." This means another year or so with Atlas, two years with Titan, and three or four years with Minuteman. Its contractual ties with the Thor IRBM, now deployed overseas, have already been cut.

STL will also complete work already contracted for on experimental space shots. This runs the gamut from system engineering for the Pioneer series, to basic engineering on the transit navigation satellite, to trajectory calculations for the Discoverer test satellite.

The upshot will be this: STL will be administratively integrated with TRW, its parent company, and take its place as a regular bidder for Air Force and other contracts to design, develop, and produce later-generation ballistic missiles and space systems.

Up to now, both STL and TRW have been barred from hardware contracts resulting from projects on which STL has been system engineer and technical director.

ELECTRONICS PLAYS AN IMPORTANT ROLE in a major highway research program just proposed to Washington by a special committee of experts. The program will be backed by federal, state, and private funds, and may be put into effect later this year.

A four- or five-year project, to cost $3 million, is proposed for development of an electronic system to control vehicle traffic. The first step: Study of criteria for such factors as the degree of communication, guidance, or control needed under all road and traffic conditions; limits of precision required for vehicle guidance; conditions electronic guidance or control must satisfy; etc. A second program, to cost $3.5 million, is proposed for development of a driving simulator.

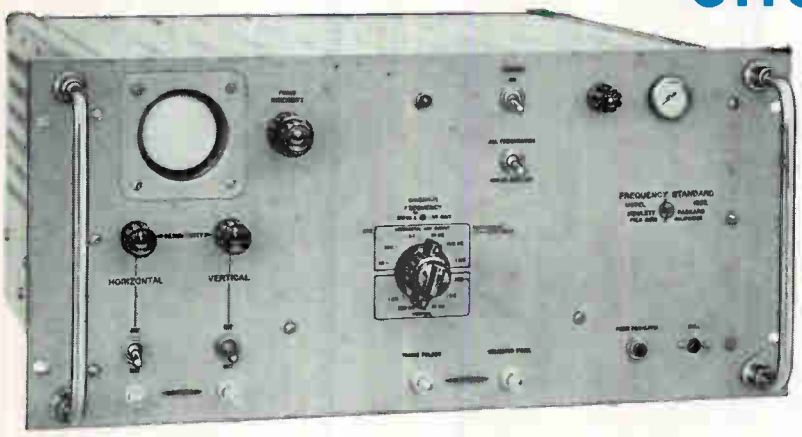
THE FEDERAL AVIATION AGENCY has started a new program to recapture some of the money it pays out to research and development contractors.

The agency is working out a plan in which companies obtaining patents from government-financed projects will be required to pay royalties back to the government amounting to about six percent of the sales price of equipment sold on the commercial market.

First test of the policy is being negotiated with General Precision Equipment Corp. on computing equipment developed under a $30-million FAA contract.

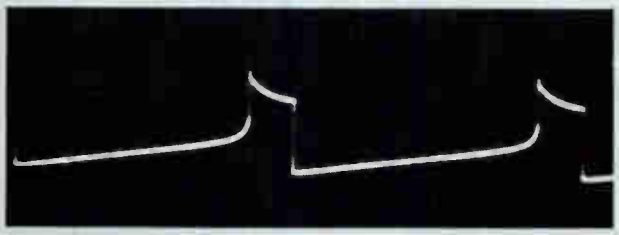
THE ARMY has solicited proposals on feasibility studies aimed to develop a ballistic missile defense system for use on the battlefield. Bids must be in to the Army Rocket and Guided Missile Agency, Redstone, Ala., this month. Presumably, the system now sought would be more sophisticated than the Plato project, cancelled by the Army two years ago.

New, compact PRECISION FREQUENCY STANDARD offers $5/10^8$ stability, just 8¾" high

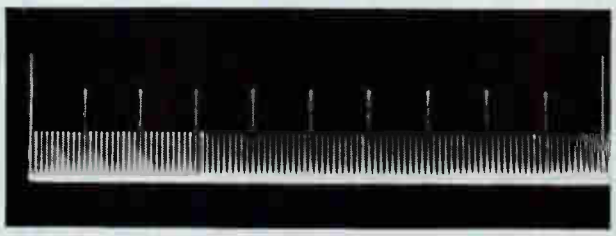


hp 100ER

FREQUENCY STANDARD



Model 100ER offers six standard sine and four rectangular frequencies in decade steps; available simultaneously and selected on front panel.



Timing comb output pips occur at 100, 1,000 and 10,000 microsecond intervals. Timing comb simplifies "fast" measurements and calibration.

Specifications

Stability:	5/10⁸ parts per week, 3/10⁸ short term.
Outputs:	Sinusoidal 10 cps, 100 cps, 1 KC, 10 KC, 100 KC and 1 MC. Rectangular 10 cps, 100 cps, 1 KC and 10 KC.
Output Voltages:	Sinusoidal 5 v rms min.; rectangular approx. 15 v peak. Harmonics to 5 MC obtainable.
Rated Load:	1 MC and 100 KC, 50 ohms nominal; 10 KC, 1 KC, 100 cps, 10 cps, 5000 ohms nominal.
Distortion:	(Sinusoidal) Less than 4%.
Frequency Adjustment:	Screwdriver tune adjusts 1 ppm.
Size:	8¾" high, 19" wide, 18" deep behind panel. Weight 35 lbs.
Price:	$900.00.

Data subject to change without notice.
Price f.o.b. factory.

This compact, highly convenient new hp frequency standard not only provides stability equivalent to complex, expensive primary standards, but offers the versatility of a wide variety of outputs. Signals available include six standard sine frequencies and four rectangular signals which may be distributed by 50 ohm cables for use at many different stations on a production line or in the laboratory. A particularly useful feature is a timing comb for calibrating, and for measurement of sweeps and time intervals.

Stability of 5 parts in one hundred million per week is assured by careful aging and testing of the crystal controlled oscillator and oven.

Model 100E includes a built-in oscilloscope which may be used as a comparison device to calibrate external equipment such as oscillators through use of Lissajous figures. The scope may also be used to check internal frequency deviation of the instrument.

For complete details and demonstration, see your hp representative or write direct.

HEWLETT-PACKARD COMPANY

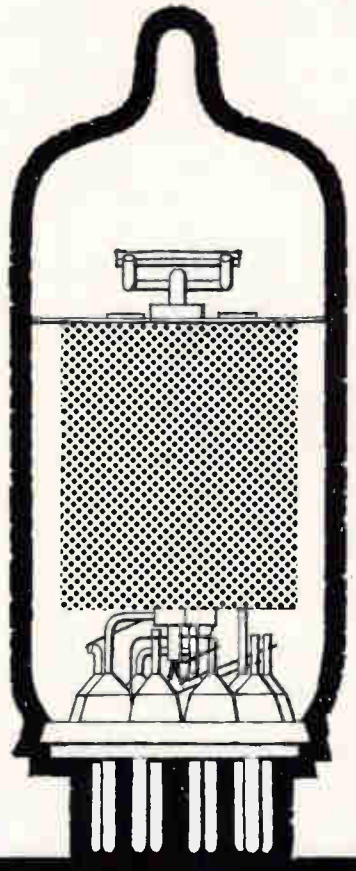
1020A Page Mill Road • Palo Alto, California, U.S.A.
Cable "HEWPACK" • DAvenport 6-7000
Field representatives in all principal areas

Hewlett-Packard S.A. • Rue du Vieux Billard No. 1, Geneva, Switzerland
Cable "HEWPACKSA" • Tel. No. (022) 26.43.36

6039

hp now offers 10 different precision oscilloscopes

EF86
6267



low noise pentode

High gain AF input pentode with exceptionally low noise, low hum and low microphony.

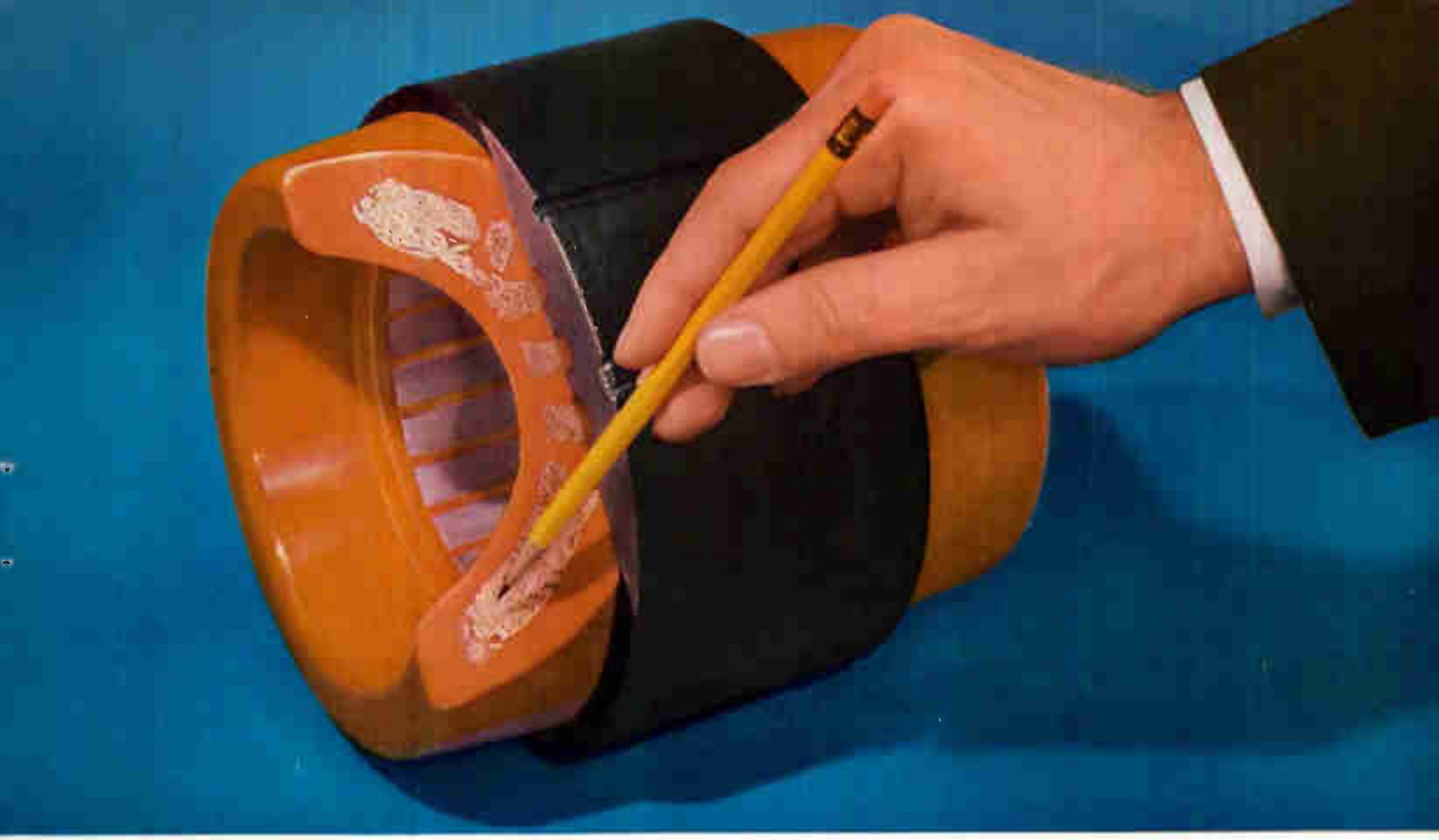
characteristics

V_a	250	V
V_{g3}	0	V
V_{g2}	140	V
I_a	3.0	mA
I_{g2}	0.6	mA
V_{g1}	−2.0	V
g_m	2.0	mA/V
r_a	2.5	MΩ
μ_{g1-g2}	38	

SUPPLIES AVAILABLE FROM

IN THE U.S.A.
International Electronics Corporation, 81 Spring Street, New York 12, N.Y., U.S.A. Worth 6-0790

IN CANADA
Rogers Electronic Tubes & Components, 116 Vanderhoof Avenue, Toronto 17, Ontario, Canada. Hudson 5-8621



This is a cutaway of an Epoxy encapsulated stator wound with Epoxy magnet wire. All-Epoxy—an ideal combination for severe applications.

EPOXY MAGNET WIRE . . . IDEAL FOR ENCAPSULATED SYSTEMS UP TO 130° C

A magnet wire must offer you *all* these important advantages when used in encapsulated systems.

The wire must have outstanding compatibility—a requirement for good bond strength at elevated temperatures—high dielectric strength under adverse moisture conditions.

The ideal magnet wire must also have excellent thermal and high-impact shock resistance. And—it must be able to resist corrosive and abrasive atmospheres.

Anaconda Epoxy meets all these requirements and more. For this 130°C (AIEE Class B) magnet wire is compatible with virtually every encapsulating compound tested to date. Equally important, Anaconda Epoxy contains no polyester modifiers —therefore offering greater resistance to hydrolysis.

In addition, Anaconda Epoxy costs no more than most Class A magnet wires—which means you can often thermally upgrade your components to Class B without additional cost. It's readily available, too—in a full range of round, square and rectangular sizes.

Epoxy can also be furnished in combination with Vitrotex (glass-served) for added thermal overload protection.

So you can see how it offers you many interesting possibilities for cutting costs and simplifying production through standardization.

Our technical staff and Research and Development Laboratory facilities are available to give you assistance in your encapsulating and other magnet wire problems. See the Man from Anaconda. Or write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y. 60252

ASK THE MAN FROM ANACONDA® *FOR* EPOXY MAGNET WIRE

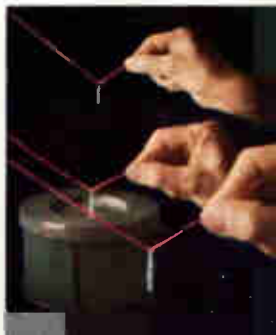
ANATHERM 155°C (AIEE Class F) high temperature resistance

NYFORM 105°C (AIEE Class A) superior windability

PLAIN ENAMEL 105°C (AIEE Class A) low-cost enameled magnet wire

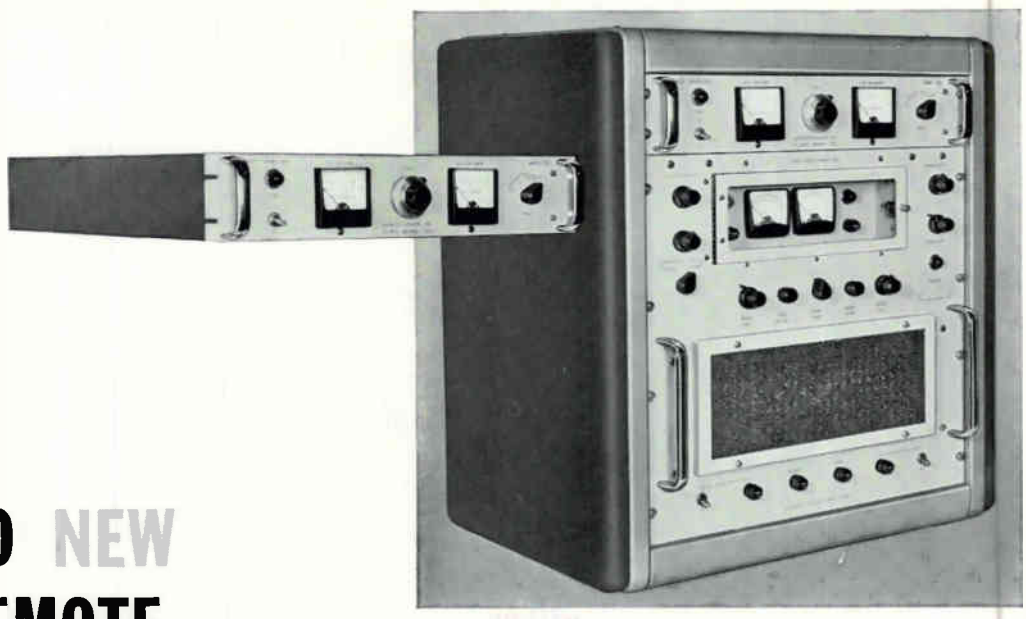
FORMVAR 105°C (AIEE Class A) proven dependability

ANALAC 105°C (AIEE Class A) solderable magnet wire



TWO NEW REMOTE TUNED SIGNAL SOURCES

(50 mc to 2 kmc, and 1 to 37.5 kmc)



Model SS 20 Signal Source Power Supply with Tuning Unit. Tuning Unit is removed to control position for remote operation. Inset shows unit removed for remote operation. In this mode, control unit can be operated up to one mile away.

Now Scientific-Atlanta offers two remote tuned signal sources which provide complete frequency coverage from 50 mc to 37.5 kmc. These sources are primarily designed for use as transmitters for antenna test ranges but find many other applications where remote tuning at distances up to a mile or more is required.

MODEL SS 30 (50 mc to 2 kmc)

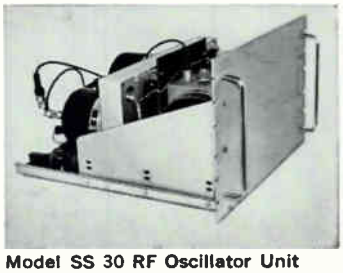
Contains three GR Unit Oscillators mechanically ganged and servo driven. • RF output capable of being sine or square-wave modulated. • Frequency accurately resettable to within ±0.5%.

MODEL SS 20 (1 to 37.5 kmc)

Extended frequency coverage with seven Series RFO Oscillator Units. Integral-magnet backward wave oscillators are voltage tunable and require no mechanical peaking. • RF output capable of being square-wave modulated. • High signal purity, low residual fm. • Will operate cm and mm-wave klystrons. • Remote tuning unit will also operate SS 30 Signal Source.

KEY SPECIFICATIONS	MODEL SS 30	MODEL SS 20
Frequency Range	50 mc to 2 kmc	1 to 37.5 kmc
Tuning Chart Accuracy	±2%	±5%
Frequency Resettability	±0.5%	±0.1% or 5 mc, whichever is greater
Power Output	80 mw into 50-ohm load	see table of RFO Oscillators

Weatherproof Enclosure and a Series RFO Oscillator Unit.



Model SS 30 RF Oscillator Unit

SERIES RFO OSCILLATOR UNITS

MODEL	FREQUENCY RANGE	OUTPUT POWER
RFO 1	1.0 - 2.0 kmc	40 - 800 mw
RFO 2	2.0 - 4.0 kmc	100 - 800 mw
RFO 3.6	3.6 - 7.2 kmc	5 - 300 mw
RFO 7	7.0 - 11 kmc	20 - 300 mw
RFO 8.5	8.5 - 16 kmc	5 - 100 mw
RFO 15.5	15.5 - 24 kmc	5 - 125 mw
RFO 23.5	23.5 - 37.5 kmc	5 - 100 mw

PRICES

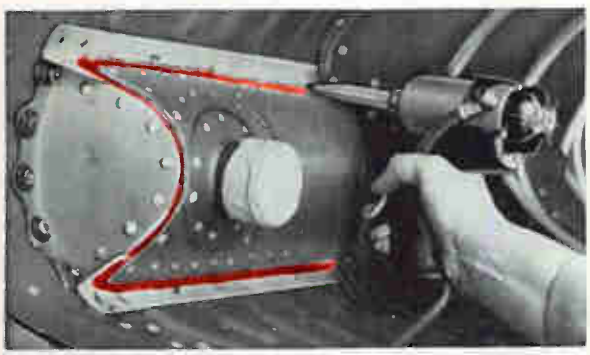
Model SS 30, $3,850; SS 20, $3,550; SSG 1 Sine-Square Wave Generator, $350; RFO 1, 2 and 3.6, $1,400; RFO 7, $1,900; RFO 8.5, $2,060; RFO 16, $3,330; RFO 23.5, $3,330. For more details, please contact your S-A representative or write directly. Address Dept. 42.

SCIENTIFIC-ATLANTA, INC.

2162 PIEDMONT ROAD, N.E. • ATLANTA 9, GEORGIA

General Electric RTV silicone rubber

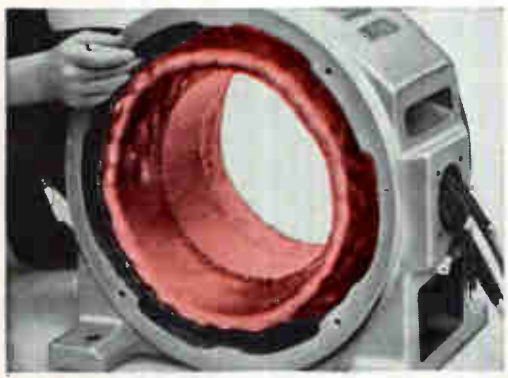
New liquid rubber cures without heat, useful from — 70 F to + 600 F, ideal for sealing, electrical insulation and flexible molds.



HEAT RESISTANT SEALING, such as shown on this Douglas DC-8 Jetliner, is made possible with RTV (room temperature vulcanizing) silicone rubber. RTV cures without application of heat; won't shrink (no solvents); forms no voids. It has excellent bond strength, plus resistance to high temperatures, moisture, weathering, ozone, aircraft fuels and solvents.

PRECISION MOLDING of prototype and engineering models and replacement parts is simplified and improved with RTV flexible mold material. G-E RTV's low shrinkage permits close tolerances and fine surface detail.

LOW-COST TOOLING with flexible RTV mold material offers added savings in time and expense. RTV's "built-in" release agent provides easy removal of this epoxy coil-winding form from mold. Total cost reduced 81%, delivery time 90%.



ENCAPSULATION OF STATOR WINDINGS, introduced by General Electric motor departments, extends service life of motors. RTV's resistance to moisture and other contaminants enables these dripproof motors to meet certain applications formerly requiring enclosed units.

POTTING OF AIRBORNE EQUIPMENT provides protection from high altitude arc-over and corona as well as vibration and moisture. RTV silicone rubber protects this cathode ray tube up to 70,000 feet.

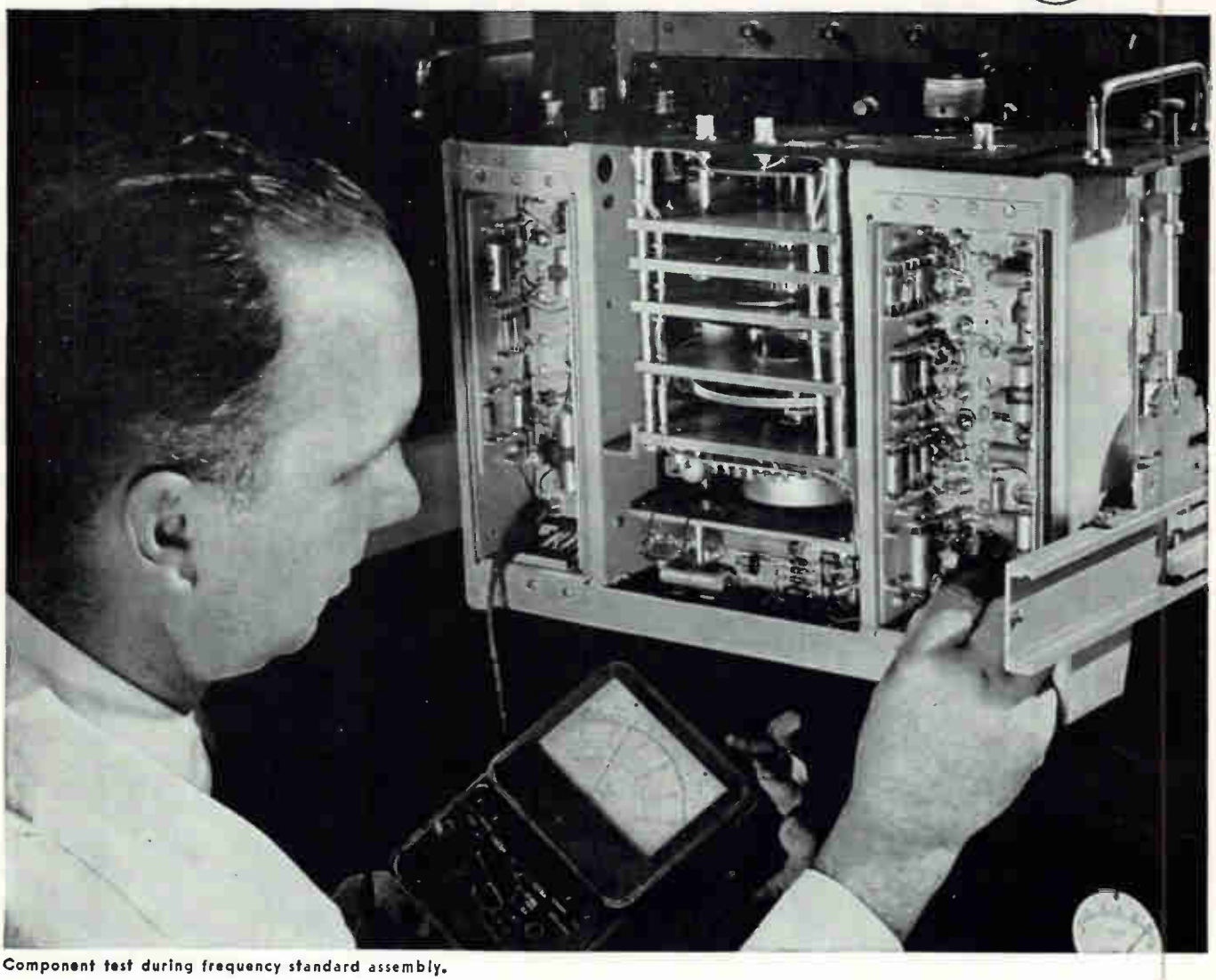
RTV COIL IMPREGNATION enables this Hughes Aircraft Co. transformer to provide top performance at 250°. Unlike other insulations tried, G-E RTV compounds proved successful both for coil impregnation and full encapsulation.

For application data and samples of General Electric RTV silicone rubber write Section N614, General Electric Company, Silicone Products Department, Waterford, New York

GENERAL ELECTRIC

CIRCLE 19 ON READER SERVICE CARD

...another assurance of reliability from BORG



Component test during frequency standard assembly.

Frequency Standards with one part in a billion stability can't be mass-produced

Borg Frequency Standards are the world's most stable standards commercially available . . . one part in 10^9 for a twenty-four hour period. To achieve this kind of stability, every standard must be *hand assembled* and tested during each phase of production. Frequency is adjustable over a range of ± 5 parts in 10^8 with a setting accuracy of one part in 10^{10} . . . in temperatures from $+32°F$ to $+122°F$ . . . withstanding shocks of up to 15 g's. Stationary or mobile models available. *Write for complete data.*

BORG

BORG EQUIPMENT DIVISION
AMPHENOL-BORG ELECTRONICS CORPORATION
JANESVILLE, WISCONSIN

Micropot Potentiometers • Turns-Counting Microdials • Sub-Fractional Horsepower Motors • Frequency and Time Standards

Magnavox Sales $23 Million Higher

Magnavox Co., Ft. Wayne, Ind., reports sales of $108 million in calendar 1959, with expectations of $150 million in 1960 and earnings of $3 a share. For the year ended June 30, 1958, the comparable figure was $85.59 million with per-share earnings of $1.19. Military electronics in the 1959 period accounted for about one-third of total sales, according to company officials, who also report a backlog of orders in excess of $70 million for the firm's Government and Industrial Electronics division.

Camloc Fastener Corp., Paramus, N. J., reports preliminary net income of $58,589 for the three months ended Mar. 31, 1960. This is equal to 17 cents a share on the 350,500 common shares outstanding. These figures compare with the net income of $70,033, or 20 cents a share, earned in the initial quarter of 1959. Gross sales for the first quarter of 1960 were $953,590. For the same period in 1959, sales were $1,110,123. The company produces quick-operating fasteners for use in electronic equipment, aircraft and other applications where frequent or rapid access is required.

Airtronics International Corp., Ft. Lauderdale, Fla., announces placement of its $300,000, six-percent convertible debentures due February 1, 1962. The issue is convertible to common stock after six months, and callable any time after that period. The funds will be used to strengthen the firm's capital structure and facilitate general plant expansion. The company makes electronic instruments and components.

Victoreen Instrument Co., Cleveland, reports acquisition of **Electronic Products Co.**, Mt. Vernon, N. Y. The purchase was made for cash and Victoreen stock, totalling approximately $800,000. The New York firm, which designs and manufactures instrumentation systems for atomic submarines, is expected to add more than $5 million to Victoreen's sales volume.

Itek Corp., Waltham, and **Hermes Electronics**, Cambridge, both in Massachusetts, jointly announce the directors of both companies have agreed in principle to combine firms. Itek would be the surviving company, with stock being exchanged on the basis of one share of Itek for 4.75 shares of Hermes. No substantial changes in personnel are contemplated.

Semi-Elements, Inc., Saxonburg, Pa., reports that approval has been voted to increase the authorized capital stock from 10,000 to 100,000 shares. Funds will be used to finance plant expansion and are expected to aid in making future mergers and acquisitions possible. The firm manufactures semiconductor crystals and specialized semiconductor devices.

25 MOST ACTIVE STOCKS

WEEK ENDING MAY 27

	SHARES (IN 100's)	HIGH	LOW	CLOSE
Gen Tel & Elec	4,963	32¾	27¾	31½
Int'l Tel & Tel	1,635	46¾	44	45⅞
Gen Inst	1,626	41⅝	34⅝	41
Standard Coil Prod	1,324	18⅜	15⅝	17½
Collins Radio	1,254	65⅞	56⅝	65¾
Univ Controls	1,185	17	15¾	16⅞
Sperry Rand	1,154	24⅜	22¼	23¾
Int'l Resistance	1,089	33⅜	25	33⅜
Du Mont Labs	1,016	9⅞	8¾	9⅝
RCA	902	76⅜	74½	75¼
Zenith Radio	764	115¾	102¾	111¾
Philco Corp	728	34¾	31⅛	32⅞
Victoreen Inst	710	13½	11⅛	13⅛
Raytheon	708	45½	41½	43¼
Ampex	675	36¾	34¾	35
Avco Corp	616	13¾	13⅛	13¾
Belock Inst	588	19⅜	15	18¾
Litton Ind	562	89⅜	81⅝	87½
Westinghouse	518	59⅞	56	59⅞
Varian Assoc	513	58⅜	51½	56¾
Siegler Corp	498	41¼	37⅝	40¼
Gen Electric	489	90¾	88½	89
Transitron	475	51⅜	45½	49¼
Western Union	468	49¼	44½	48⅛
Reeves Sndcrft	466	9⅜	8½	8¾

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., investment bankers.

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

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

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

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

Can't we read the handwriting on the wall?

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

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

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

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

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

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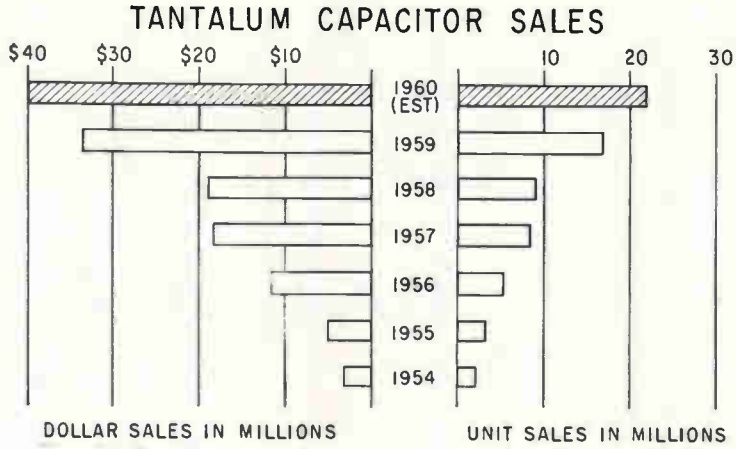


Tantalum Capacitor Business Up 20%

MANUFACTURERS look for another sizable increase for tantalum capacitor sales this year, with dollar sales rising 20 percent over the 1959 level to $40.0 million and units increasing by 35 percent to 22.2 million.

Few components, other than semiconductors, can point to a record of sales growth comparable to tantalum capacitors. Between 1955 and 1959 dollar volume multiplied more than six times ($5.0 to $33.4 million), while units multiplied about five times (3.0 to 16.4 million). Special characteristics, such as small size, low leakage, high capacitance and reliability, light weight and long operating life have spurred sales.

Military accounts for lion's share of dollar sales, 68 percent in 1959. But the civilian market took 52 percent of last year's unit output. Major areas of use include missile and aircraft electronics, telephone communications, hearing aids, computers, atomic energy and oil drilling equipment.

Dry solid slug sales are growing far faster than sales of the other three tantalum types (wet slugs, foil and wire). Since they are used with transistor circuits, their growth tends to parallel the transistor growth curve. In 1960 dry solid slug unit sales should increase 78 percent over the 1959 total of 5.9 million, while dollar volume is expected to jump 51 percent over last year's $5.9 million.

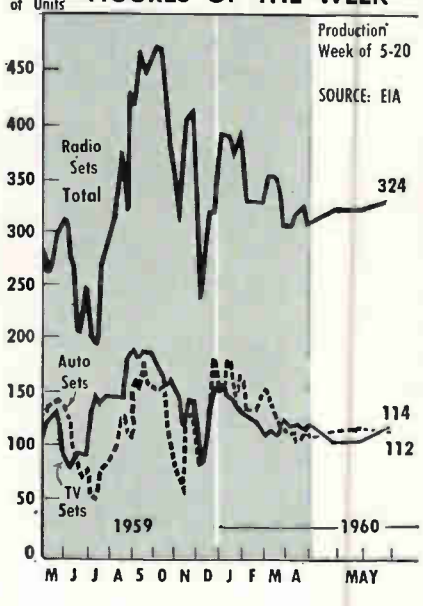
Foil sales are headed for unit and dollar sales gains of 18 and 12 percent respectively. Wet slugs will probably enjoy a 10-percent gain in both units and dollars. Increases in wire type sales should be about five percent.

Estimated 1960 sales are shown below in millions of units and dollars.

	Units	*Dollars*
Dry slugs	10.5	$11.6
Wet slugs	4.6	13.4
Foil	4.0	13.1
Wire	3.1	1.9

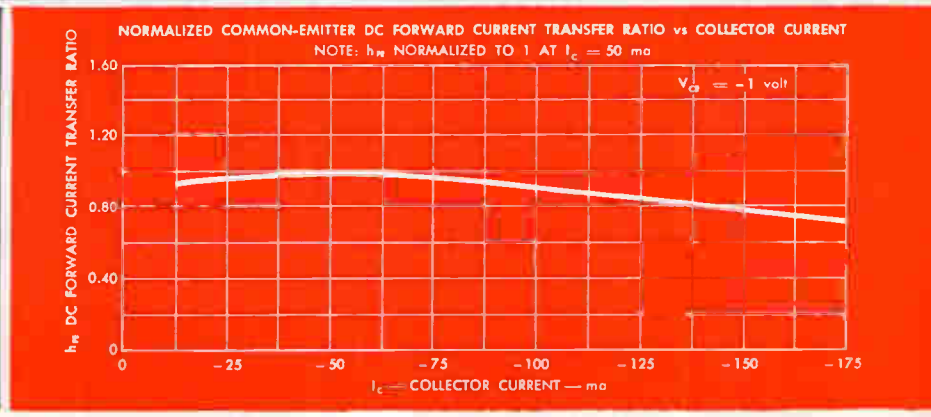
Note: Estimates received on wire tantalum types varied widely, with some estimating 1959 and 1960 sales in the neighborhood of 4½ million units and $2.7 million.

FIGURES OF THE WEEK



TI low cost germanium general purpose transistors give you 250 mw dissipation

...with beta spreads as low as 2:1



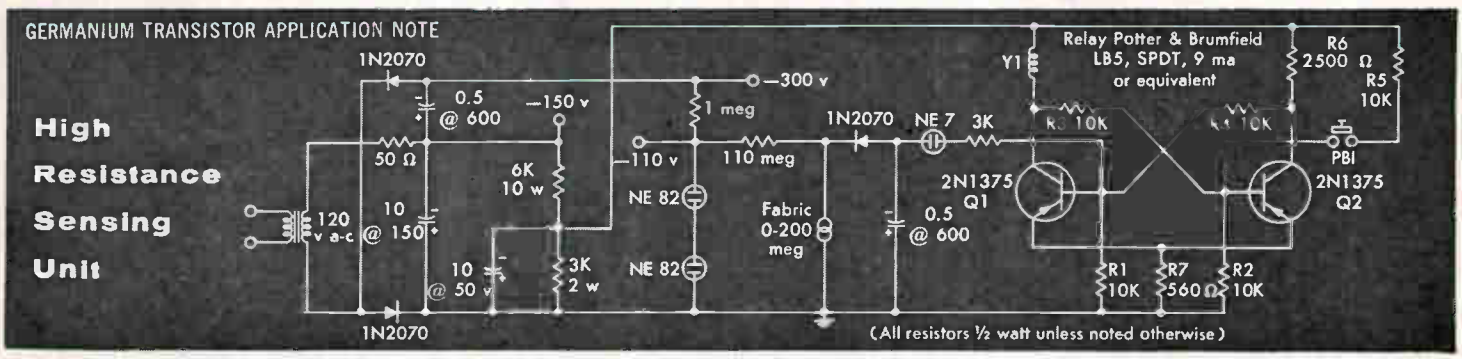
Available in commercial production quantities, TI 2N1372 series germanium P-N-P alloy transistors make possible low-cost applications that provide linear beta, high power gain and low distortion characteristics. These general purpose economy transistors are especially suited for your medium frequency switching circuits, audio amplifiers and motor control applications.

Fully automatic testing and classification by CAT (Centralized Automatic Testing) completely eliminates human error and assures uniformity and reliability . . . ideal for your production assembly and testing requirements.

Evaluate the specifications below and contact your nearby TI distributor or TI sales office for the devices most suited to your particular requirements.

maximum ratings at 25° C ambient		2N1372	2N1373	2N1374	2N1375	2N1376	2N1377	2N1378	2N1379	2N1380	2N1381	Unit
Collector—Base Voltage		−25	−45	−25	−45	−25	−45	−12	−25	−12	−25	v
Collector Current		−200	−200	−200	−200	−200	−200	−200	−200	−200	−200	ma
Total Device Dissipation		250	250	250	250	250	250	250	250	250	250	mw
Storage Temperature Range						−55 to +100						°C
electrical characteristics at 25° C ambient												
I_{CBO} Collector Reverse Current												
(V_{CB} = −12v I_E = 0)	(max)							−7		−14		μa
(V_{CB} = −20v I_E = 0)	(max)	−7	−7	−7	−7	−7	−7		−7		−14	μa
(V_{CB} = −1.5v I_E = 0)	(typ)	−3	−3	−3	−3	−3	−3	−3	−3	−3	−3	μa
h_{FE} dc Forward Current Transfer Ratio*	(min)	30	30	50	50	75	75	95	95	30	30	
(V_{CE} = −1v I_C = −50 ma)	(typ)	45	45	80	80	95	95	200	200	100	100	
	(max)	95	95	150	150	150	150	300	300	300	300	
$f_{\alpha b}$ Common-Base Alpha-Cutoff Frequency (V_{CB} = −5v I_C = −1 ma)	(typ)	1.5	1.5	2	2	2	2	3	3	2	2	mc
Noise Figure 1000 cps†	(typ)	7.0	7.0	6.5	6.5	5.5	5.5	4	4	5.5	5.5	db

*Tolerance on all values ±10% for test set correlation. †Conventional noise compared to 1000 cps and 1 cycle bandwidth.



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WHAT HAS THE **7182 S BAND MAGNETRON** IN COMMON WITH THIS CAT?

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The 7182 retains its remarkable stability and reliability during a life of 10,000 hours, and is one of a series of magnetrons now in production providing peak powers of 5 MW. These magnetrons operate at voltages and current densities usually associated with magnetrons rated at a fraction of the power output.

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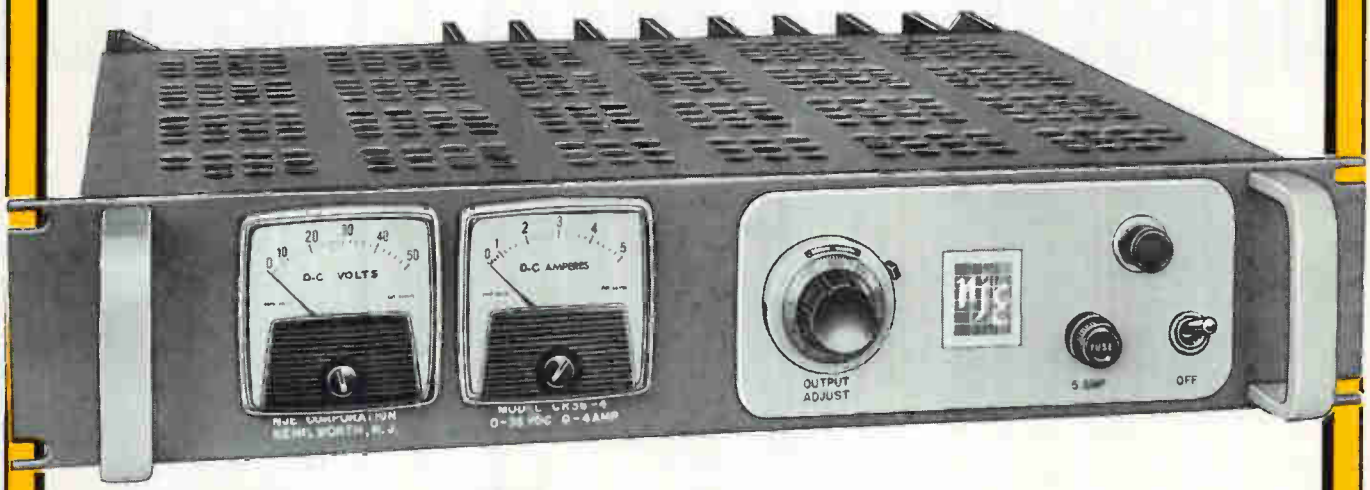

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Output Volts	Output Amps	Model No.	Input Power Volts	Input Power Freq.**	Max. Ripple mv RMS	Static Regulation Load*	Static Regulation Line*	Dimensions H x W x D	Approx. Weight Pounds	Price
0-10	0-10	QR-10-10	105-125	55-65	1	±0.01% or ±1 mv	±0.03% or ±3 mv	3½" x 19" x 16⅝"	41	$485
0-18	0-6	QR-18-6	105-125	55-65	1	±0.01% or ±1 mv	±0.03% or ±3 mv	3½" x 19" x 16⅝"	41	485
0-36	0-4	QR-36-4	105-125	55-65	1	±0.01% or ±1 mv	±0.03% or ±3 mv	3½" x 19" x 16⅝"	41	485
0-60	0-2.5	QR-60-2.5	105-125	55-65	1	±0.01% or ±1 mv	±0.03% or ±3 mv	3½" x 19" x 16⅝"	41	510

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Radiation, Inc., already operating its new plant in the Port Malabar industrial-residential development

FLORIDA'S NEW INDUSTRIAL LURE:

Plant-and-House Package

PORT MALABAR, FLA.—FLORIDA LAND COMPANIES—always alert to new promotion possibilities — have turned full-face on a brand new campaign. Touting the idea of a-home-and-a-job in Florida, all in one package, they are taking their first steps toward creating pre-planned communities complete with integrated industrial park-residential areas.

This latest effort of the land developers to ride the state's industrial growth, as well as its home-building boom, is already leading them squarely to the doorstep of the electronics industry.

Tenants: Both Electronics

In fact, the first (and up to this time, the only) industrial-residential development to actually get underway has landed two industrial tenants, and both are electronics firms.

Radiation, Inc., Melbourne, Fla., designer and manufacturer of telemetry and antenna systems, has begun construction of a $5-million plant in the Port Malabar community, being developed by Miami-based General Development Corp., three miles south of Melbourne on the Florida east coast.

Now, Soroban Engineering, Inc., also of Melbourne, has announced it will build a $1-million facility in the same project. A designer-producer of data-processing and control equipment, the firm specializes in the manufacture of electro-mechanical components for automation and data-processing applications. Though its present Melbourne plant has less than 25,000 sq ft, company expects to have constructed a minimum of 100,000 sq ft at its Port Malabar operation by 1965.

The firm has purchased outright a five-acre tract and Charles F. West, president of the six-year-old organization, indicates he will exercise options he holds on another thirty-five acres. He envisions a jump from the current 185 employees to 1,200 by the end of the five-year expansion period and "most of them will live within ten minutes of the plant."

Radiation officials are equally enthusiastic about their prospects. Vice President George S. Shaw sees a tremendous increase in personnel in the next five years—from the present 600 to 3,000.

'Showcase' for Future

Although 46,000-acre Port Malabar — located some thirty miles south of bustling Cape Canaveral—is Florida's first planned community to have an industrial park included, the developer sees it only as its "showcase" for such projects.

"This is the beginning of a major industrial and economic development, not only at Port Malabar, but also at our other Florida communities, and it will mark the first time that any major Florida developer—or industry—has been able to offer a house-and-job combination," says Elliott J. Mackle, secretary and director of General Development and president of Mackle Co., Inc., Miami firm which builds homes for General.

The "other Florida communities" to which Mackle refers are the Port Charlotte community—a 92,000-acre development between Ft. Myers and Sarasota on the west coast, and Port St. Lucie, a 35,000-acre community project underway near Ft. Pierce on the Atlantic.

Another Florida giant in community development, Arvida Corp. of Boca Raton, has also launched an industrial development program by setting aside for industrial use some 15,000 acres west of Ft. Lauderdale. Arvida's future plans for this development are contingent upon the outcome of its offer to sell Broward County (Ft. Lauderdale's county) an 8,000-acre tract for development of an international jet airport.

Florida's attractions for the electronics industry are many but the very special advantage a development such as Port Malabar offers is easy to pinpoint—lower land costs. The companies already there single this out as the biggest factor in their decision to relocate here.

A development spokesman explains the willingness to make exceptionally attractive land offers to industry:

"We are not in the industrial land business—we are developing land, building homes and shopping centers and dedicating school sites. In short, we are building whole communities. Naturally, the presence of industry—of jobs—within our project makes our selling much

easier and our whole package much more attractive."

Canaveral Is Spur

With Florida's industrial site prices approaching what executive West calls "the phenomenal", this one inducement alone is almost sure to lure additional plants, and chances are strong that a good portion of new tenants will be connected with the electronics industry.

In the four-year period from 1955 to 1959, Florida led the nation in percentage increase in industrial jobs and the electronics-missile field accounted for more than a quarter of all new industrial jobs.

The obvious spur behind this growth is Cape Canaveral, but there are several other explanations for the state's almost unique affinity for electronics.

What might prove a drawback in luring some industries is inconsequential to electronics manufacturers. For example, the state's power rates are comparatively high, but this industry is not considered a big power user.

From the standpoint of distribution, Florida's location would present transportation-cost problems for some types of manufacturing. But here again, with their relatively low transportation factor, electronics firms would not weigh this consideration heavily, if at all.

Thus, with these possible problem areas written off, the plusses for the industry stand out vividly. Florida has a vast pool of "retired" skilled and professional workers . . . not retired in the sense that they are 65 and have gone south to sit out their days in the sunshine and warm air, but people who—for one reason or another—have left their old jobs at a relatively early age and sought a more desirable climate.

A great portion fall in the 40- to 50-year-old group and constitute a highly attractive labor pool. (Many are workers who "retired" after 20 years from a company located elsewhere or from a government job but plan to work another 10 or 15 years in Florida.)

This situation, added to a generally favorable labor climate (Florida has an anti-closed shop law), has proved a forceful drawing card.

Of course, there are also the advantages traditionally associated with the state—pure air, abundant water, highly-desirable climate.

In fact, whether or not a plant is to be located in Florida is a question that gets as much attention from the state as from the company involved. As Governor LeRoy Collins points out: "We can afford to be choosey about new business. We don't want business that will spoil our clean air."

While this selectivity has ruled out many industries, the electronics-missiles-aircraft firms remain the most sought-after, since by and large, they are high-paying, clean, and pointed toward the future with expansion probable.

Asia Labs Develop Teleprinter Circuits

ELECTRONIC distributor circuits for teleprinter equipment have recently been developed at two Asian laboratories.

Kokusai Denshin Denwa, Japan's government-owned overseas cable agency, is working on replacing the entire electromechanical complex of the teleprinter with electronic circuits, even including the typebar selector mechanism.

At India's Roorkee University, a distributor circuit has been developed that uses a ring counter of cold-cathode trigger tubes. Timing pulses are derived from the power line frequency, which is 50 cps in India.

The timing oscillator runs free, does not have to be doubled to obtain the 1.5-unit STOP pulse. The STOP signal is produced by reversing the phase of the sinusoidal signal that drives the pulse generator during the stop time.

Russians to Conduct Controls Conference

VIENNA, AUSTRIA (McGraw-Hill World News)—Moscow will be host to the First International Congress on Automatic Control, which is scheduled to start June 27. Twenty-one countries have agreed to meet in Moscow to hear 285 scientific papers about automation and automatic control.

Tass, quoting statements made by Soviet scientists at a Moscow press conference, says that Anatoli Blagonravov, member of the Academy of Sciences of the U.S.S.R., predicts the congress will influence the development of automation throughout the world.

Professor Alexandr Letov, president, International Federation for Automatic Control and a member of the Academy, explained that engineers, scientists and businessmen in many advanced countries are actively interested in the forthcoming congress. This activity, he said, indicates the realization that supplying each country's population cannot be solved without automation of production.

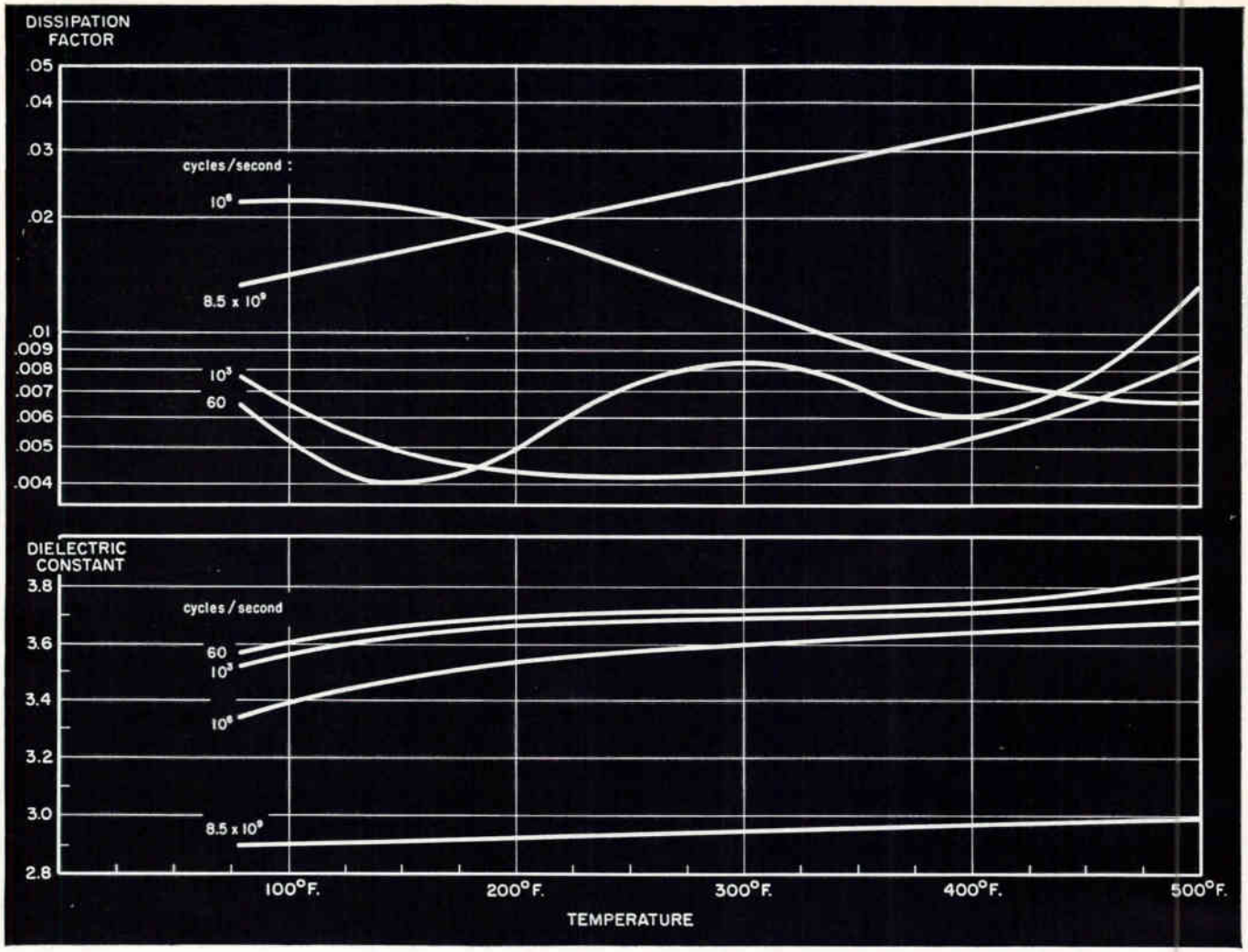
Vadim Trapesnikov, another member of the Academy, who also serves as chairman of the Soviet Committee for Automatic Control, said the United States will present 73 papers, the USSR a total of 8[illegible]

Berlin Atom Center Gets New Computer

BERLIN (McGraw-Hill World News)—The mathematics division of West Berlin's Hahn-Meitner Institut für Kernforschung (Institute for Nuclear Research) has been inaugurated, and its center piece is an electronic computer designed and built by the Siemens-Schuckert Werke AG, Berlin.

The apparatus, designated Siemens-Digital-Rechner 2002, has 15,000 transistors. It was built entirely from German parts for the first time. It cost $300,000.

Capacity of the installation is 1,800 to 2,200 arithmetic calculations, according to the difficulty of each problem. The magnetic memory can store 10,000 words. A punch card system, with a capacity to record 300 signs per second, will be added to the installation soon.



Good electrical properties at H.D.T.'s* above 500°F. now possible in epoxy resin potting systems

Turn an appraising eye on the chart above. These data were assembled in tests of epoxy resin systems which had been cured with Du Pont's pyromellitic dianhydride (PMDA).

Note the unusual stability of electrical properties at elevated temperatures.

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There's more. PMDA provides several advantages in addition to high heat resistance.

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**(H.D.T.—Heat Distortion Temperature)*

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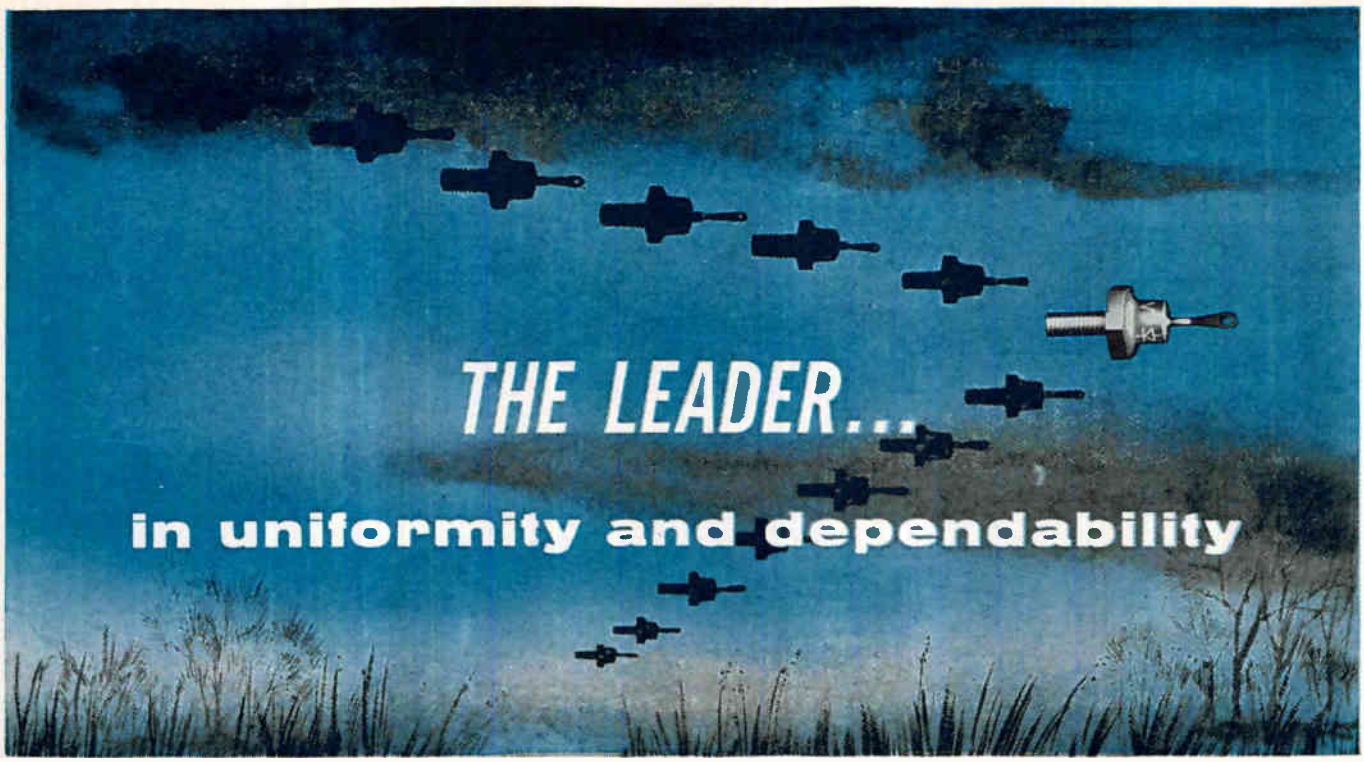

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EPA 3300-e

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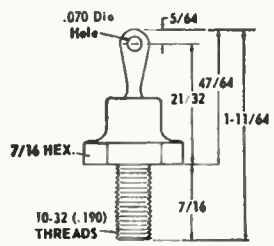
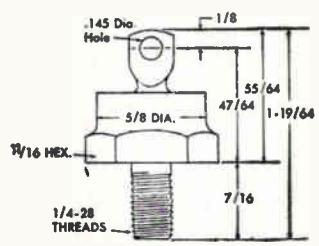
Peak Inverse Voltage	LOW POWER			MEDIUM POWER	
	2 Amperes	8 Amperes	12 Amperes	18 Amperes	35 Amperes
50V	—	—	—	DA05	EA05
100V	—	—	—	DA10	EA10
150V	—	—	—	DA15	EA15
200V	AA20	BA20	CA20	DA20	EA20
250V	—	—	—	DA25	EA25
300V	AA30	BA30	CA30	DA30	EA30
350V	—	—	—	DA35	EA35
400V	AA40	BA40	CA40	DA40	EA40
500V	AA50	BA50	CA50	DA50	EA50
600V	AA60	BA60	CA60	DA60	EA60



Types AA, BA & CA



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British Seek More Reliability Data

Attendance of 1,000 top designers at one-day symposium indicates reliability engineers are a quickly multiplying breed in Britain today

LONDON (McGraw-Hill World News)—Reliability engineers are a fast-growing breed in Britain today.

Evidence of this was apparent as more than 1,000 of Britain's top design engineers recently crowded into the one-day special symposium on Electronic Equipment Reliability, organized by the Institute of Electrical Engineers.

Although the program was split into three free-for-all open discussion sessions covering the problems of the user, system designer and component maker, the recurrent theme throughout all sessions was for more statistical information on component reliability ratings.

Failure Rates

In the first session on user problems, rapporteur R. Brewer of the General Electric Company's Research Laboratories presented the highlights of 10 papers in this section.

Here comparative reliability figures for entertainment, data processing systems, missiles, aviation, submarine cables and telephone systems gave designers a feel of what they should be aiming for. Figures quoted covered tube failure rates of 0.3 percent per month derived from tests on 300 tv receivers and rates down to 0.6 percent per 1,000 hours on a 5,000-tube computer.

Aviation equipment failure rates, while aiming for 3,000 hours between failures, currently stand around 3 percent per 1,000 hours, while the 50,000 contacts involved in a transatlantic trunk call demand reliability standards for telephone and submarine cable systems of at least one order higher.

But how to improve these design figures was the unanswered question of the meeting. Proposals for increasing current reliability, summarized in the second session by L. Knight of International Computers and Tabulators Limited, suggested laying out computers on telephone exchange engineering principles with low equipment per unit area ratios.

Increasing computer size would automatically improve reliability, probably raising it from 90 to 95 percent—an amount worth $15,000 a year and well able to finance the extra computer floor-space required, he said.

Other solutions offered during the session included:

Automatic changeover systems for telephone exchanges of the incoming call registers on any failure; for aviation, increased equipment redundancy, and for guided weapons, the provision of component survival curves.

Ideally these curves show temperature and vibration failure distributions at any specified parameter value, also the parameter distributions for various specified stress and time values and the time-to-failure distributions at any specific parameter level.

First steps to provide such curves have been taken by the British Electrical Research Association, which has been collating statistical reliability figures on resistors.

Seek More Statistics

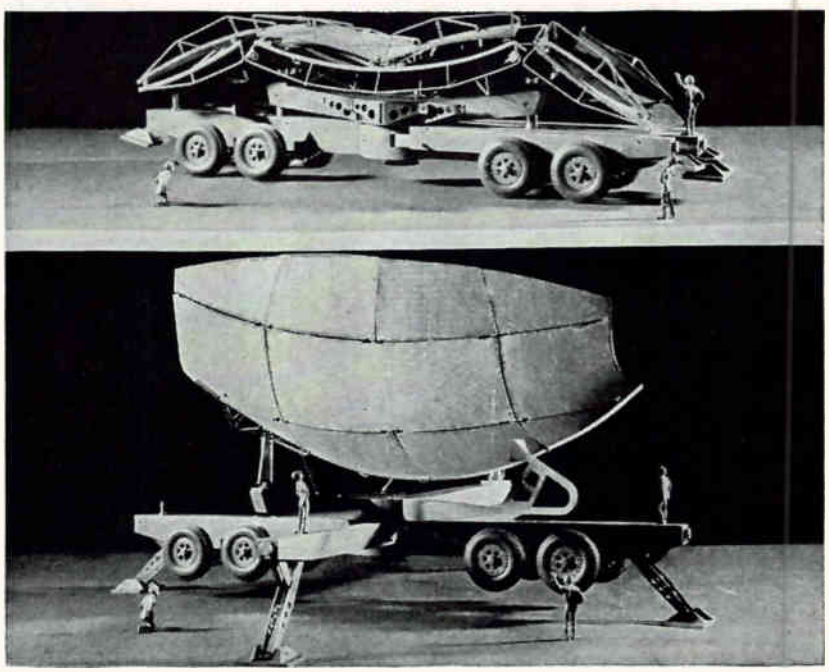
But most engineers called for yet more statistics to allow them to predict more precisely the expected failure rates.

The final session on components gave them some of this information as G. W. A. Dummer of the Government Radar Research Establishment, Malvern, summarized some of the currently available component reliabilities.

Semiconductor junction diodes running between 500 and 1,000 hours were averaging failure rates of 0.35 percent, while junction transistors averaged 0.063 percent, he said. This compares with some subminiature ruggedized tube failure rates quoted at 0.6 percent per 1,000 hours. Micromechanical relays weighing only 2.5 gm with a single change-over contact are clocking up 108 failure free operations.

Endorsed by most engineers was

Military to Get "Instant" Radar Assembly



Model of new mobile, high-power, folding radar developed by GE and McKieran-Terry. Radar, 20 ft by 43 ft, is erected by five men in 15 minutes

the suggested long-term aim of including practical training courses in the electronics engineers' syllabus on how and when to use the right components.

As one delegate pointed out, this trails by two years a Russian proposal from the Central Board of the A. S. Popov Radio Factory made in 1958 to set up such courses and also a National Russian Reliability Laboratory to collate component information.

Camera Satellite To Watch Satellites

WATCHDOG satellites, carrying tv cameras and electrostatic tape-recording equipment, are proposed by RCA to follow orbiting satellites and record performance.

According to the proposal made to American Rocket Society, a satellite would be accompanied into orbit by a camera-carrying vehicle launched separately or even by the same rocket. The camera vehicle would travel about 100 ft away, could maneuver about the main satellite and view its operation from various angles.

Pulsed-light sources on the main satellite would keep the watchdog on course, help aim and focus the camera, provide illumination for picture-taking where necessary. Up to 300 pictures could be stored on tape, transmitted to ground on command at the completion of each orbit.

Computer to Run Rubber Plant

COMPUTER CONTROL will shortly take over synthetic-rubber production at Goodyear's huge Houston, Tex., plant.

A digital computer will be the central coordinator for the control system being engineered for its parent by Goodyear Aircraft. The system will also include sensors and analog measuring and control devices.

The computer system will also be used to calculate refrigerant load availability, which has a direct bearing on plant capacity. The system will thus establish maximum production rates within refrigerant limits.

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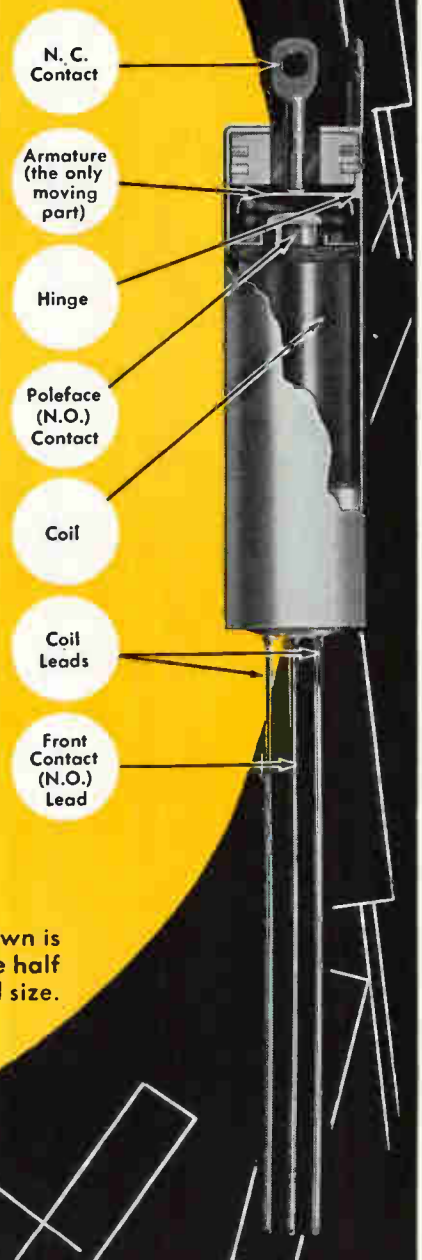

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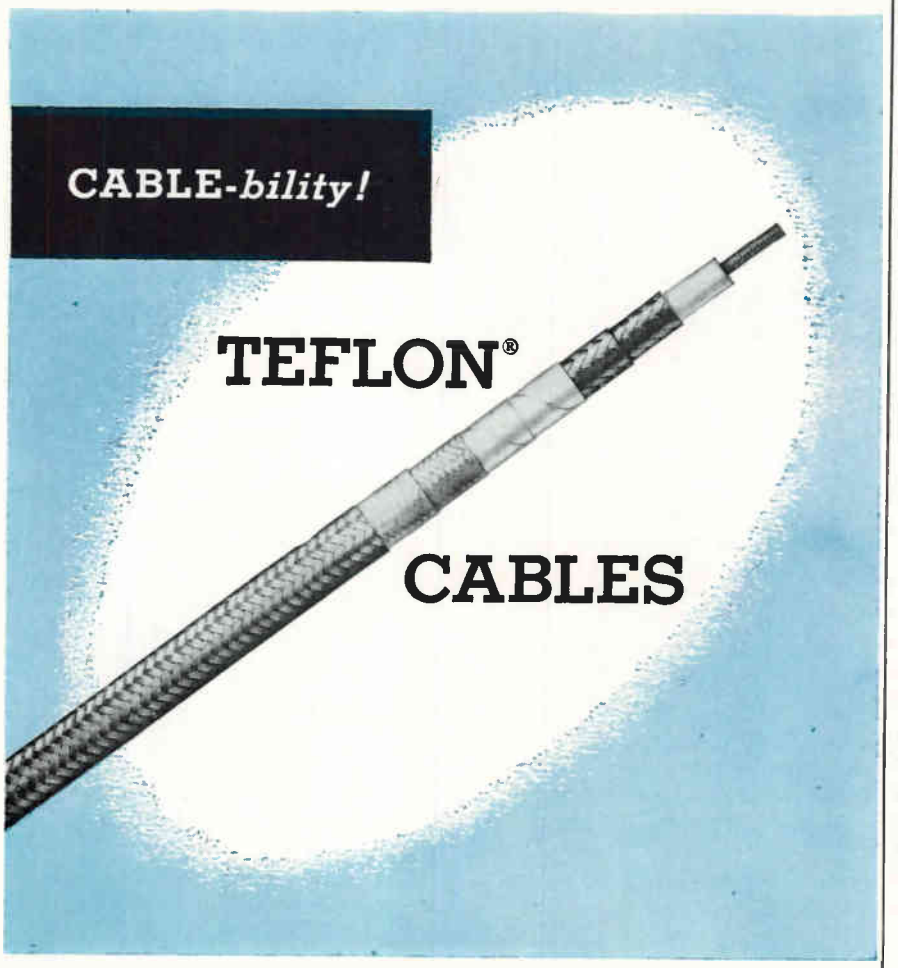

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Electromagnetics Captures Spotlight

Control systems and solid-state electronics also featured at IRE meeting in Seattle

SEATTLE—Control systems, solid-state electronics, and electromagnetics were featured in 14 technical sessions as Seattle recently hosted the 7th Regional IRE Conference for the second time in ten years.

A thousand representatives of the industry convened at the Olympic Hotel and viewed the latest electronics wares at the joint IRE-ISA exhibit's 190 booths housed in the National Guard armory.

Electromagnetics got the biggest play in technical sessions, with 15 papers presenting a cross-section of some of the most exciting projects currently in research. The far-ranging character of these projects, and the "space theme" in evidence throughout, were graphically illustrated in introductory remarks by O. G. Villard, Jr., of Stanford University's radio science lab.

"Three papers are concerned with gas in the region roughly 70 miles above the sea," he pointed out, "Three with gas in the region 180 miles above sea level, one with gas in the region 6,000 miles high, one with an object 168,000 miles above sea level (the moon), three involve some more gas 93 million miles above sea level (the sun), and the remaining three are concerned with objects outside our solar system."

Two papers outlined recent strides made in the field of propagation at elf and vlf, some of which have resulted from the impetus of the necessity to communicate with submarines lying at ever-increasing depths. The author of one explained the usefulness of the concept that radio waves are guided between earth and ionosphere as in a giant waveguide.

The other author posed an interesting idea for artificially controlling the ionosphere in a possible and practicable way. In his proposal for a "geocyclotron," the earth would serve as a cyclotron to accelerate trapped electrons in the lower radiation belt regions. A circularly-polarized vlf wave would be sent up for the purpose of urging ambient trapped electrons into oscillations of ever-increasing intensity.

He estimates that within a few days' time an artificial shell of high-energy radiation would exist, and that its presence could be demonstrated by a satellite carrying a Geiger counter.

One paper by two SRI scientists on the subject of radar astronomy made a plea for its economic advantages as contrasted with expensive "one-shot" space probes. Their studies indicate it would be possible to construct a unique 800-ft diameter dish costing only $7½ million, or 10 percent of the current Navy 600-ft project.

Other papers discussed progress made with Convair's 2-mile-long antenna for studying the sun's corona, plans for measuring the roughness of a planet's surface, and radar studies of the lunar surface in preparation for the "soft landing."

In rounding up recent developments in the semiconductor state-of-the-art, Pacific Semiconductor's Harper North, in a keynote address, stressed the ever-changing technology with a graphic quote: "Today's premium device is tomorrow's reject."

He predicted that up to 5 percent of all germanium semiconductor devices currently in use will be replaced by those utilizing silicon. He pointed out that the availability of silicon in the earth's crust will be a big factor in future price reductions of silicon devices, and questioned the near-future economic feasibility of solid-state circuits for prosaic applications.

Optimistic about the future of controlled rectifiers, he opined "if controlled rectifiers are as cheap as I'm sure they will be, there will be many new uses even in such lowly applications as dimmers for house lighting."

In the field of high-frequency high-power silicon transistors, he reported on a PSI experimental device capable of delivering 1,500 watts with little frequency degradation under 10 mc.

S. R. Hoh of ITT outlined a practical method for directly converting heat into electricity by means of newly developed ferroelectric converters. Cascading converter stages should result in outputs of several hundred thousand volts, according to Hoh.

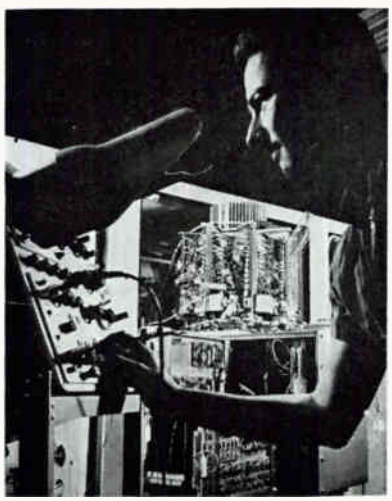
In a welcoming address, IRE's president Ronald L. McFarlan reviewed medical electronics achievements to date. Large digital computers, with memories containing up to six billion decimal digits of information, are being considered as diagnostic aids.

McFarlan reported that several eastern universities, including Yale, Columbia, Pennsylvania, and Rochester, New York, are launching programs whereby graduates can obtain PhD's in medical electronics. Curriculum will be 80 percent electronics and 20 percent medical subjects.

Products displayed by local firms included a fully transistorized potentiometric voltmeter with extreme sensitivity in the microvolt range, and a solid-state electrocardiograph small enough to be strapped to the wrist or around the waist of a spaceman or lay patient.

IRE's 7th Region boasts a membership of 17,000, some 22 percent of the national total.

Memory Test



Oscilloscope checks operation of Librascope memory drum used in GPL's air traffic control system

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If you're like most of us, you'd take the job with the more tempting salary and the brighter future.

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In the face of this growing teacher shortage, college applications are expected to *double* within ten years.

At the rate we are going, we will soon have a very real crisis on our hands.

We *must* reverse this disastrous trend. You can help. Support the college of your choice today. Help it to expand its facilities and to pay teachers the salaries they deserve. Our whole future as a nation may depend on it.

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

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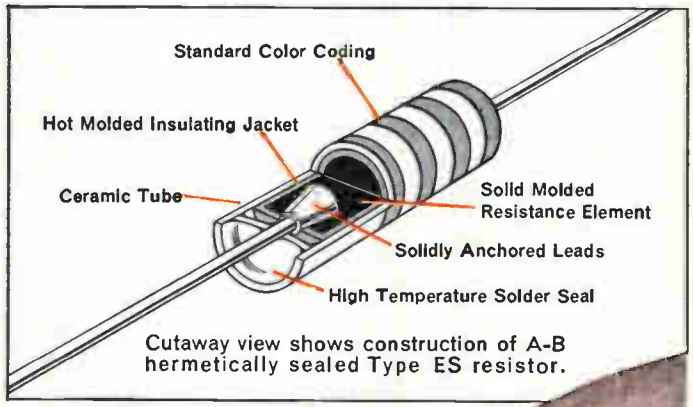
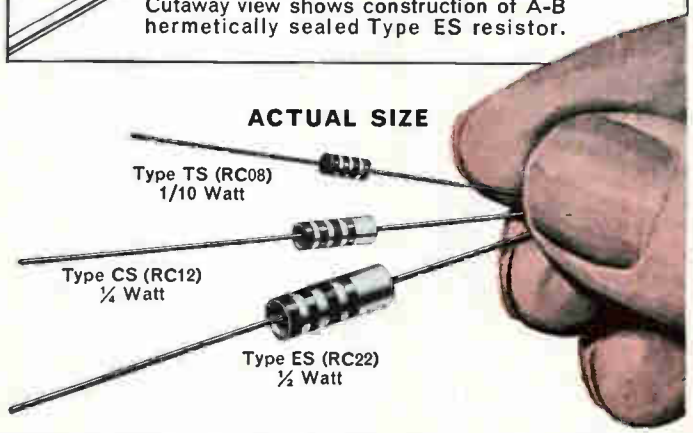


Cutaway view shows construction of A-B hermetically sealed Type ES resistor.



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Outline Space Communications Plans

Top military and civilian brass speak at armed forces group meeting in Washington

WASHINGTON—A short teletypewriter message sent to Hawaii and back by way of the moon kicked off the Armed Forces Communications and Electronics Association's 14th convention here late last month.

The high-frequency Communication Moon Relay system uses the moon as a passive reflector for long distance communication. The system is under study to determine the value of passive satellites in future communication.

Government buyers and industry sellers of electronics and communication equipment were on hand. About 160 exhibits covered all available in-door and out-door space at the Sheraton Park Hotel, including exhibits by Army, Navy and Air Force honoring Signal Corps' 100 years in communication.

Keynote speaker, Adm. Arleigh Burke, chief of naval operations, warned against pricing our military readiness out of the market and called for simpler, cheaper equipment with ease of maintenance and more reliability. Criticizing what he called unwarranted campaigns against the limited military frequencies of the radio spectrum, he said that if the Armed Forces have to shift to new frequencies and thus change equipment, it would result in a great waste of money and reduced readiness.

Space Communications

Difficulties in transmitting large amounts of information over enormous distances with today's space communication technology were discussed by Maj. Victor W. Hammond, USAF, office of space flight programs, NASA.

For example, Pioneer V, at that time slightly over 11 million miles from earth, was indicating that the power supply system had deteriorated; since May 18, it has been impossible to turn on the 150-watt transmitter by ground command. The 5-watt transmitter is still operating, he said, with a reduction in the length of transmission.

To increase the amount of information that can be transmitted, NASA is studying vehicle transmitters, which are useful when large payload weights are available. Hammond said that power transmitters in the range of one to 10 Kw will be used in this decade. A way must be found to place an antenna on a vehicle to concentrate all the radiated power towards the earth.

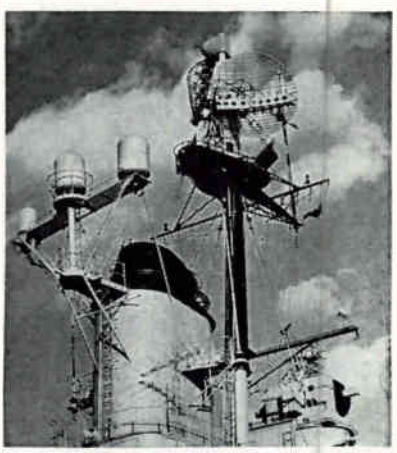
Next year, JPL will try placing a small parabolic antenna on an attitude stabilized space probe vehicle and will increase its communication range by a factor greater than seven, he said. Adequate power is expected to be available on advanced vehicles, such as Saturn. As for ground stations, NASA is installing a three-station network for deep space communications, equipped with 85-ft antennas.

One is in operation in Goldstone, Calif., with two 85-ft antennas. A receiving station will be operational in Australia in the fall, operating for the next few years about 960 Mc and will be able to handle NASA's deep space exploration program.

Communications Network

A world-wide instantaneous communications network is required for the safe controlled reentry of man from space, Leonard Jaffee, chief, communications satellites, NASA.

3-D Target Finder



AN/SPS-30, long-range, 3-D radar (detects range, azimuth and height), produced by GE, is on USS Macon

said, and such a system is extremely difficult with present techniques.

J. R. Pierce, of Bell Labs, said satellite repeaters may provide means for supplying present radio and cable overseas telephone circuits and also for transoceanic circuits of tv bandwidth, requiring a highly reliable system with long life. Work has been going on in measurement of sky noise, low noise, antennas, masers, parametric amplifiers, long-life microwave tubes, broadband modulation techniques and the investigation of radiation damage of semiconductors.

Describing briefly BTL's part in project echo, W. J. Jakes said that it is intended to demonstrate two-way voice communication between the two stations located at Holmdel, N. J., and Goldstone, Calif., by reflections from a 100-ft-diameter orbiting balloon. Test will be made to study microwave propagation involved.

Industry Exhibits

In the exhibits, International Telephone and Telegraph featured an operative model of a new electronic star tracking system that some say may tell space vehicles where they are and where they are going. A multiplier phototube which transforms a star's optical image into an electrical signal, amplifying these signals 2,000,000 times, is used.

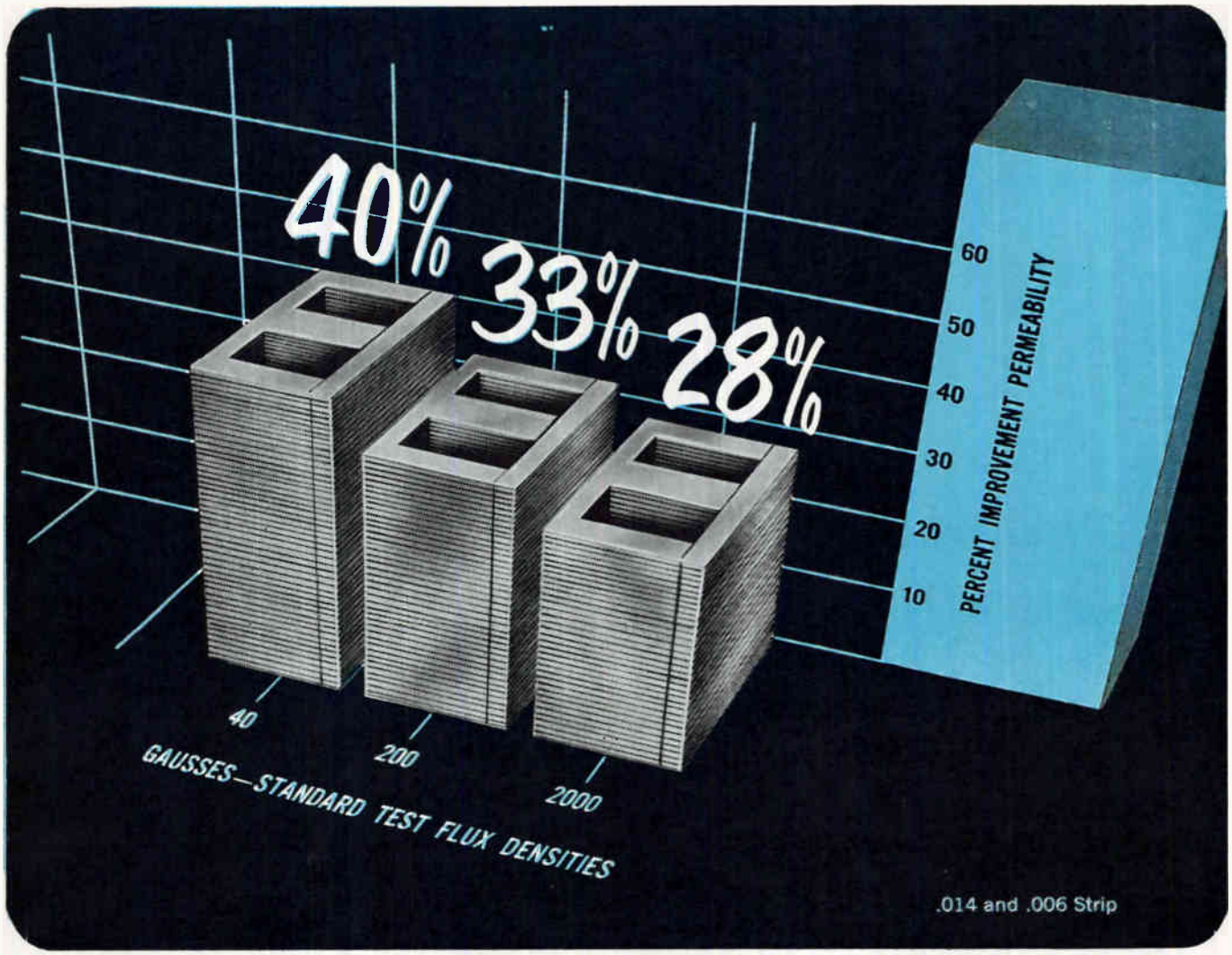
An aerial camera that snaps photos, day or night from 50,000 ft, was displayed by Chicago Aerial Industries. The KA-30, designed for military reconnaissance, freezes the picture on the film by moving the film at the same relative speed of the aircraft and delivers clear pictures.

A pint-size tv tape recorder that takes only 11 sq ft of floor space and weighs under 500 lb was demonstrated by Ampex. The armed forces now have 40 of these machines, which are especially designed for mobile and small studio installations.

Stromberg-Carlson Co., division of General Dynamics Corp., described a basic battle area surveillance and integrated communications system. Small, hand-held digital message generators transmit a tactical display to a command post.

AT&T demonstrated a new group alerting service.

Experience**—the added alloy in **A-L Electrical Steels



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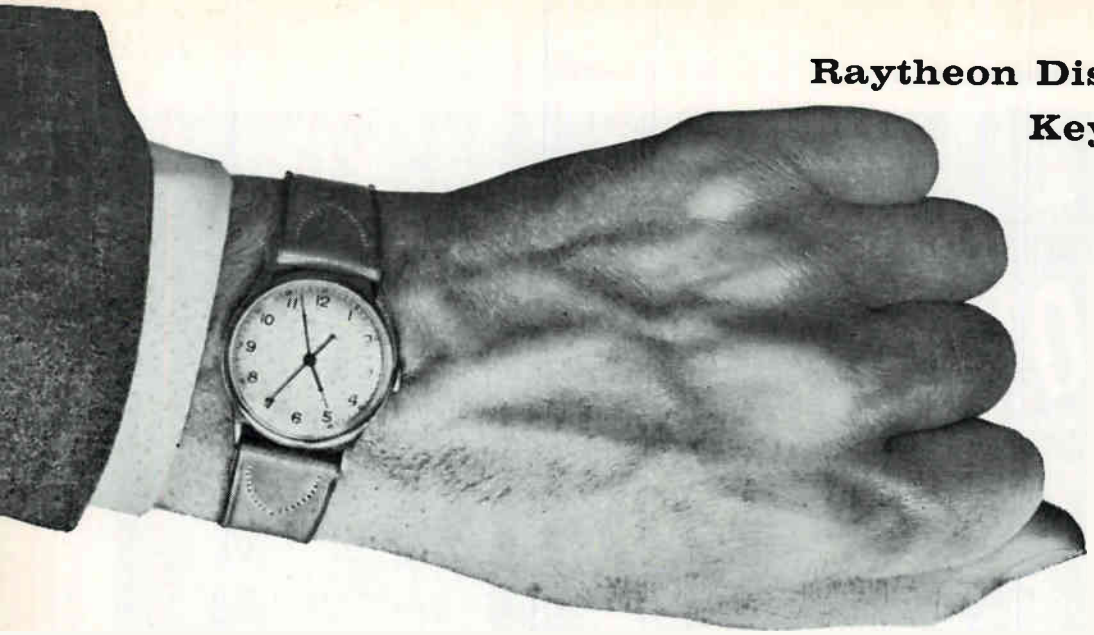

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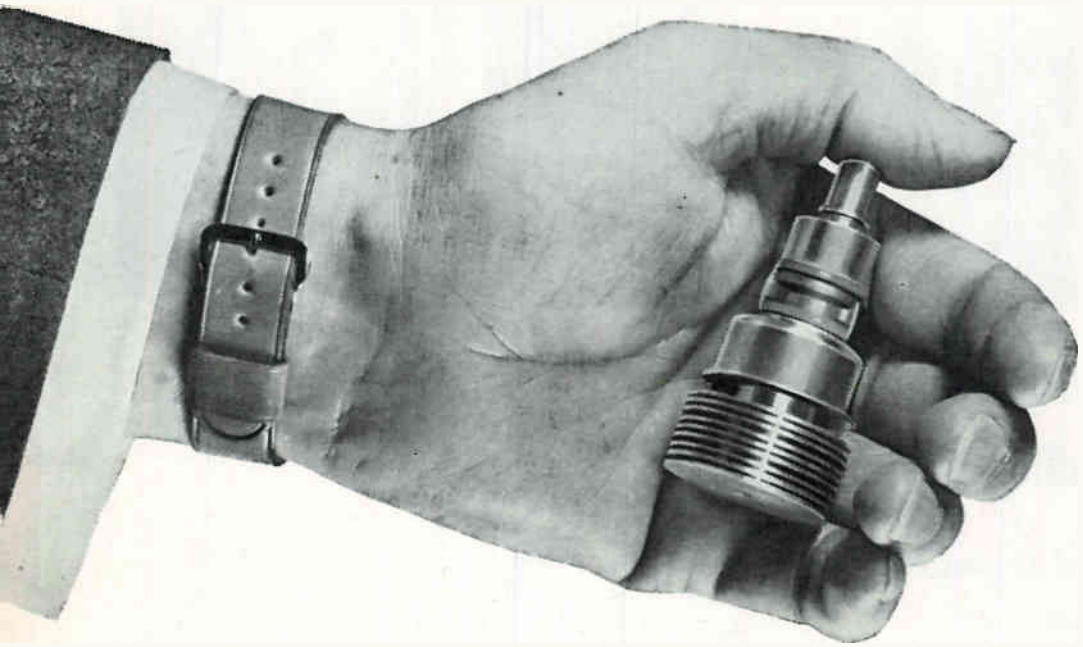

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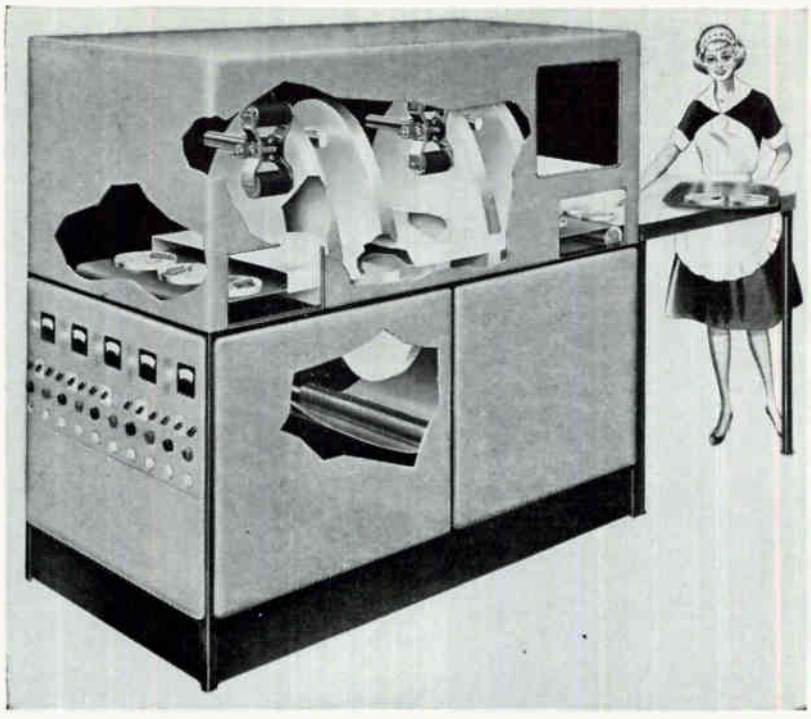

Actual heating time for one meal is one minute

Cooks Meals Quickly

New electronic oven uses microwave technique for "assembly line" production of pre-frozen meals

EINDHOVEN, HOLLAND — An electronic oven which utilizes the microwave technique to cook pre-frozen meals at a rate that could run as high as 150 an hour has been developed by Philips Works.

Five magnetron elements provide a microwave capacity of 10 kw. The magnetrons generate a high-frequency electrical alternating field in an energy zone 12½-in wide.

The five zones are passed through alternately. To prevent the magnetrons from affecting one another, equalization and isolation zones have been placed between the energy zones. Furthermore, at the beginning and end of the electronic range, isolation zones prevent the microwave energy from escaping.

Heating takes place as the dipole molecules of the food try to bring their position in the high frequency alternating current field in accordance with the direction of the changing electrical field volume.

Meals are brought to one end of the oven by hand and are heated from the deep-freeze temperature of minus 25 C to serving temperature of plus 80 C.

Time to prepare meals in the oven is about eight minutes at maximum capacity. The actual heating time, however, is one minute. The remainder of the time the meals are in equalization and isolation fields. Work is now being carried out to reduce the time required in each stage.

Since the oven handles pre-frozen foods, a large inventory as well as an extensive variety are possible. This makes it suitable for cafeterias, restaurants, hospitals and certain institutions, the company says.

The process is said to result in little loss of vitamins in the food.

Width of the production line is 28 inches. Possible hot air and condensation is taken off the interior of the oven by means of a ventilator. There are windows in the oven's exterior so food may be seen going through the oven.

Water consumption is about 2.6 gallons per minute.

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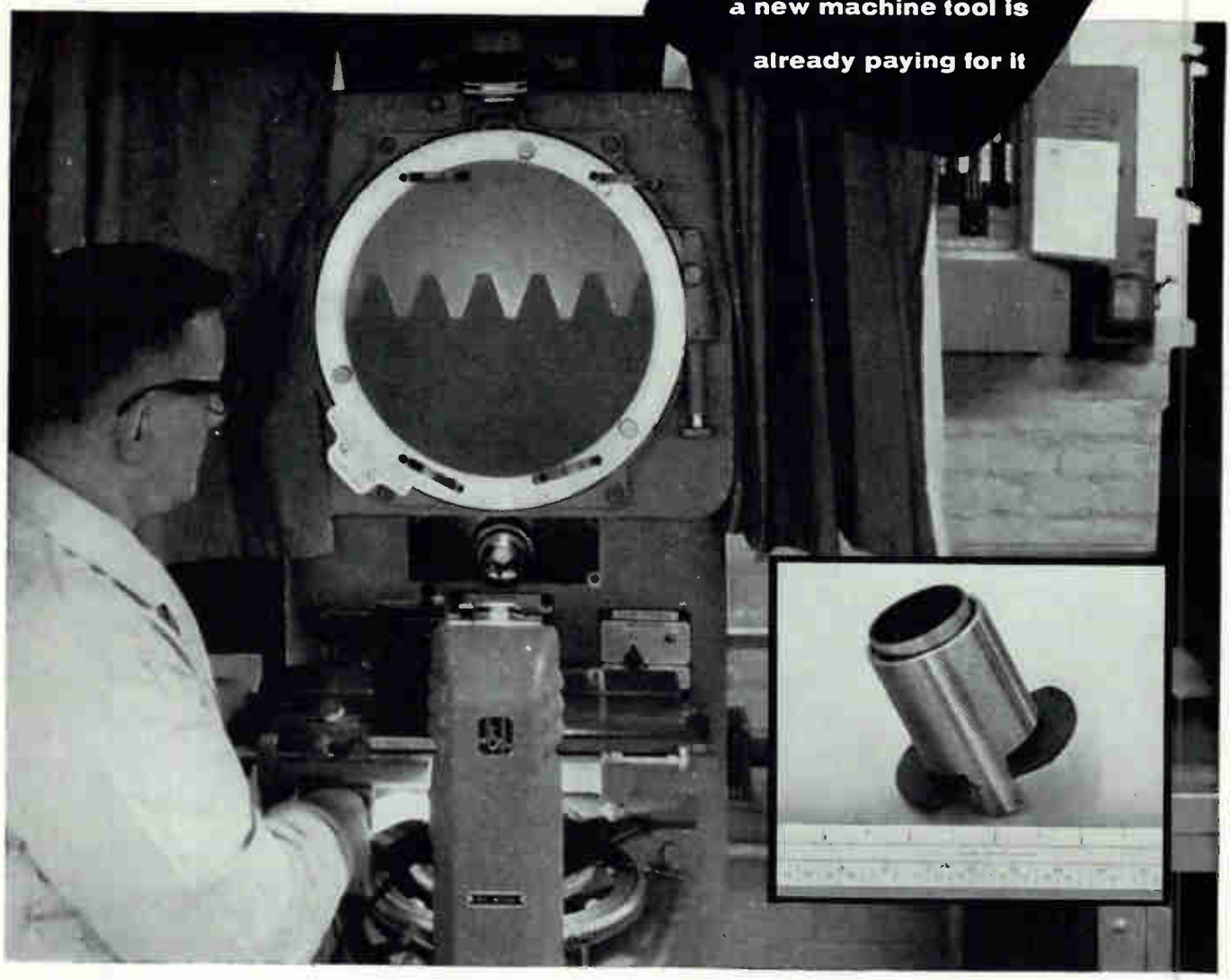

Unretouched photo (above) shows this cylindrical rack being inspected at 62.25X. Photo, courtesy of Baird-Atomic Inc., Cambridge, Mass.

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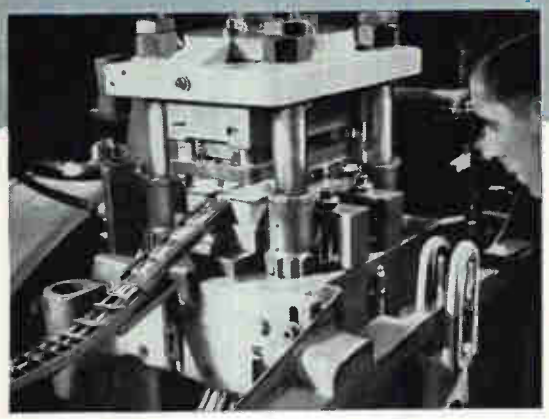

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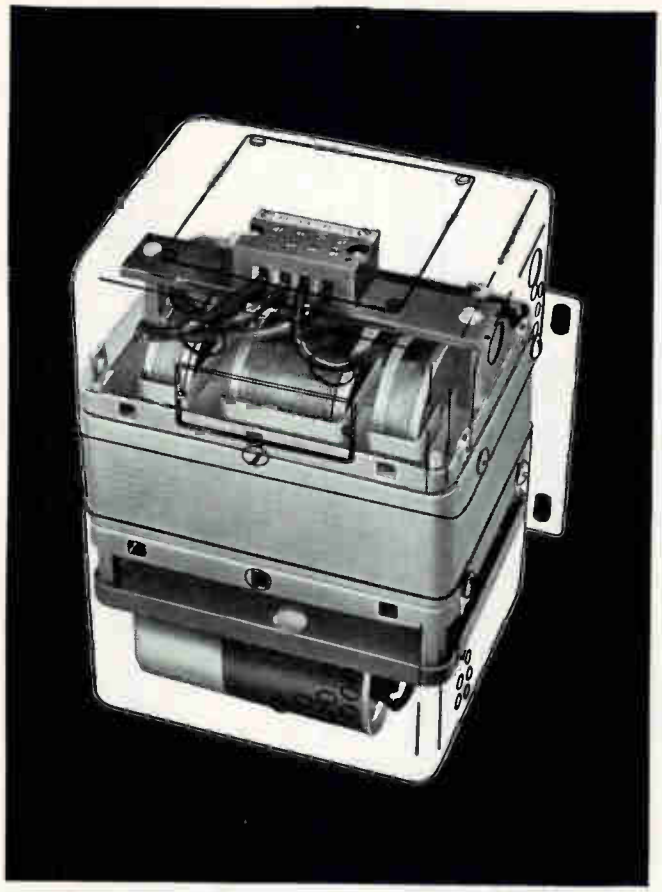
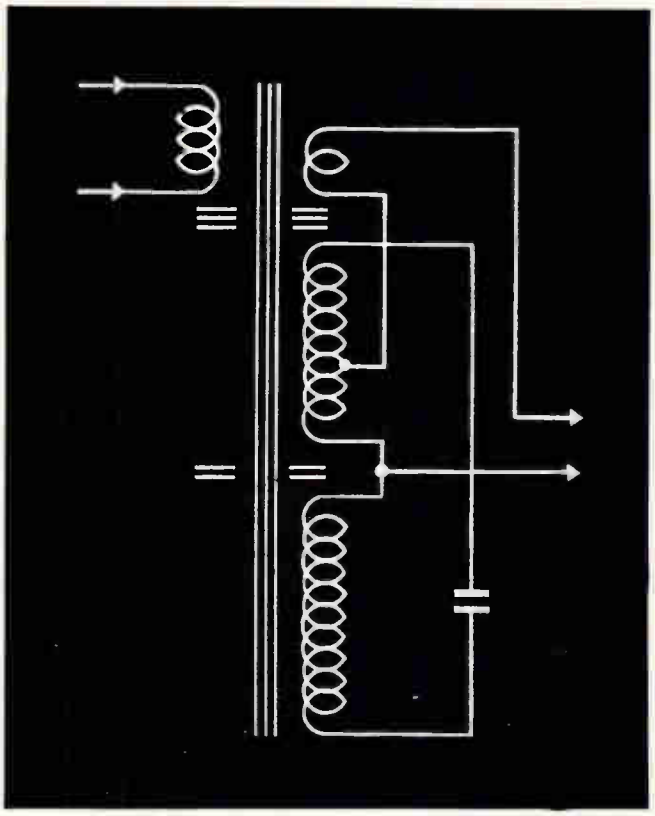


Phantom view shows simplicity of Sola design. Note absence of components requiring maintenance such as motors, gears, contactors, tubes and relays.

Schematic diagram indicates the complete reliance on static elements. This is the circuit of a representative Type CVS regulator which delivers output having less than 3% total rms harmonic content.



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When they designed the Sola Constant Voltage Transformer, what did they leave out? Trouble, for one thing. Original equipment manufacturers and plant engineers know that when you build in simplicity, you build out maintenance headaches.

The two illustrations at the left show clearly the Sola's few parts and straightforward design. This compact simplicity is possible because Sola regulators employ static-magnetic methods of voltage control.

The basic Sola design eliminates moving parts, renewable parts, manual adjustments, routine maintenance, and spare parts stock. Because there is nothing to wear out, no tubes to burn out — you know that when you specify Sola voltage stabilization, you automatically specify trouble-free reliability.

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MEETINGS AHEAD

June 10-26: British Exhibition, Electrical And Electronic Equipment, Coliseum, N. Y. C.

June 12-15: American Nuclear Society, Annual, Palmer House, Chicago.

June 13-14: Radio Frequency Interference Symposium, IRE, Shoreham Hotel, Wash., D. C.

June 14-16: Railroad Communications, Assoc. of Amer. Railroads, Communications Section, Sheraton-Cadillac Hotel, Detroit.

June 20-21: Broadcast and Tv Receivers, Chicago Spring Conf., IRE, Graemere Hotel, Chicago.

June 20-24: American Institute of Electrical Engineers, Summer General, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 22-24: Standards & Electronic Measurements, NBS, AIEE, IRE, NBS Laboratories, Boulder, Colo.

June 23-24: Solid-State Electronics Workshop, IRE, ASEE, Purdue University, Lafayette, Ind.

June 26-29: New England Electronic Conf., ERA, the Balsams, Dixville Notch, N. H.

June 26-July 1: Materials Sciences, ASTM, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 27-29: Military Electronics, National Convention, PGME of IRE, Sheraton-Park Hotel, Washington, D. C.

June 27-July 7: Automatic Control, International Conf. of IFAC, AACC, ISA, ASME, AIEE, IRE, AICHE, Moscow, Russia, contact: R. Oldenburger, Purdue Univ., Lafayette, Ind.

July 4-7: British Computer Society Conf., Leeds University, Sun Pavilon, Harrogate, Yorkshire.

Aug. 23-26: Western Electronic Show and Convention, WESCON, Memorial Sports Arena, Los Angeles.

Oct. 10-12: National Electronics Conf., Hotel Sherman, Chicago.

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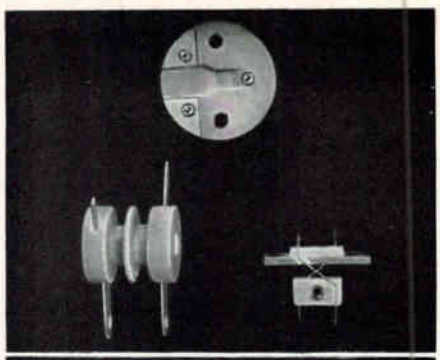

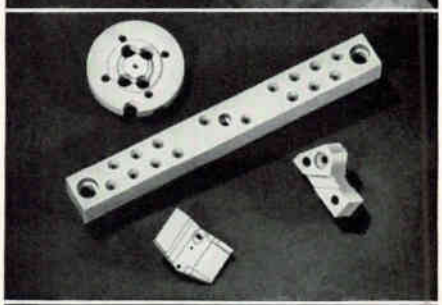

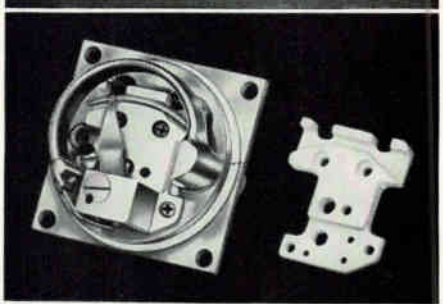

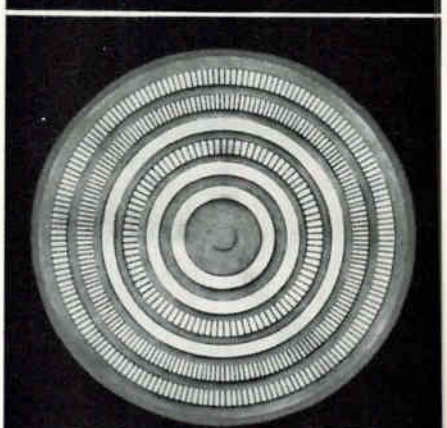

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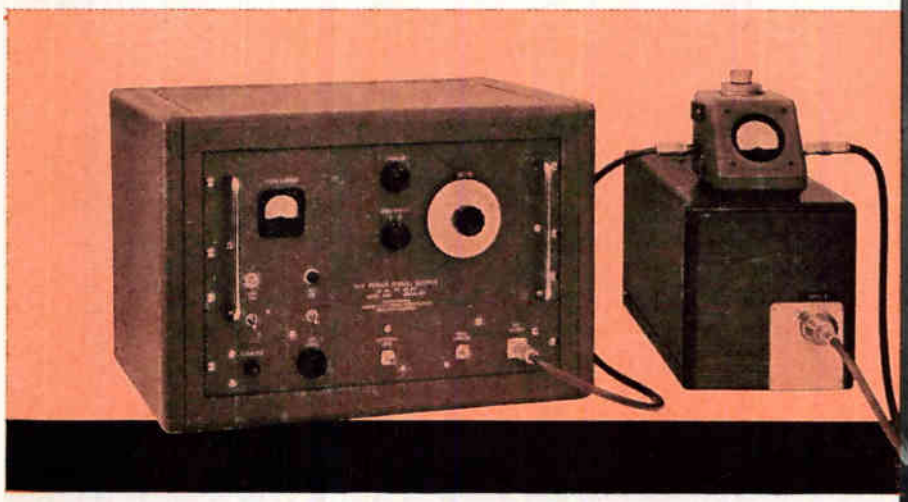

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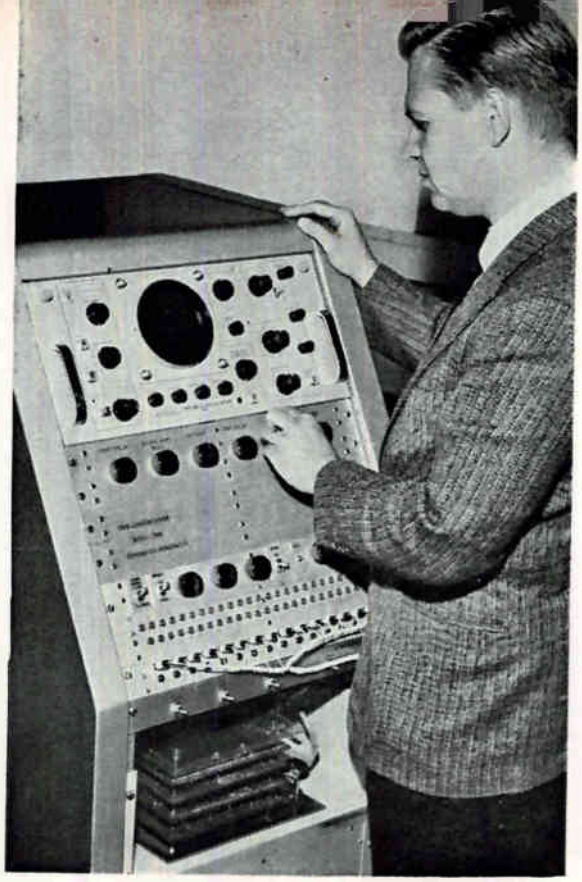


One of the authors makes adjustments on a demonstrator model of the character generator

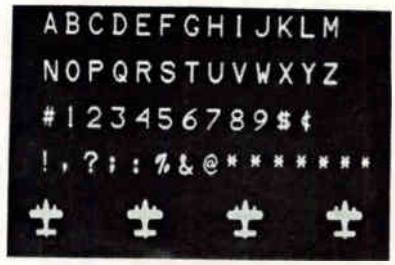
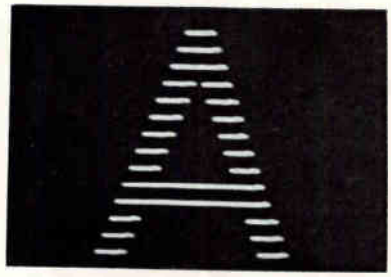


FIG. 1—Generated characters displayed on conventional crt; enlarged view of character shows raster structure



GENERATING HIGH-QUALITY

Characters and Symbols

Solid-state character generator, part of a visual information display and control system, features speed, character quality, stability, simplicity of adjustment, high display intensity and reliability

By J. KENNETH MOORE,
Section Head, Digital Techniques Section,
and MARVIN KRONENBERG,
Section Head, Communications Section,
Military and Industrial Systems Dept.,
CBS Laboratories, Stamford, Conn.

A NEW solid-state character generator, developed for VIDIAC (*Vi*sual *I*nformation *DI*splay *A*nd *C*ontrol) systems, combines the speeds required by modern high-speed digital computers with superior symbol quality. Its memory configuration allows a repertory of many hundreds of characters. By use of plug-in units, sets of stored symbols can be changed at will.

This desirable combination of characteristics is obtained with essentially standard digital techniques. The result is a modular system which is stable with a minimum of adjustments and which allows a wide variety of system specifications to be met by properly assembling basic plug-in units.

The developmental model of the character generator, shown in the photo, has been used with a standard Tektronix 515 oscilloscope to generate the symbols shown in Fig. 1A. The high quality achieved is evident in the special symbols @, &, $, #, %, and the like. In this developmental unit the symbols are generated at a basic rate of 50 microseconds per character or 20,000 characters per second. Rates as high as 250,000 characters per sec-

ond could be achieved by the same basic approach although at a sacrifice of character quality.

The character generator is basically a function generator giving a character formed from a line raster. One of the characters of Fig. 1A is expanded in Fig. 1B to show the raster structure. High frequency spot wobble may be used to fill in the spaces between raster lines to give a solid symbol without impairing the resolution. A 14-line raster has been employed and the horizontal resolution is 20 lines. Thus 280 tv picture elements are available to form a desired character.

The complete VIDIAC system, which is still under development, is shown in Fig. 2A. The character generator, with which this article is primarily concerned, shown in Fig. 2B, is comprised of the following elements: a memory to store the geometry or shape of the various characters; a selection system to allow the controlling device to choose a desired character; a converter to generate a video signal from the information obtained from the memory; and synchronizing generators to give the deflection signals which form the raster on the display device.

A decoder, controlled by a set of digitally coded input lines, closes the appropriate switches to select both: a set of cores corresponding to a particular character in a magnetic core matrix; and the core plane in the matrix containing the desired character (the double selection allows a virtually unlimited number of symbols to be stored with negligible noise and drive problems). The control logic writes a binary ONE into the cores corresponding to the selected character and then reads and resets the cores back to the ZERO state in an ordered sequence corresponding to the raster line structure.

The signals corresponding to each raster line are obtained from the core matrix in parallel. They are converted into the desired serial video form in the parallel-to-serial (P-S) converter. The P-S converter generates a pulse at the end of the conversion (which corresponds to the end of a given raster line) and this pulse initiates the logic cycle which obtains the video signal necessary to control the next raster line to be displayed. This sync signal also controls the sawtooth and staircase generators (in Control Logic block) which give the proper character raster when applied to the deflection system of the display. These various elements are described in greater detail below.

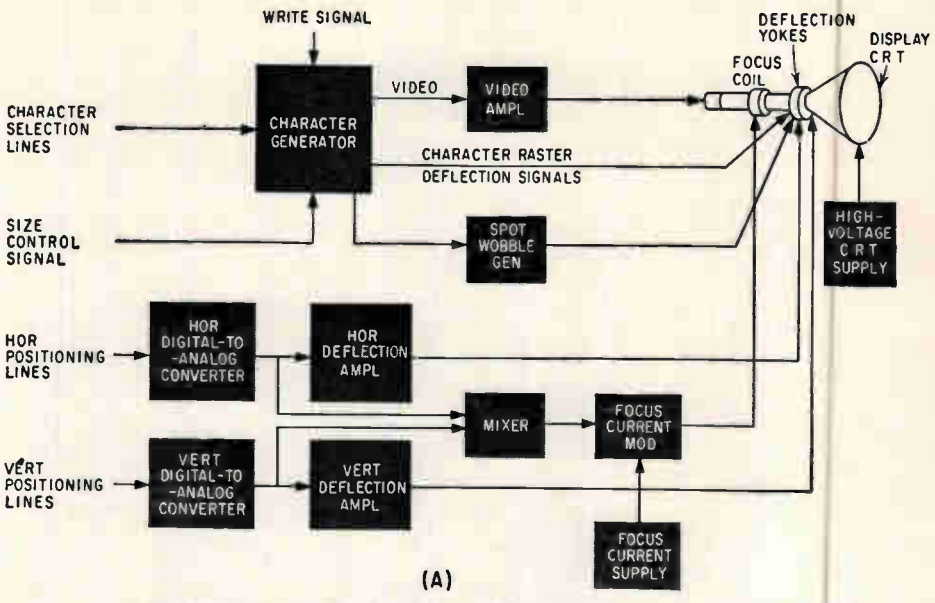


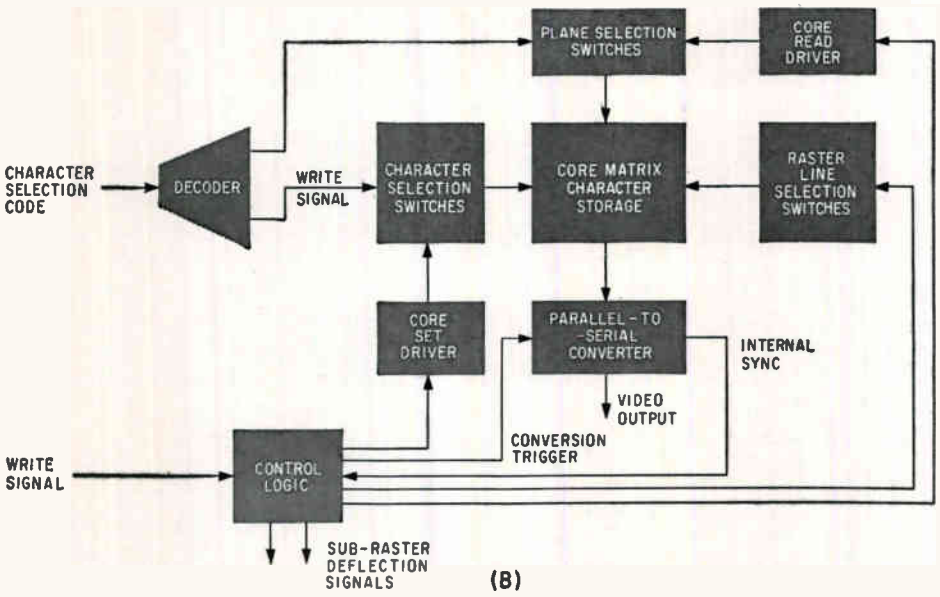
FIG. 2—Complete developmental VIDIAC display system (A);

Figure 3 shows the basic method of defining an arbitrary symbol's shape so that it will be adaptable to storage by digital techniques. For purposes of illustration a 10-line raster structure is used with the letter A. Figure 3A shows a matrix with 10 horizontal and 25 vertical intersecting lines. The desired symbol is drawn on tracing paper and then placed over the matrix. The intersections of the edges of the character with the horizontal lines of the matrix correspond to transition points, that is, black-to-white or white-to-black transitions for video signals controlling raster lines equivalent to the horizontal matrix lines.

Because of the finite number of vertical lines, it is not possible to specify precisely these intersections and the nearest matrix intersection to the desired intersection is used. We may consider that the letter A is approximated by the ten 25-bit binary words shown in Fig. 3B. In the present developmental character generator, fourteen 60-bit words are used to define each character. The figure of 20 lines horizontal resolution is obtained because the system was designed so that at least two binary ZEROS always separate two binary ONES.

A larger number of vertical lines than horizontal lines is required to ensure smooth slopes for the edges of the displayed symbols. Figure 3C shows the character that would be obtained from the word set of Fig. 3B. This is a rougher character than the one shown in Fig. 1B because only ten raster lines and 19 vertical lines have been used. For a good character there should be three times the number of vertical lines as horizontal lines in the matrix when the characters include slopes of 60 deg or greater. Naturally, for a symbol like E far fewer vertical lines are necessary. At first glance the large number of bits represented by even the rough matrix of Fig. 3B may seem prohibitive for a moderate number of characters but fortunately most of this information is redundant and relatively few bits must actually be stored and retrieved to generate a high quality symbol.

A single character core storage matrix for the letter A is shown in Fig. 3D. The horizontal wires of the matrix are *read* lines and correspond to the horizontal raster lines. The vertical lines, identifying allowable transition points, are *sense* lines. The wire which threads each core of the individual character is the selection or *write* line.



character generator is shown alone in (B)

Cores of square-hysteresis-loop material are placed at intersections corresponding to the desired video transitions. Forty cores, on the average, are required to define a character when using a 14-line raster. Low-coercive-force switch-core material is entirely satisfactory because the square hysteresis loop is only used for selection; no coincident current mode is required. This makes it possible to assemble a memory using relatively nonuniform cores and low-impedance current drivers.

In operation the character is selected by pulsing its write line which sets all the cores of the character into the ONE state. The selection switch corresponding to the first raster line is closed and a read pulse is generated. The two cores on the top read line in Fig. 3D are switched back to the ZERO state and generate switching voltage signals on their sense lines. It will be noted that these signals occur at the same time (in parallel). After this information is processed by the P-S converter, the raster line switch corresponding to the next line is closed, another read pulse is generated and another set of sense lines are energized.

In a complete alphabet store the corresponding sense lines and read lines are wired in series and the selection lines are connected to a driver through a suitable set of selection switches. This simple wiring is satisfactory until the store size is such that excessive noise is generated by the read current pulses and series inductance is built up to the extent that it restricts the drivers. The plane-switching necessary to reduce these limitations and make very large stores practical is illustrated in Fig. 4. The plane containing the character is selected at the time that the character cores are set. The number of characters driven in series by the read driver is thereby limited to those in one plane.

The only remaining inherent limit on the size of the character store is due to transmission line effects in the sense lines. This is much less of an effect than that present in coincident-current memories because there are far fewer cores present on any given sense line. Experience indicates that no additional gating should be required for character stores of 300 characters. For much larger stores it becomes necessary to incorporate buffers and OR gates in the sense lines.

The P-S converter allows the use of moderate-speed ferrite switch cores in the memory while achieving a very high information processing rate. In the present model as many as 80 bits of information (for the letter W) are used in 3.5

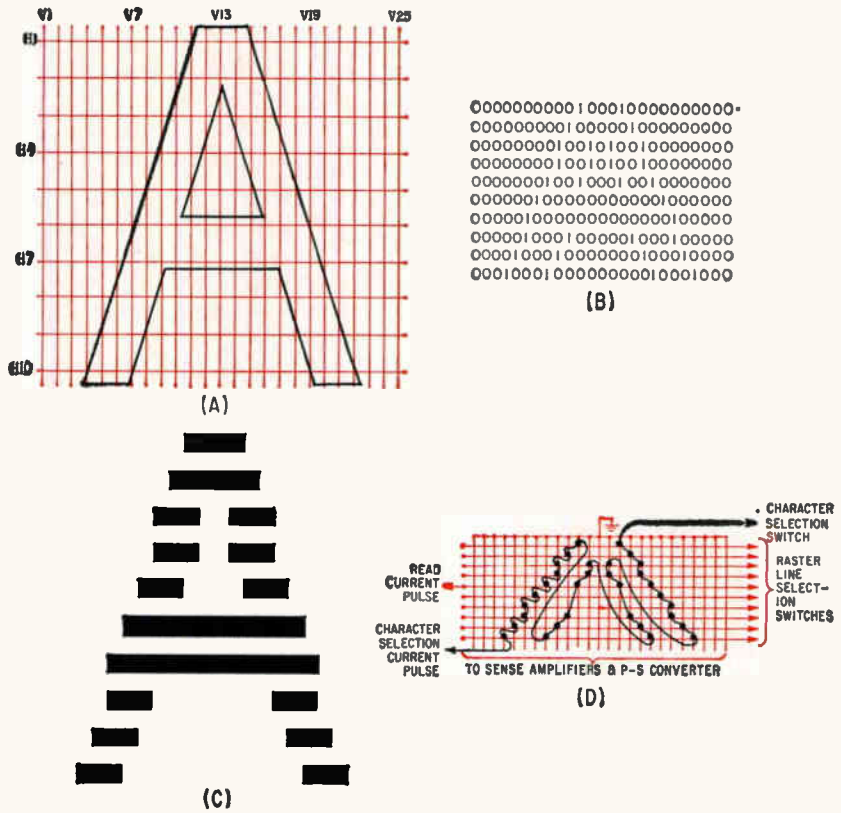


FIG. 3—Letter superimposed on 10-line raster with 25 allowable horizontal transition positions (A), its matrix representation by ten 25-bit words (B), letter as produced by this coarse matrix (C), and diagram of storage matrix (D) for letter

μsec. If the more usual process of memory access were used (that is, step-by-step sampling of each possible memory location) at least 840 μsec. would be required for the character resolution obtained.

Figure 5A is a block diagram of the P-S converter. The sense-line amplifiers, shown at the top, drive a secondary storage register (Int. Storage) which retains the information read out on the sense lines from the character store for the duration of the writing cycle. A sampling pulse distributed by a tapped delay line samples sequentially the states of the elements of the storage register in the set of AND gates. These gates drive the one large mixing OR gate whose output triggers the count input of a high-speed complementing flip-flop. The output of this flip-flop is the required video information because the flip-flop is triggered by signals corresponding to the character transition edges. The horizontal sweep of the display device is easily scaled to the velocity of propagation of the sampling pulse down the tapped delay line and synchronized with the initiation of this pulse.

The entire system timing is self synchronized by using the final output of the delay line to initiate the next cycle of operation. A simplified timing diagram is shown in Fig. 5B. A staircase signal is used for vertical sweep of the display device because it eliminates raster skew and consequent twisting of the display character, and also because it reduces the effect of any small time-jitters in the system. The steps of this staircase are controlled by the internal sync signal which generates the reset for the horizontal scan. A high degree of timing stability and uniformity from line-to-line in the character raster is required in order to produce high-quality characters. This is relatively simple to achieve with standard transistor pulse circuitry.

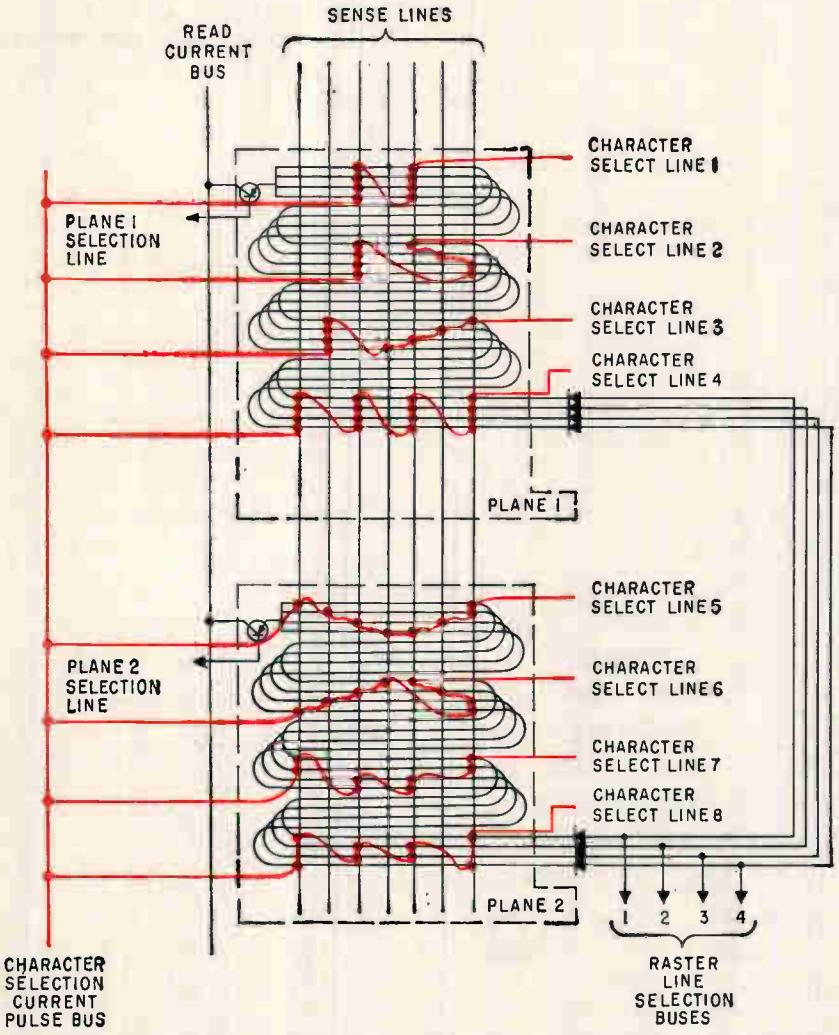


FIG. 4—Simplified schematic shows interconnection of two planes with plane selection

The straightforward circuit techniques used in the P-S converter are illustrated in Fig. 5C. With the plane selection used there are never more than eleven core noise pulses on one sense line; core noise is therefore no problem and unilateral signals may be used to simplify the sense amplifiers. The two transistors in each sense amplifier could be reduced to one transistor at the expense of tighter tolerance requirements. Transistor Q_3 with diodes D_1 and D_2 forms one intermediate storage element. Minority carrier storage in the transistor is used to furnish this temporary storage with a minimum number of components. Worst-case design has been feasible for this stage. In general, a marked decrease in storage time with aging is not expected, so that the storage period should be stable.

Transistor Q_4 is driven by the tapped delay line and with Q_3 forms a two-high AND gate for sampling the state of Q_3. Diode D_3 removes any of the delay line signal from the output bus when Q_3 is not saturated.

The delay line used in the developmental unit has 40-nsec delay between each of 60 taps. A horizontal line of video therefore requires 2.4 μsec. A 0.1-μsec pulse is used for sampling so that the horizontal resolution obtainable is one part in twenty. This exceeds the vertical line resolution and is therefore entirely satisfactory. The fourth line from the top in the letter A utilizes this resolution fully. Any hysteresis in the mixing gate or flip-flop will produce ragged edges in the displayed characters. A recovery time of less than 100 nsec is required for these elements in the present model and this has been considerably bettered. The mixing gate and the flip-flop are the only logic elements in the system requiring a high operating speed.

The emitter of Q_3 is returned to a common bus which is made negative at the end of a line cycle to clear out any remaining stored holes. This bus is also used to produce strobing of the memory sense line signal. As long as it is held

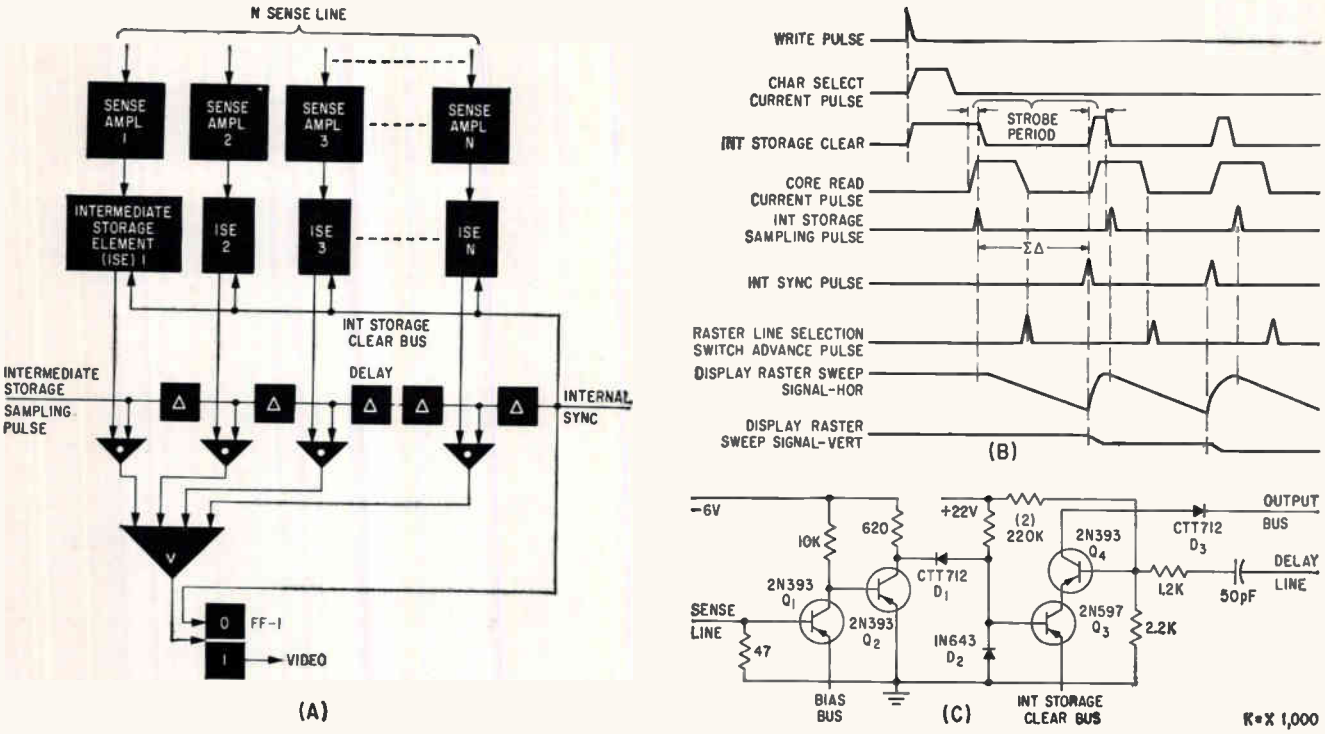


FIG. 5—Diagram of parallel-serial converter (A), simplified timing diagram of entire system (B) and typical circuit for a parallel-serial converter channel (C)

negative, Q_3 will not respond to input signals. The reset and strobe (Internal Storage Clear) bus is therefore held negative until all noise signals have died down.

The logic as described is satisfactory for generating characters with the quality of Fig. 1 at speeds up to 40-50 thousand characters/sec. As the speed is increased, however, the portion of the total character writing time used for changing from one line to the next becomes larger. The brightness of the final display is reduced with respect to theoretical maximum and the speed required for video processing becomes very high. To alleviate these problems, interlaced readout of the memory may be used. Thus while the right-hand side of a raster line is being processed by a P-S converter, the left-hand side may be read out of a left-hand character store into a left-hand P-S converter. When the left-hand P-S converter is processing the left-hand portion of the line the right-hand store may be read into the right-hand P-S converter. The available video duty cycle thus approaches 100 percent, but at the expense of circuit complexity. This technique allows 100,000 character-per-second operation with readily available components.

Additional gains in speed may be achieved with an additional set of logic elements which sense the transition points set into the intermediate register and then move the display sweep to the transition points immediately. Thus the electron beam in the display will move very fast when it is OFF and slower when it is ON. Since the actual area duty cycle for an alphanumeric symbol is 10-20 percent, a considerable gain in speed is possible for asynchronous systems.

The following packages may be considered the modules of the system: core storage planes; current drivers; plane selection switches; character selection switches; P-S converter elements; tapped delay line; video flip-flop; and clock logic elements.

To change the basic character writing speed (or dwell time) over wide ranges it is only necessary to change the total delay of the tapped delay line. Quantized changes in dwell time may be even more simply arranged by repetitive writing of a selected character.

To increase the available number of characters or symbols it is only necessary to add planes (which may easily be made plug-in), and plane and character selection switches. No extra load will be seen by the current drivers. Of course, the control signals and decoders, if any, must be increased in number.

Changes in characters or in their styling is effected by changing planes or individual character wiring. Characters may be made individually plug-in but the total number of connectors required will then be high.

Changes in character resolution are made by changing the number of raster lines and sense lines. Naturally this requires the change of the storage planes. In addition, the number of current driver switches for readout, the number of P-S converter elements and the number of taps on the delay line must be changed. All of these elements, however, will remain basically the same and a simple change in the number of modules used is all that is required.

A simple set of modules may then be used to assemble systems whose basic parameters cover the following ranges: time per character—4 to 1,000 μsec; number of picture elements per character — 50 to 5,000; number of characters—10 to 3,000.

The authors wish to express their thanks to H. Dingley and S. Bouchier who built the major portions of this equipment.

Analytical Design of Transistor

By RONALD H. RIGGS,
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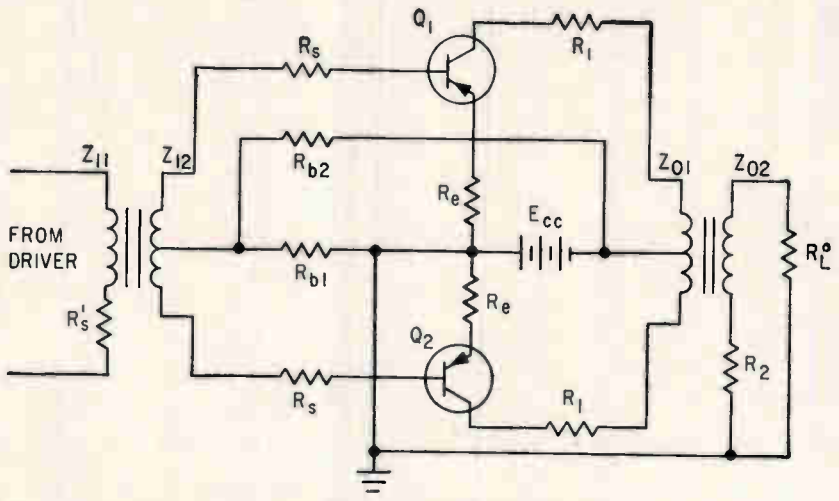

FIG. 1—Circuit diagram of push-pull amplifier defines terms used

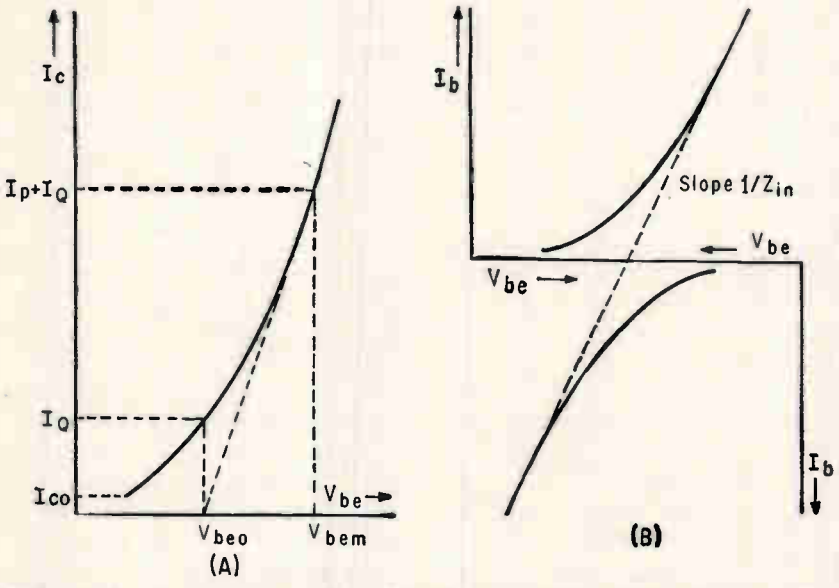

FIG. 2—Typical transistor transfer characteristics (A) and composite input characteristics (B)

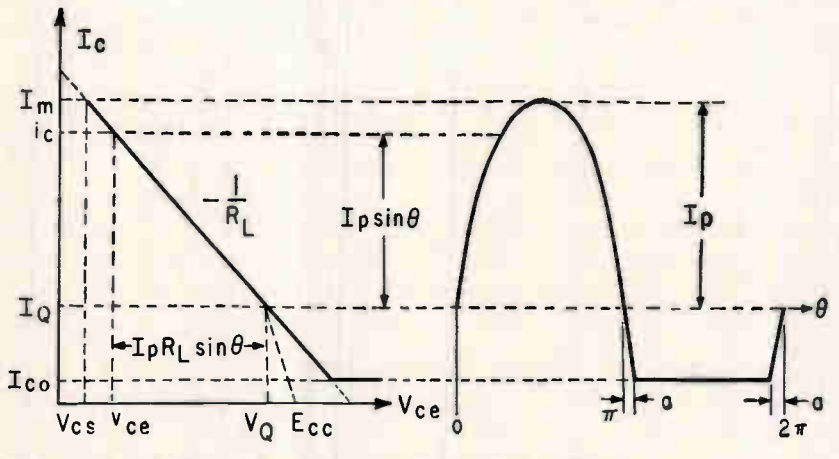

FIG. 3—Load line and output waveform of amplifier

WITH THE advent of transistors capable of high power levels, mobile battery-powered transistorized electronic equipment is becoming increasingly popular. In applications requiring large quantities of battery power, the efficiency of the output stage is of great importance. In the past there have been only approximate methods[1, 2] for calculating the efficiency of transistor power amplifiers. Furthermore, factors such as gain and bias resistance values were usually found experimentally. Developed here is a set of exact equations involving physical parameters whose values are readily available. These equations make it possible to calculate exactly, within the accuracy of the parameters used, the efficiency, power gain, maximum power output, maximum power dissipated per transistor and to specify the impedance parameters required. Thus, it is possible to compare performances of power amplifiers mathematically, without breadboarding each circuit —a saving of time and money.

A transformer-coupled common-emitter power amplifier is shown in Fig. 1. This diagram defines the dissipative elements R_{b1}, R_{b2}, and R_e of the circuit, and the d-c winding resistances R_1, R_2, R_s', and R_s of the transformers. Figure 2A shows a typical transistor transfer characteristic. Projected cutoff is indicated in the diagram—the point at which the transistors are to be biased. This allows a quiescent current I_Q to flow, but biasing to projected cutoff gives a reduction in the distortion of the signal. The transfer characteristic should be considered when the transistors to be used are selected. The value of the quiescent current should, for high efficiency, be small compared to the peak current, I_p, thus the

Push-Pull Amplifiers

Using a mathematical analysis of collector waveform and equivalent circuits, expressions for making an exact determination of gain, efficiency and bias circuit design are derived. Example cited shows results

knee of the curve should be sharp. In addition, this characteristic should be linear for low distortion. Figure 2B illustrates the method by which the composite input impedance, Z_{in}, is found. Four times Z_{in} gives the minmum value of the total input secondary winding impedance Z_{22}.

Referring to the load line of Figure 3, note that it has a slope of $-1/R_L$, where

$$R_L = (R_L' + R_2)(Z_{01}/4Z_{02}) + R_e + R_1 \quad (1)$$

Thus R_L equals the sum of all the effective resistances in the output primary circuit.

From the geometry of Fig. 3, $R_L = (V_Q - V_{ce})/I_p$ or

$$I_p = [E_{cc} - I_Q(R_{ce} + R_1 + R_e)]/(R_L + R_{ce}) \quad (1A)$$

since $R_{ce} = V_{ce}/I_m$ = the collector saturation resistance and $V_Q = E_{cc} - I_Q(R_1 + R_e)$.

Also, $R_L = (V_Q - v_{ce})/_p \sin\theta$ or $v_{ce} = V_Q - I_p R_L \sin\theta$. Since $i_c = I_Q + I_p \sin\theta$, $p_c = v_{ce}\, i_c$ or $p_c = (V_Q - I_p R_L \sin\theta)(I_Q + I_p \sin\theta)$ = the instantaneous collector power for the interval $-a < \theta < \pi + a$. For the interval $\pi + a < \theta < 2\pi - a$, the instantaneous collector power is $p_c = (E_{cc} + I_Q R_{Lac} - I_{co}R_L)\, I_{co}$ where

$$R_{Lac} = (R_L' + R_2)(Z_{01}/4Z_{02}) \quad (1B)$$

Thus, R_{Lac} = the reflected load + the reflected d-c resistance of the output secondary winding (the a-c portion of the total load line impedance). Integrating the above expressions for p_c, total average power dissipated per transistor becomes

$$P_A = (\tfrac{1}{2}\pi)\int_{-a}^{\pi+a} (V_Q - I_p R_L \sin\theta)(I_Q + I_p \sin\theta)\, d\theta + (\tfrac{1}{2}\pi)\int_{\pi+a}^{2\pi-a} (E_{cc} + I_Q R_{Lac} - I_{co}R_L) I_{co}\, d\theta \quad (2)$$

The total average load power supplied by the battery is

$$P_L' = (1/\pi)\int_{-a}^{\pi+a} I_p^2 R_L \sin^2\theta\, d\theta + (1/\pi)\int_{\pi+a}^{2\pi-a} I_{co}^2 (R_L - R_{Lac})\, d\theta \quad (2A)$$

Total d-c collector power supplied by the battery is the sum of the power dissipated by both transistors plus the load power supplied by the battery. Thus $P_{d\text{-}c} = 2P_A + P_L'$ or, after integrating Eq. 2 and 2A and combining terms

$$P_{d\text{-}c} = (2/\pi)[E_{cc} - I_Q(R_1 + R_e + R_L)] \sqrt{I_p^2 - (I_Q - I_{co})^2} + (2/\pi)[E_{cc}I_Q - I_Q^2(R_1 + R_e) - (E_{cc} + I_Q R_{Lac} - I_{co}R_{Lac})I_{co}] \sin^{-1}[(I_Q - I_{co})/I_p] + E_{cc}I_Q - I_Q^2(R_1 + R_e) + (E_{cc} + I_Q R_{Lac} - I_{co}R_{Lac})I_{co} \quad (3)$$

Total a-c power actually delivered to the load is

$$P_L = (1/\pi)\int_0^{\pi} I_p^2 R_L' \sin^2\theta\, d\theta = (I_p^2 R_L'/2\pi)\left[\theta - \sin\theta\cos\theta\right]_0^{\pi} = \tfrac{1}{2} I_p^2 R_L' \quad (4)$$

where the load reflected to the output primary is

$$R_L' = (R_L' Z_{01}/4Z_{02}) \quad (4A)$$

The maximum undistorted power obtainable is then

$$P_{LM} = \tfrac{1}{2}\left[\frac{E_{cc} - I_Q(R_1 + R_e + R_{ce})}{R_L + R_{ce}}\right]^2 R_L' \quad (5)$$

The maximum power dissipated by each transistor can now be found. Maximum dissipation does not occur at maximum collector current. When the quiescent current is small ($I_Q = I_{co}$) maximum dissipation using Eq. 2 is

$$P_{AM1} = [E_{cc} - I_{co}(R_1 + R_e + R_L)]^2/\pi^2 R_L + E_{cc}I_{co} - I_{co}^2(R_1 + R_e) \quad (6)$$

When the quiescent current is large ($I_Q - I_{co} \geq I_p$) $P_A = (1/\pi)\int_a^{2\pi} (V_Q - I_p R_L \sin\theta)(I_Q + I_p \sin\theta)\, d\theta$ and maximum dissipation is then

$$P_{AM2} = E_{cc}I_Q - I_Q^2(R_1 + R_e) \quad (7)$$

The absolute maximum dissipation which can occur is simply the sum of the terms in Eq. 6 and 7. In general, then, the average power dissipated per transistor cannot exceed

$$P_{AM} = E_{cc}(I_Q + I_{co}) - (I_Q^2 + I_{co}^2)(R_1 + R_e) + [E_{cc} - I_{co}(R_1 + R_e + R_L)]^2/\pi^2 R_L \quad (8)$$

under any combination of circumstances.

Summing the voltages about the input circuit in Fig. 4A gives

$$v_i = i_b[R_s + R_e + R_{b1}R_{b2}/(R_{b1} + R_{b2})] + v_{be} + i_c R_e \quad (9)$$

Replacing the instantaneous values by peak excursions we have

$$v_{imax} = I_{bm}[R_s + R_e + R_{b1}R_{b2}/(R_{b1} + R_{b2})]/h_{fe} + (V_{bem} - V_{beo}) + I_p R_e \quad (10)$$

Average input power then is $P_{in} = v_{imax} i_{bmax}/2$ or

$$P_{in} = \left\{I_p(R_s + R_e + R_{b1}R_{b2}/R_{b1} + R_{b2})/h_{fe} + I_p R_e + V_{bem} - V_{beo}\right\} I_p/2h_{fe} \quad (11)$$

where V_{bem} and V_{beo} are defined by figure 2A.

Summing the voltages about the two loops of Fig. 4B, gives

$$E_{cc} = I_a(R_{b1} + R_{b2}) - I_b R_{b1} \quad (12)$$

$$0 = V_{beo} + I_b(R_s + R_e + R_{b1}) - I_a R_{b1} + I_c R_e \quad (13)$$

Thus, $I_a = (E_{cc} + I_b R_{b1})/(R_{b1} + R_{b2})$ and since $I_b = (I_Q - I_{co})/h_{FE}$, the total d-c power supplied by the battery to the input circuit is

$$P_B = E_{cc}I_a = E_{cc}[E_{cc} + (I_Q - I_{co})R_{b1}/h_{FE}]/(R_{b1} + R_{b2}) \quad (14)$$

Solving Eqs. 12 and 13

$$R_{b1}/R_{b2} = [V_{beo} + (I_Q - I_{co})(R_s + R_e + R_{b1})/h_{FE} + I_Q R_e]/[E_{cc} - V_{beo} - (I_Q - I_{co})(R_s + R_e)/h_{FE} - I_Q R_e] \quad (15)$$

which gives the relationship of the bias resistors to each other.

These same resistors should also give a stability factor[4] adequate for thermal conditions expected. The stability factor here is

$$s = \left\{[R_{b1}R_{b2}/(R_{b1} + R_{b2}) + R_s](2 + h_{FE}) + R_e\right\} / \left\{[R_{b1}R_{b2}/(R_{b1} + R_{b2}) + R_s](1 + h_{FE}) + R_e\right\} \quad (16)$$

Since Eq. 6 holds where the leakage current is large, it may be solved for the maximum collector current

to get the following expression

$$I_{com}=(\pi/k)[1.465(R_L E_{cc})^2+kR_L P'_{AM}]^{1/2} -(3.93R_L-R_1-R_e)E_{cc}/k$$

where $k=(R_L+R_1+R_e)^2-\pi^2 R_L(R_1+R_e)$ and P'_{AM} is the allowable dissipation at a specified maximum Kelvin temperature T. The maximum stability factor then should be

$$S=\left\{[(\pi/k)\sqrt{1.465(E_{cc}R_L)^2+kR_L P'_{AM}} -I_Q-(3.93R_L-R_1-R_e)(E_{cc}/k)]/I_{co}\right\} /\left\{(T/T_0)^2\exp[(A/T_0)-(A/T)]-1\right\} \quad (17)$$

where T_0 is the Kelvin temperature at which I_{co} is specified, $A=9{,}100$ for germanium and $A=14{,}000$ for silicon. Equation 16 should then be set equal to the value of S obtained from equation 17 to prevent thermal runaway.

Actual selection of resistors satisfying the above equations is by trial and is based partially on the size of the other components. Resistor R_{b1} should be significantly smaller than the input impedance Z_{in}, and is usually chosen on the basis of experience or manufacturer's application data.

Overall efficiency of the output stage is a combination of Eq. 3, 5 and 14, thus

$$\text{Efficiency}=P_{LM}/(P_{d-c}+P_B) \quad (18)$$

The exact power gain may be calculated by using Eq. 5 and 11 as

$$\text{Power Gain}=P_{LM}/P_{in} \quad (19)$$

In most cases the leakage current specified by the manufacturer is given for the common base connection and is designated I_{cbo}. The common emitter leakage current, designated I_{ce} in this paper, is

$$I_{ce}=I_{cbo}(1+h_{FE}) \quad (19A)$$

Maximum value of E_{cc} should be half of the minimum collector to emitter punch-through voltage, since a voltage equal to twice E_{cc} appears across the transistor that is cutoff. Note that if the driver stage is operated in class A, the maximum power obtainable[3] from it is

$$P_{LM}=\tfrac{1}{2}\left[\frac{E_c-I_Q(R_s'+R_c+R_d)}{R_L+R_{2s}}\right]^2 R'_L \quad (20)$$

This should be equal to or greater than the value obtained in Eq. 11. Here, R_c, R_L, R_{2s} and I_Q refer to the driver stage. The second-harmonic distortion[1] of the driver stage can be expressed as

$$\text{Distortion}=[I_p-(I_Q-I_{co})]/2(I_p+I_Q-I_{co}) \quad (21)$$

where I_p is the peak signal current of the driver stage. To determine the distortion of the output stage harmonic analysis[2] must be used. This will not be treated here.

Finally, it can be shown[5] that the relation between a-c and d-c current gain is

$$h_{fe}=\frac{(h_{FE})^2}{h_{FE}-(I_p+I_Q-I_{cbo})\,dh_{FE}/dI_c} \quad (22)$$

The following example serves to illustrate the application and accuracy of some of the preceding formulas. For the test, two 2N285A transistors were used with TA-10 and TA-12 (Stancor) transformers. The following data were then obtained from manufacturers' specifications

$Z_{o2}=8$ ohms, $Z_{12}=16$ ohms, $I_Q=100$ ma, $Z_{01}=20$ ohms, $Z_{11}=2000$ ohms, $I_{cbo}=1$ ma, $R_2=0.35$ ohms, $R_e=2$ ohms, $V_{beo}=0.2$ v, $R_1=0.275$ ohms, $R'_s=250$ ohms, $h_{FE}=40$, $P_{AM}=25$ w, $V_{pt}=35$ v, $R_{cs}=0.4$ ohm (est.) Next, the following parameters were selected, $R_{b1}=4.7$ ohms, $R_e=0$, $R^\circ_L=8$ ohms, $E_{cc}=17$ v and applying the formulas derived earlier

$R_L=(8.35)(20/32)+.275=5.49$ ohms (1)
$R_L'=5$ ohms (4A)
$R_{Lac}=5.22$ ohms (1B)
$I_{co}=41$ ma (19A)
$I_p=(17-.07)/5.89=2.87$ amp (1A)
thus
$V_{bom}=0.7$ v (from manufacturer's data sheet)
$P_{LM}=\frac{1}{2}(2.87)^2(5)=20.6$ w (5)
$R_{b2}=4.7(16.8-.003)/(.2+.01)=377$ ohms (15)
$P_{AM}=17(.14)+(16.77/\pi)^2/5.49-.275(.0116)=7.57$ w (8)
$h_{fe}=(40)^2/(40+29.69)=23$ (22)
$P_{in}=[2.87(6.63)/23+.5]2.87/46=0.083$ w (11)
$P_B=17(17+.28/40)/381.7=0.758$ w (14)
$PG=$ Power Gain $=20.6/.083=249$ or 23.95 db (19)
$P_{d-c}=(2/\pi)[1.7-.003-(17.52-.21)(.04)]\sin^{-1}(.06/2.87)+(2/\pi)(17-.58)(2.87)\sqrt{1-(.06/2.87)^2}+1.7-.003+(17.52-.21)(.04)=32.5$ w (3)
Efficiency $=20.6/33.3=62$ percent (18)

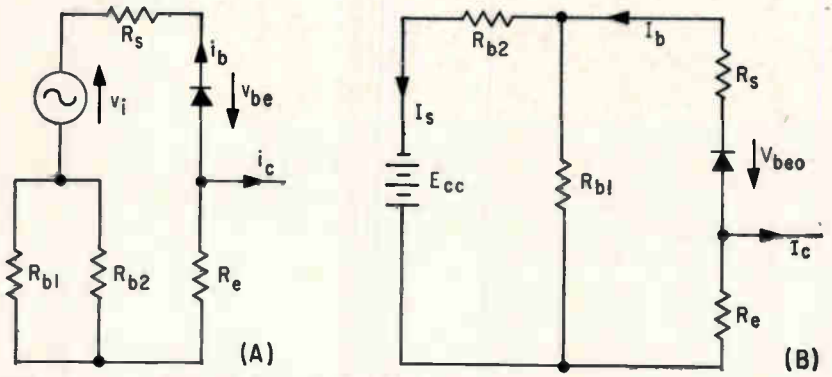

FIG. 4—A-c (A) and d-c (B) equivalent input circuits

Actual results obtained from the test circuit at 2 Kc were PG = 24.3 db, Error 0.35 db; Eff = 68.5 percent, Error 6.5 percent; P_{LM} = 20.5 w, Error 0.5 percent; P_{in} = 0.076 w, Error 8.4 percent; $P_{d-c}+P_B$ = 30.2 w, Error 9.3 percent; R_{b2} = 375 ohms, Error 0.5 percent.

These errors were due to the deviations from the nominal values of the transistor and transformer parameters which were supplied by the manufacturer. In all cases, errors were within the manufacturing tolerances. Since the gain and the input power, for a constant output, will usually vary by about 3 db over the audio range, the error in power gain and the error in input power may be considered negligible.

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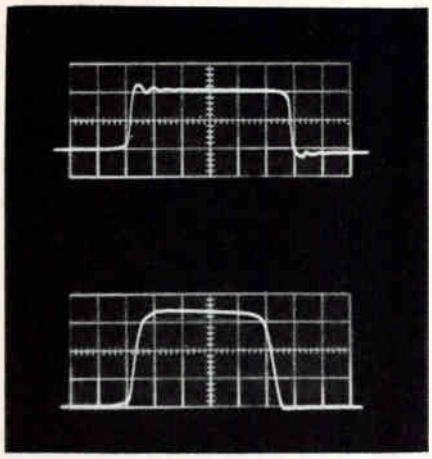

Waveforms of output show 5-percent overshoot for no load, less than 10-percent droop for 90-ohm load

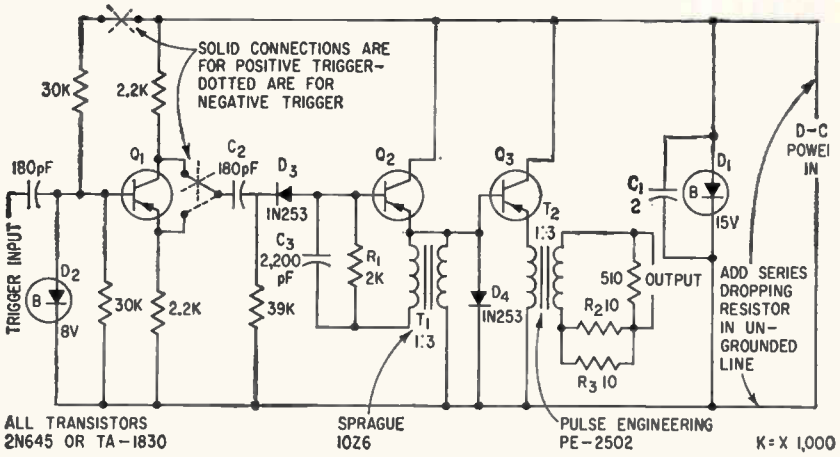

FIG. 1—Pulse generator is triggered by a positive pulse, but two simple wiring changes allow triggering with negative pulse. Positive or negative signal is available from isolated output

Pulse Generator FOR SYNCHRONIZING EVENTS

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THE zero-gradient synchrotron is a 12.5-bev proton synchrotron being constructed by the Particle Accelerator Division of Argonne National Laboratory. The synchrotron will have six major buildings and cover forty acres. To operate the machine, timing pulses must be sent between various buildings to synchronize events. Since various groups will build different parts of the complete device, a standardized pulse was developed to minimize connection problems. A transistorized pulse generator was designed to generate the pulse.

Power to the pulse generator, shown in Fig. 1, can have either positive or negative side grounded. A series resistor, determined by pulse repetition rate and supply voltage, must be placed in the ungrounded lead of the power supply. Zener diode D_1 limits the voltage across the circuit to 15 volts and capacitor C_1 provides the pulse power. Diode D_1 also keeps supply transients from the generator circuit.

The input trigger to the pulse generator drives transistor Q_1, which is connected as a phase splitter. Input impedance is 8,000 ohms, while Zener diode D_2 limits the input voltage swing to 8 volts and also acts as a d-c restorer after higher amplitude trigger pulses. Depending on how the generator is connected, either a positive or a negative pulse greater than 5 volts will trigger the generator. A negative pulse, obtained from either collector or emitter of the phase splitter, depending on the polarity of the trigger pulse, fires a blocking oscillator formed by Q_2.

The pulse is coupled into the blocking oscillator by capacitor C_2 and diode D_3, which isolates the stages as soon as regeneration takes place. Pulse width of the blocking oscillator is controlled by R_1 and C_3; for the values shown, pulse width is approximately 1 μsec. Diode D_4, across the primary of blocking oscillator transformer T_1, forms a time-constant circuit that limits the maximum repetition rate of the generator to 40 Kc.

A negative pulse from the blocking oscillator drives the base of output emitter follower, Q_3. The primary winding of step-up transformer T_2 forms the emitter load; the secondary is left floating so that either polarity pulse is available. Resistors R_2 and R_3 prevent damage if the output is short-circuited.

Although transistors can be pulsed to high currents if their gain and thermal time constants are satisfactory, these characteristics are not listed on the specification sheets and can be determined only by experiment. Tests indicated that approximately 70 percent of RCA 2N645 and RCA TA-1830 transistors will handle the 1-ampere pulse current in the output transformer primary. Those transistors that will not operate satisfactorily in the emitter-follower circuit are used in the two preceding stages. The generator output pulse is shown in the oscillograph traces.

The pulse generator will operate when triggered with an input of 5 volts or more and the circuit can be arranged to accept either a positive or negative trigger. Rise time of the trigger must be greater than 2 volt/μsec. Output to a 90-ohm load is an isolated pulse 1 μsec wide, $\pm$0.4 μsec, rise and fall times of 0.2 μsec, less than 10-percent droop with 90-ohm load and less than 5-percent overshoot on open circuit. Maximum repetition rate is 40 Kc.

The final circuit was packaged in two forms, one version for plugging into sockets typical of vacuum tube circuits, and one version on the flat plug-in boards typical of transistor circuits.

Reflex Klystron Amplifiers

WITH HYBRID T COUPLING

Hybrid T coupling improves gain and linearity of one-port amplifiers

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SOME of the disadvantages of reflex klystron amplifiers can be overcome with hybrid T coupling. Reflex klystrons when used as regenerative amplifiers[1, 2, 3] are one-port devices, and in this respect they are similar to some types of semiconductor parametric amplifiers and maser amplifiers. Since these devices have only one port, input and output terminals are common and it is necessary in practical circuits to arrange separate input and output terminals, as is shown in Fig. 1.

The poor isolation of input to output means that a considerable portion of the amplified signal returns to the input circuit. The directivity of the amplifier system, which is the ratio of forward to backward power, is low. A similar disadvantage occurs when two or more amplifier stages are cascaded to obtain high gain. Cascading reflex klystron amplifiers also has the disadvantage of saturating the second stage at high input levels. A hybrid T coupled reflex klystron amplifier gives a substantial increase in directivity and allows higher input signals.

A hybrid-T-coupled reflex klystron amplifier is shown in the photograph. Two reflex klystrong amplifiers are coupled by a hybrid T and a variable phase shifter; the reflex klystron tubes are mounted in the individual boxes. The reflex klystron amplifier at the left, with a phase shifter ahead of it, is connected to one of the colinear arms of the hybrid T and the right-hand amplifier is connected directly to the second arm of the T. The other end of each of the reflex klystron amplifiers is terminated by a shorting plunger, as shown in the photograph. The H-plane arm of the hybrid T was the input and E-plane arm was the output of the hybrid-T-coupled amplifier.

Operating principle of the hybrid-T-coupled reflex klystron amplifier is similar to Autler's proposal for a maser amplifier[4]. If the hybrid T is perfectly matched and the system is adjusted so that the output powers from the two amplifiers at the junction of the hybrid T are equal but opposite in phase, then the amplified power will appear only at the E-plane arm due to the inherent charactertistics of the hybrid T. Hence, if the input signals are fed into the H-plane arm to excite both amplifier tubes, one way amplification is possible. Therefore, the hybrid-T-coupled reflex klystron amplifier is efficient because of good directivity. Since in this arrangement the tubes are connected in parallel to the input circuit, saturation of the individual amplifiers will not be as serious as in the cascaded amplifier.

To realize the proper operation of the hybrid-T-coupled reflex klystron amplifier, the individual amplifier units must work under one-port amplifier conditions. The amplifier and phase shifter in the left arm of the hybrid T was replaced by a reflectionless termination and the right-hand amplifier alone was tested.

Maximum gain of 20 db at 9,355 Mc was obtained as shown in Fig. 2A. Next the termination was removed, the left-hand amplifier with its phase shifter reconnected to the T, and tested with the right-hand amplifier inoperative. A maximum gain of 20 db was also obtained for the left-hand amplifier as shown in Fig. 2B.

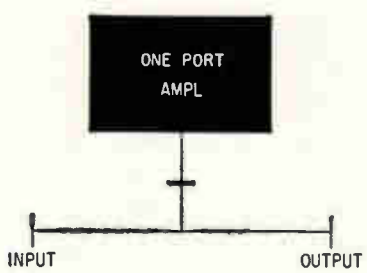


FIG. 1—Separation of input and output in a one-port device

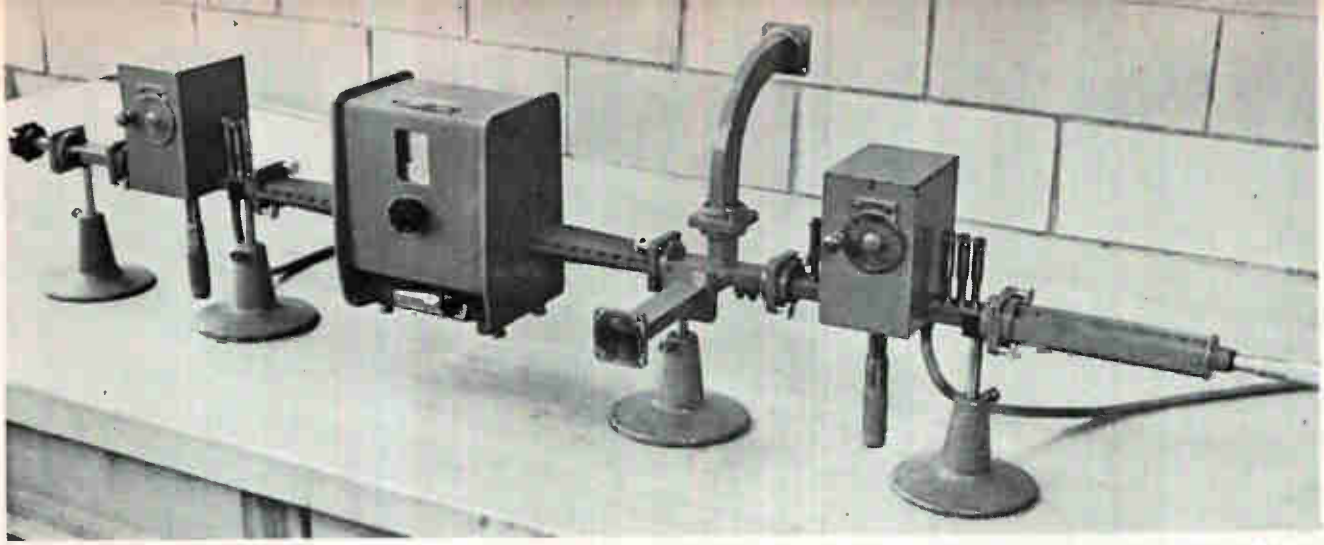
The frequency characteristics of the hybrid-T-coupled amplifier is shown in Fig. 2C. A gain of 30 db and a frequency bandwidth of 2.8 Mc were obtained at a center frequency of 9,358 Mc. The maximum gain was higher than that of either one of the two individual amplifier units. When the gain was readjusted to 35 db at 9,362 Mc, the bandwidth was 1.4 Mc.

Linearity of this amplifier is shown in Fig. 3A, which also shows that the amplifier does not saturate at relatively high input signal levels. On the other hand, a direct-coupled cascaded reflex klystron amplifier starts to saturate at an input level of −85 dbm and an isolator-coupled cascaded reflex klystron amplifier starts to saturate at the input level of −80 dbm.

A phase characteristic of the hybrid-T-coupled amplifier is shown in Fig. 3B. The phase margin of 15 degrees keeps gain variation within 3 db of the optimum and is larger than the phase margin (4 degrees) of the phase-shifter-coupled cascaded amplifier.

Gain versus repeller voltage is shown in Fig. 3C, with repeller voltage of one of the two amplifiers as a reference. Repeller voltage margin which keeps the gain within 3 db of the optimum is one volt.

A directivity of 3 db was obtained when the gain was 20 db. When the circuit was readjusted carefully to obtain the gain of 35 db, the directivity was 7 db. These values were not as high as expected.



Two reflex klystron regenerative amplifiers are coupled in hybrid T circuit. Phase shifter is used to obtain the optimum phase relationships in the T coupling

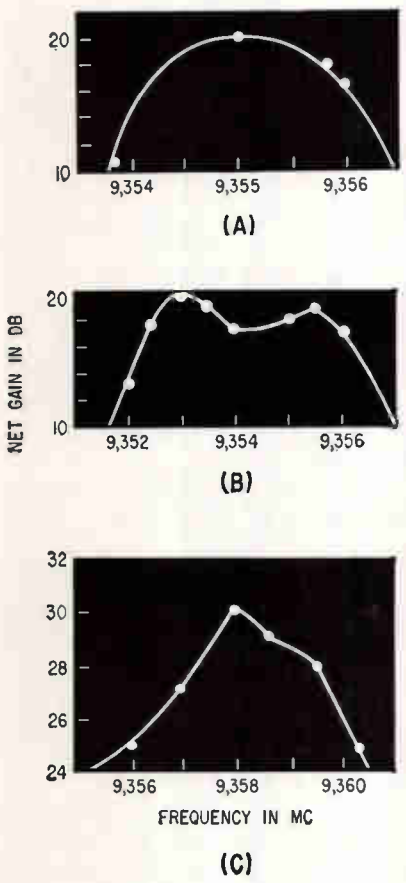


FIG. 2—Gain of the individual circuits (A) and (B); gain of the hybrid-T-coupled amplifier (C)

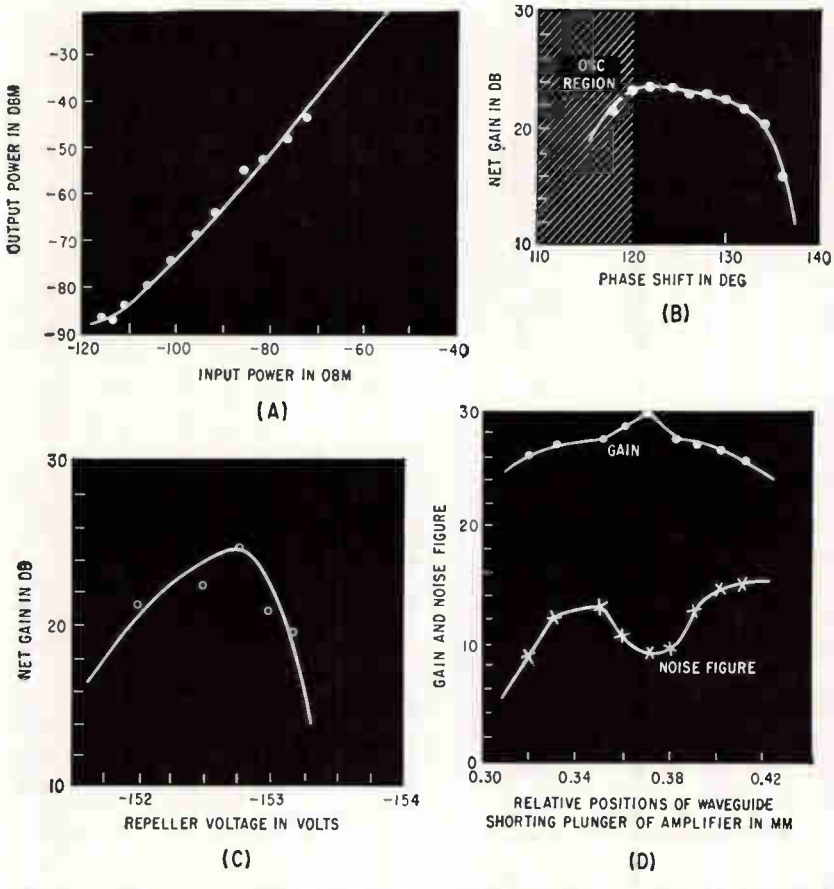


FIG. 3—Power input to hybrid-T-coupled amplifier can be higher than with cascaded amplifiers (A). Phase characteristic (B); repeller voltage characteristics (C); gain and noise figures (D)

Noise measurements are shown in Fig. 3D. The noise figure is comparable to that of cascaded reflex klystron amplifiers. For these measurements, the hybrid-T-coupled amplifier was adjusted for maximum gain of 30 db.

The stability test of the hybrid-T-coupled amplifier showed that the average gain fluctuation over a 10-minute period was 0.125 db—stability that is comparable to that of the phase-shifter-coupled cascaded reflex klystron amplifier.

Several conclusions can be made about the hybrid-T-coupled amplifier. The directivity of the hybrid-T-coupled amplifier, 7 db, is greater than that of the single-stage reflex klystron amplifier, which is at most 2.5 db. The linearity of the hybrid-T-coupled amplifier, at relatively high input signal levels, is better than that of cascaded reflex klystron amplifiers.

The author extends his thanks to E. H. Scheibe, University of Wisconsin, and L. Heiting, J. Tsui, S. Krupnik and J. D. Horgan, Marquette University.

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Instrumentation For Plasma

Use of plasma as a means of propelling vehicles through space appears promising. Creating and investigating plasmas in the lab require unique instrumentation to get data

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A PLASMA IS A COLLECTION of ions, free electrons and atoms in a very highly excited state (sometimes referred to as high temperature). The energy of the electrons and ions is high enough to preclude recombination at the instant being considered. The atoms present are those that have not received enough energy to be ionized.

If the supply of energy producing ionization is stopped, the ions and electrons will lose momentum, and thus energy, by colliding with each other. After a certain loss of energy, recombination of electrons and ions takes place. The electrons return into their proper orbits by stages. At each stage the energy added to break loose an electron is released in the form of light. The light emitted by each element has a unique wavelength for each of its stages of recombination, and it is this light that appears as spectral lines.

Energy placed into a plasma is soon lost due to a variety of reasons and as large amounts of energy are required to produce a highly ionized plasma, it is difficult to sustain the energy supply for extended periods. Consequently, a high-energy plasma generally exists only for a short time.

Incidentally, it is with the problem of sustaining a plasma in a highly excited state that thermonuclear experimenters have been so concerned in the past. The present trend seems to be towards the use of plasma accelerators combined with strong magnetic focusing fields.

There are several methods of producing a plasma and accelerating it. The method to be described, originated some little time ago by A. E. Kunen, is a simple adaptation of the well-known linear pinch.

In the usual linear pinch, two circular plane electrodes are placed facing each other, a certain distance apart, to form the ends of a vacuum chamber, as shown in Fig. 1. (An insulator forms the walls of the chamber.) A gas is then introduced into the chamber and maintained at a pressure of a few mm Hg. A high electric potential whose magnitude depends upon the electrode spacing, the type of gas and its pressure, is placed across the electrodes; breakdown occurs in the gas and then a pinch is formed.

The mechanism by which a pinch is formed and then proceeds is not absolutely clear, but one explanation follows.

At the start of the ionization process, a Townsend shower is formed. In this, a free electron is accelerated towards an electrode by the voltage differential. As it moves, it collides with other atoms, knocking out more electrons and developing into a chain reaction to produce a shower of electrons. This shower develops into a glow condition across the electrode space, which allows an increased current to flow.

Because of skin effect, the increasing current is initially confined to a relatively thin skin at the outer periphery of the gas between the electrodes. In the skin area, the opposing flow of electrons and ions causes many collisions, thus ionizing additional atoms to form even more ions and electrons. The energy level, or temperature, of the particles in this area is raised tremendously. The flow of charged particles gives rise to magnetic fields which interact with the moving particles, causing them to be driven towards the center of the cylindrical chamber. This inward motion of the skin or current-carrying "magnetic piston" takes place at very high speed, in the order of tens of thousands of meters per second. This motion produces shock waves which increase the particle collision, thereby raising the temperature of the gas to still higher values.

In Republic's propulsion system, this pinching is literally turned to better advantages.[1, 2] In this system, the linear pinch electrodes are altered so that the pinch, instead of closing in on itself, is gradually directed through an opening in the center of one of the electrodes. Thus, the pinch produces a thrust directed along the centerline of the pinch chamber. If the pinch is repeated again and again, a pulsating thrust is obtained.

The basic feasibility of this device has been proven in the experimental engine shown in Fig. 2. This engine has produced thrusts which indicate that the application of such an engine to space-vehicle propulsion would be quite practical. The engine has run continuously for long periods, over 100 hours, with no trouble and little or no erosion of the electrodes. There is every indication that after only a relatively short development time such an engine could be produced for use in a satellite or even an interplanetary vehicle.

To produce a plasma and form a pinch, one of the basic requirements appears to be a very high rate of current rise. In producing a plasma, a large amount of energy, running into many thousands of joules, is fed into the gas in a few microseconds. The usual method used to achieve this is to charge up a bank of capacitors to the thousands of volts required to produce breakdown, then discharge the bank into the gas between the electrodes.

An interesting sidelight is that the spark gap switches often used

Propulsion

in plasma-producing experiments may be a direct contributor to a good experiment. The spark switch is usually placed quite close to the pinch chamber and by its proximity induces a low level of preionization in the chamber. If the switch is not close to the chamber or a non-sparking type switch is used, difficulty may be experienced in obtaining good or consistent results.

To obtain the high current rise and complete discharge in a short time, the circuits must be designed for small inductance, usually measured in nanohenries for the entire system. The capacitors are placed close to the pinch chamber and are arranged symmetrically, so that the connection from each is short and the same length as the others. This is done to ensure discharge of all capacitors at the same time; otherwise, one capacitor might receive the discharge from the rest of the bank if it got out of step due to different inductance value, resulting in a different ringing frequency.

Coaxial cables are often used to connect the capacitors to the pinch chamber. Although theoretically not as good as strip or plate transmission lines, the cables are more flexible for rearrangement or access and maintenance. The switching system that holds and fires these experiments is a system of gas triggering which has made extended trouble-free running possible.

Instrumentation is required to obtain data to determine the thrust produced; data include the mass of the efflux compared to the mass supplied and the condition of the ejected mass (temperature, ionization, density distribution, and others). In experimental engines the average thrust is often small, but each pulse gives a high force lasting for an extremely short time. The temperature of the plasma can be tens of thousands of degrees and

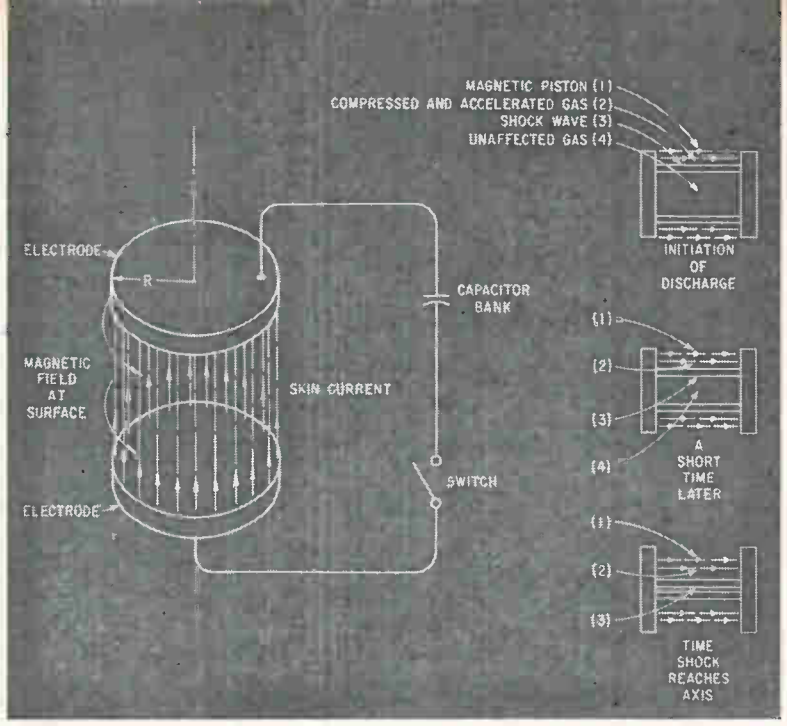

FIG. 1—Linear pinch-producing arrangement

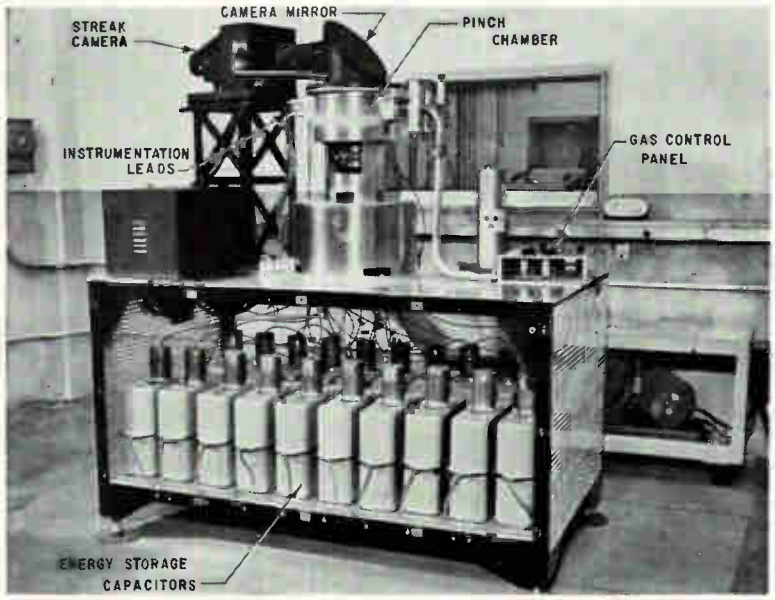

FIG. 2—Experimental setup for plasma production and measurement

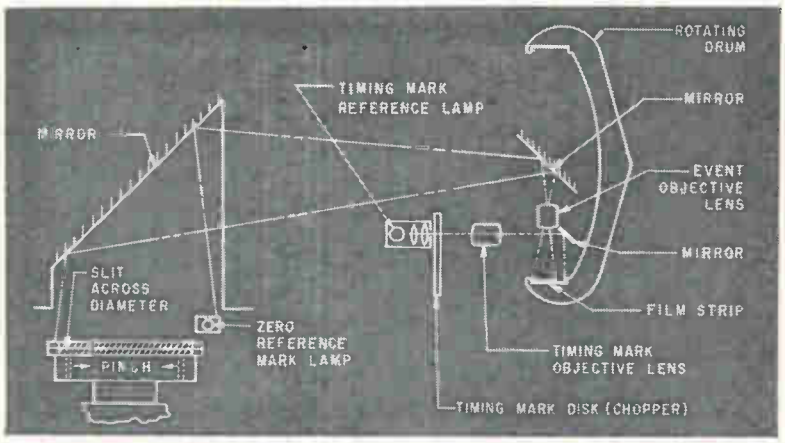

FIG. 3—Streak photography system

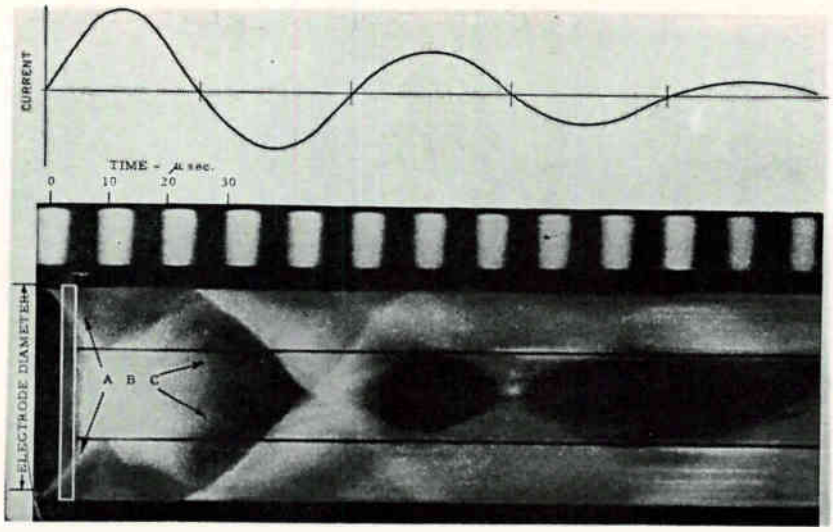

FIG. 4—Letter indications on streak photo point out: motion of magnetic piston during first pinch (A); compressed ionized gas (B); expanding de-ionized gas (C). The 5.5-μsec blip is just above, slightly to right, of oblong

the plasma can often last for only a few microseconds.

Thrust is one of the fundamental pieces of data required but is often difficult to determine. One typical engine configuration can give a force of 8,000 pounds lasting for only half a microsecond—how can this be measured?

One method is to place piezoelectric crystals behind a freely suspended pinch chamber, then to measure the output of the crystals on deflection. A difficulty immediately arises in calibrating the crystals and supporting structure for what is a ballistic condition with small movements. Another method is to mount the pinch chamber as a pendulum of long period. The thrust can be obtained from the displacement of the pendulum; if the configuration is well chosen, the pendulum can give rise to relatively large movements which can be accurately determined.

To measure velocity, photomultiplier tubes may be used to detect the motion of the highly luminous plasma. Two tubes are spaced a short distance apart looking from the side into the axis of the efflux. They are masked to see only a narrow portion of the plasma. As the plasma is ejected, first one tube, then the other, sees the ionized gas, thus giving the time interval between the arrival at two points.

Space-vehicle engines may be required to operate continuously for many months. In many systems of electric propulsion, the erosion of the electrode is an important factor that may affect the life of the engine. The ablated electrode material may increase the thrust of the engine by increasing the mass ejected; in fact, some systems propose the electrode be used as the main propellant. In most systems, however, the erosion of the electrode is detrimental and in many systems it is a real problem. With the method being described, the electrode erosion is so small that it is practically non-existent.

One method of determining the amount of electrode material ejected is to place a cup over the nozzle of the pinch chamber, and fire the engine a number of times. If the cup is now irradiated in an atomic pile, analysis of the radioactive sample gives the type and the amount of material present to a high degree of accuracy. This form of analysis, known as neutron activation analysis, may determine electrode erosion quite accurately in relatively short experimental runs. An alternative is to determine the loss of material by weighing the electrodes before and after a run. This would be a long and tedious method of comparing materials and shapes if, as in the system being described, a hundred hours continuous run results in only a small fraction-of-a-pound of electrode erosion.

The condition of the plasma may be analyzed by spectroscopy, the different positions and widths of the spectral lines giving the degree of ionization of the gas atoms and the percentage of the gas at each degree. However, in some experiments the luminosity of the spectrum can be so low or the plasma duration so short that a photographic record is difficult to obtain. Repeated exposures are not necessarily a good solution to this, as the exact reproducibility of a plasma is questionable. Analysis may still be carried out, however, by using photomultiplier tubes to record the intensity of the spectral lines.

Another method of analyzing the ionized population of a plasma is to use a form of mass spectroscopy. A magnetic field placed across the ejected plasma will cause deflection of particles, depending on their charge, mass and speed. A variation on this method is to place plates in front of the efflux; by varying the charge and voltage on these plates, the potential required to stop various particles may be obtained, thus providing additional valuable data on plasma.

One of the first pieces of instrumentation developed for these experiments is a high speed streak camera. This camera takes photographs of the pinch process.

In the particular experiments that were photographed by the streak camera, the speed of the magnetic piston was expected to range from 17,000 to 45,000 meters per second. The shock in the gas ahead of the pinch ionizes the gas, and the area between the shock and the piston was expected to be intensely luminous; but the brightness could not be predicted with any accuracy. The piston was to move over a 4-inch radius and so would be present for only 2 to 8 μsec. The system evolved and used to photograph the experiments is shown in Fig. 3.

The series of experiments was on the ordinary linear pinch, as shown in Fig. 1. For the photography, a diametrical slit, 0.05-inch wide, was cut in the upper electrode, then covered with glass. This gave a view looking axially down into the pinch chamber. By means of the system of mirrors and lenses shown in Fig. 3, the view through this slit was projected onto a strip of movie film carried on the inside surface of a drum. The drum was rotated at about 30,000 rpm, the pinch fired and the streak recorded on the film.

A photograph obtained in this manner is shown in Fig. 4. Above the photo is a diagram of current wave form, taken from the supply cable very close to one electrode.

In the photograph, time is shown horizontally and the motion of the luminosity, seen through the 0.05-inch slit in the electrode, is shown vertically. To more fully explain the photograph, a white oblong section has been added; within this oblong, the area shows what is seen through the photographic slit at one instant in time. The light areas are the ionized portion of the gas, its degree of excitation being indicated by relative brightness. At the instant shown by the oblong, the two light areas are ionized gas between the magnetic piston and the shock wave front. The view is symmetrical about the centerline of the chamber, the two dark lines being produced by markers across the slit, both the same distance from the centerline.

A little earlier than the time indicated by the oblong, the ionized areas are nearer the periphery of the chamber and a little later they are at the center. The edge of the ionized area towards the center is the front of the shock wave ahead of the piston. The edge of the area towards the periphery is the driving portion of the pinch—the magnetic piston.

The photograph as a whole shows a series of pinches, roughly coinciding with each rise in current in the circuit. The bright areas moving out towards the periphery after each pinch, are the reflection of the shock wave from the center high compression area. It will be seen that a pinch forms at each current rise, regardless of the direction of the current. As the ringing out proceeds and the capacitors lose energy, the pinches get slower (indicated by the less steep slope) and the ionization is less.

The brightest area, which is the most highly ionized area, is the portion where the first pinch reaches the center. This is the portion that has been the point of interest for fusion experiments, but the plasma does not remain in this condition for even ten μsec.

The pulses of light, seen above the streak portion, are timing marks. As the speed of the motor driving the film may vary, these marks appear on each film strip to give the time base for the run.

The marks are produced by a flash tube (V_1, Fig. 5A) the light from which is chopped by a glass disk with alternate clear and opaque radial lines. The disk is rotated at constant speed by a synchronous motor to ensure consistent timing marks. The flash tube is pulsed by the discharge of a capacitor at the beginning of each pinch discharge.

A pulse, derived from the first current rise of a pinch discharge, drives the grid of V_2 positive. This causes autotransformer T_1 to develop 30 Kv on the trigger coil around the body of the flash tube. Ionization of the gas in the tube follows, providing a conducting path for the energy stored in the capacitor, whose discharge produces a light flash.

The duration of the flash is dependent on the value of the capacitance and the load resistance. The values shown were found to be optimum for a flash of satisfactory illumination level and duration to span the life of the pinches. However, these values give an appreciable time lag for the tube flash to reach photographic levels, as shown in Fig. 5B.

A second flash tube is therefore triggered by the initial pinch discharge. By using a higher voltage and smaller capacitance and resistance, a light pulse of photographic level is obtained only 5.5 μsec after the pinch initiation. It is a spike type of discharge, which provides a small "blip" of light that can be seen immediately above the beginning of the streak.

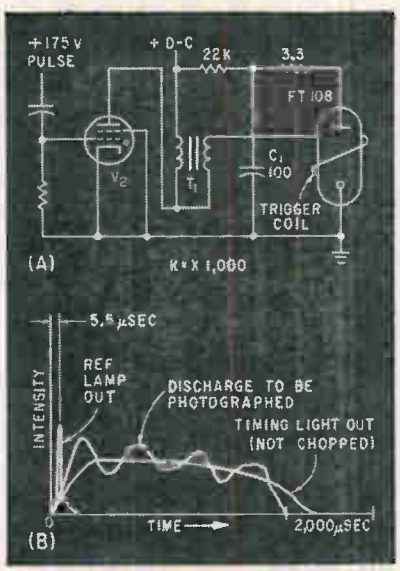

FIG. 5—Flash tube circuit produces timing marks (A). Pip is produced at 5.5 μsec in (B) by another flash tube, which is not shown

The streak camera has been used to monitor the experiments for asymmetry that may be produced by other instrumentation or variation in electrode shapes.

The pictures have confirmed that a pinch effect is being achieved, which is difficult to demonstrate by other instrumentation. In addition, since a space-time record is obtained, the velocities and accelerations throughout the process may be estimated.

As illustrated in the record shown, comparison with the current wave form gives a correlation between the circuit parameters and the initiation and propagation of the pinch process.

The front of the ionized area gives the approximate position of the shock front and the rear roughly locates the magnetic piston; the broadening of the ionization gives the acceleration of the shock ahead of the piston.

The plasma pinch engine, like other systems of electrical propulsion, is essentially a low thrust, long endurance form of propulsion; eminently suitable for long-range or long-term space missions. In one configuration, Republic's pinch engine uses only 0.25 kilogram of propellant a day, demonstrating that even for missions lasting hundreds of days the required propellant supply would not be heavy.

One of our studies shows that a space vehicle of 5,000 pounds payload could be placed in orbit around Mars. Using one of these engines to provide thrust for transfer from an Earth orbit to a Mars orbit, a vehicle of 27,000 pounds would have to be placed in orbit.

Some of the investigations into electric propulsion have been undertaken by Republic Aviation with partial support by the Office of Naval Research under Contract No. NONR-2851(00).

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Pulse Response Pinpoints Armature Faults

Armatures are rotated during test, so that each coil is examined in turn

Production armatures are tested by comparing them with an armature known to be fault-free. Identical current pulses are injected into both armatures, whereupon transient response permits fault diagnosis and location

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RECENT fault-testing methods used in the production of coils, stator windings and small d-c or universal motors compare the voltage transient of a fault-free winding with a similar transient produced by the winding under test. Both windings are excited with identical current pulses and their transients are displayed alternately on a cathode ray tube. A disadvantage of this method is the difficulty of comparing, or detecting small differences between, two transients with large absolute voltages.

The new difference detection technique displays a signal dependant upon the instantaneous difference between these two transients, rather than presenting their absolute values on a crt for visual comparison. By so doing, this new method permits more accurate diagnosis of such faults as mixed leads, wrong number of turns, shorts, opens and grounds. Furthermore, when testing armatures rather than coils, the fault can even be pinpointed to a particular armature slot.

A variable voltage power source simultaneously charges two identical pulsing capacitors during alternate half-cycles of the supply voltage. (They are discharged during the other half-cycle.) One capacitor is charged to a positive voltage with respect to ground, the other is negatively charged. These capacitors are connected to the external circuit by two hydrogen thyratrons, which are triggered simultaneously. A synchronizing capacitor ensures that the thyrotrons fire not more than 0.05 microseconds apart, so that slight phase differences do not lead to erroneous readings.

The bridge circuit of Fig. 1A shows how the difference between voltage transients is observed. A voltage-measuring device, an oscilloscope for example, is connected between ground and the common point of the windings. If both windings have identical characteristics, the output between their center-point and ground will be zero; if the windings differ, due to faults mentioned earlier, then an output, characteristic of that type of fault, will appear. With experience in using the equipment, the shape of the display can quickly be related to the type of fault that causes it.

The circuit diagram of the basic power unit is shown in Fig. 1B. The capacitors C_1 and C_2 are the heart of the circuit and are charged to their peak voltage through the 2X2A rectifiers V_1 and V_2 once every cycle. The 3C45 switching thyratrons V_3 and V_4 connect these charged capacitors to their external load, their firing control being a combination of grid-triggering and anode-cathode interconnection. The

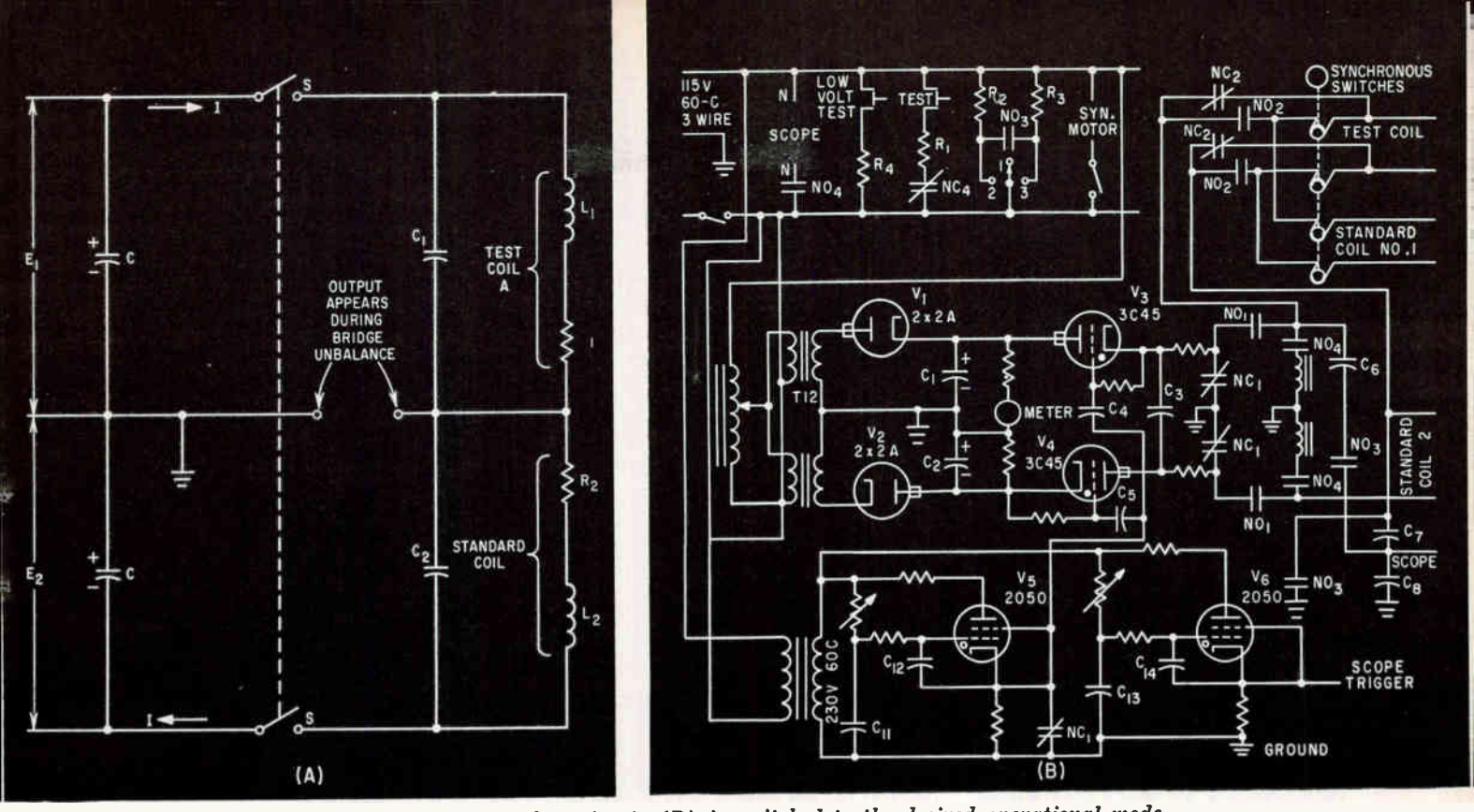

FIG. 1—Basic bridge circuit (A); complete circuit (B) is switched to the desired operational mode

switching thyratron grids are capacitance-coupled to a pulse circuit using a single 2050 control thyratron V_5 supplied from 230 volts, 60 cycles, and which delivers a positive triggering pulse of about 300 volts. Capacitor C_3 synchronizes firing of V_3 and V_4 by causing whichever tube fires first to fire the other tube. This action is successful in synchronizing the two tubes to within 0.05 microsecond.

Both control thyratrons V_3 and V_4 are timed by simple *R-C* phase shift circuits, with the output of tube V_5 firing switching thyratrons V_3 and V_4. The output of V_6 triggers either the sweep circuit of the detector or intensity modulates its beam. Phase shift control permits a fine adjustment between sweep triggering and current discharge so that the trace may be moved or centered on the face of the detector scope. With the intensity modulation application, emphasis of any part of the trace may be obtained. Conventional safety equipment is used for both equipment and operator safety.

For greater flexibility of operation, a selector switch introduces four different modes of operation. Under normal operation, (position 1 of the selector switch), the unit operates with one standard and one test winding and utilizes the bridge connection already described. The detector is capacity-coupled between the common terminals of the standard and test winding and ground, resulting in a single trace that is ideally a straight line if the two windings are identical, and a recognizable trace if some fault is present.

If greater sensitivity is desired, it is possible to introduce a rotating switch that presents alternately on the crt the null trace from two standard windings and then the null trace from a test and a single standard winding. By using this second method, the operator can compare the traces of two sets of coils. Position 2 of the selector switch introduces this comparison method.

A third operating mode is similar to that of the conventional surge unit, wherein the common terminal is grounded and the detector is coupled across the test unit to observe the entire voltage transient. In this case, the rotating switch alternately presents the transients from the standard and test windings.

All three of the above methods require a time base presentation on the oscilloscope and a triggered sweep capable of writing a 50-μsec trace once each sixtieth or thirtieth of a second.

A fourth mode of operation included in the basic power unit provides for a 60-cycle test, which is sometimes required to pick up poor solder connections in a multipath winding. The 60 cycle operation is carried out by use of the basic bridge circuit, substituting a 60 cycle voltage for the capacitors and thyratrons. The same detector may be used without further sweep adjustment and gives a straight line trace that is moved off-center when an open or bad connection upsets the balance. The trace is actually a sine wave, but the short period observed is near the crest of the wave and is essentially linear for the few microseconds that the wave is displayed.

An alternate method of fault detection uses the principle of Lissajous patterns. This technique has the advantage of requiring no special scope capabilities other than a reasonably high accelerating potential for fast writing rate.

Contact to the armature is made with tungsten-tipped electrodes, spring loaded to maintain their contact with the commutator bars much the same as carbon brushes. The tip of the electrode is pointed, or knife-edged, and makes definite

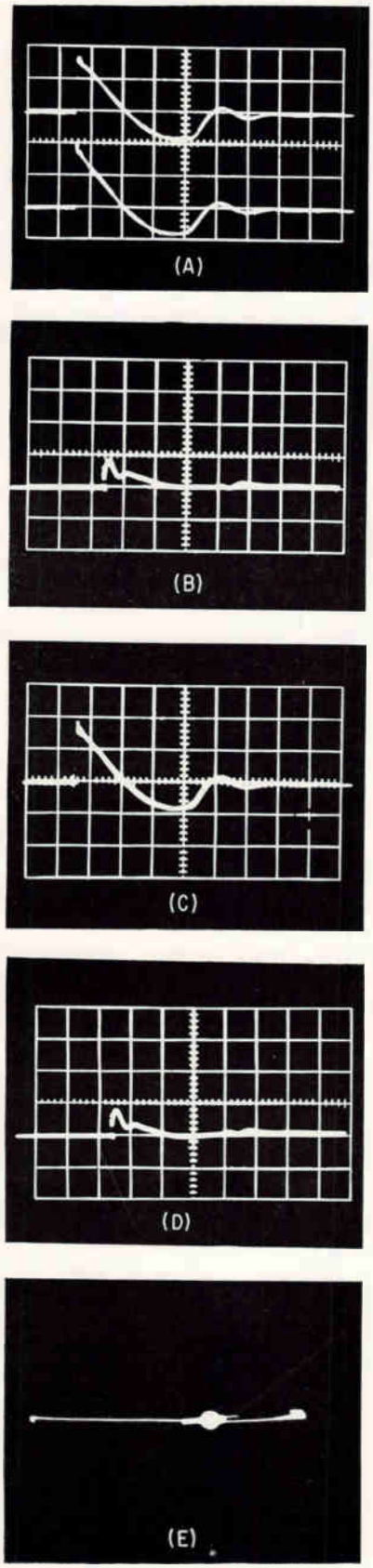

FIG. 2—Results of bridge test show absolute waveform displays (A); the two waveforms superimposed (B); difference between the waveforms (C) reference trace produced by two fault-free coils (D), Lissajous type of display (E)

contact with one bar at a time. The span between the two contact electrodes may be varied from a single gap between two adjacent bars, to approximately one-half the winding with the electrodes in the 180-degree position. It is desirable to test all points of the winding as quickly and as uniformly as possible. The armature is supported in a fixture that rotates the armature and completes a full turn in a fraction of a second while simultaneously subjecting each bar of the commutator to the test impulse. The sensitivity of the unit is such that it is possible to span 120 to 180 degrees of the commutator and still easily observe any construction fault.

The reference armature is not rotated, but has a fixed connection made to the commutator at the chosen interval of 120 to 180 degrees. Thus, although a slight fluctuation of the picture takes place as the test unit is rotated, the picture remains reasonably fixed and a complete rotation can be made in a fraction of a second while observations are being made. Since the common electrode of the two windings operates at or near ground, one point on the test winding is always at or near ground. As the commutator is rotated, this point moves around the winding as does the high-voltage electrode. Thus, each bar of the commutator is subjected to the peak test voltage with respect to ground. If the frame of the armature is grounded, this serves as a ground test as well. Location of the fault may be easily determined by its proximity to a commutator bar, since the magnitude of the fault indication will vary with respect to the location of the high-voltage electrode on the commutator.

The versatility of this power unit has made it possible to compare the various methods of exciting the test winding and the different techniques of detection. Figures 2A through 2D are actual photographs showing the results of the different test methods and detection schemes.

The voltage transients of the test and standard winding are shown separately in Fig. 2A and superimposed in Fig. 2B. Figure 2C shows the null pattern obtained by the bridge method on a considerably expanded scale. Figure 2D shows two superimposed traces contrasting the two standard windings and the test and standard windings. Figure 2E is the trace obtained using the Lissajous technique. Although both bridge and Lissajou detection methods have advantages over simple observation of the entire voltage transient, for certain applications it is useful to be able to observe the actual waveshape.

Experimental results with the basic power unit have proven without question its ability to produce the necessary simultaneous discharges. The auxiliary equipment of rotating switch and low voltage test may or may not be included on a particular unit depending upon its use. In general these added features add complexity and create sources of trouble. This has been particularly true of the rotating switch and is often a cause of complaints. It is difficult to choose at this time between the two null detection methods as each has its own particular advantages. Cost and operator reluctance to change might be considered as important as any other factor in determining the choice.

The author wishes to express his sincere appreciation to The Robbins and Myers Co., Inc., Springfield, Ohio, and particularly to T. C. Lloyd and H. Karr for their interest and cooperation during the development of this unit, and for making possible the test results and circuit diagrams of the power unit, which is covered by U. S. patents granted and pending.

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CIRCLE DIAGRAMS FOR Impedance Matching

Graphical methods are applied here to matching transmitter to antenna

By AL HORVATH
Laboratorio De Radio-Ingenieria,
Quito, Ecuador

EACH TRANSMITTING antenna tower usually differs enough from other towers to require special feeder matching and antenna tuning networks. Graphical methods of network design are sufficiently accurate that standard value components can be selected and delivered to the tower site with assurance that the resulting circuit will be within the fine tuning range of variable elements.

In practical cases the problem breaks down into two parts: tuning or matching the transmitter output to the feeder, then matching the feeder to the antenna. The block diagram is shown in Fig. 1A.

First step is to measure the antenna reactance and resistance, then select the best feeder.

The circle diagram will be explained through the following practical problem. The transmitter is to deliver 500 w at 920 kc; $E_b = 1{,}600$ v d-c; $I_b = 0.42$ a d-c; efficiency approximately 75 percent. Allowing 10 percent residual d-c plate voltage gives 1,440 v maximum peak, equivalent to E_p (*rms*) = 1,000 v. Consequently $I_p = 500/1{,}000 = 0.5$ a, $Z_p = E_p/I_p = 2{,}000$ ohms.

In the circuit diagram, Fig. 1B, the effect of the shunt feed r-f choke is disregarded but plate to filament capacitance is considered as part of C_p.

To develop the circle diagram, (Fig. 1), let $Q = 10$. Then $X_{cp} = Z_p/Q = 200$ and $I_{cp} = Q \times I_p = 5$ a. Output to a 52 ohm is $E_o = 161.5$ v and $I_o = 3.1$ a.

Scales for voltage and current vectors are selected to give a fair size diagram, taking into consideration that the maximum current vector will be approximately 20 times I_p. Mark the E_o and I_o vectors, then draw circles with radii of the scaler values of E_p and I_p vectors. Draw the circle of the scaler value of the I_{cp} vector for $Q = 10$. Erect a perpendicular at the end of I_o to intersect the I_{cp} circle. The I_{co} vector leads its voltage vector E_o by 90 degrees. Vector sum of I_o and I_{co} is I_L.

Next step is to draw the volt-

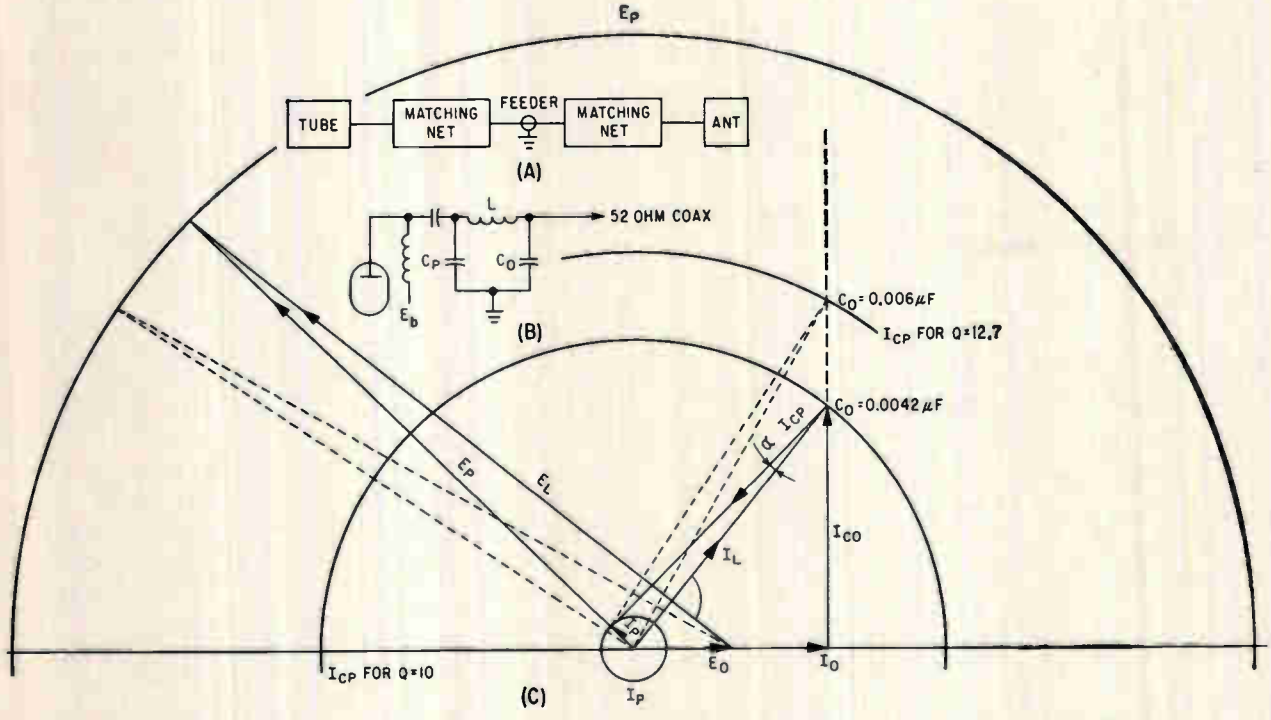

FIG. 1—General load matching problem is shown in (A); π tank circuit in (B). Scales for the circle diagram are chosen as convenient, such as 1 mm per amp; 1 mm per 100 volts, etc. The above diagram, and others in this article, were originally drawn to some such scale but are here scaled down arbitrarily

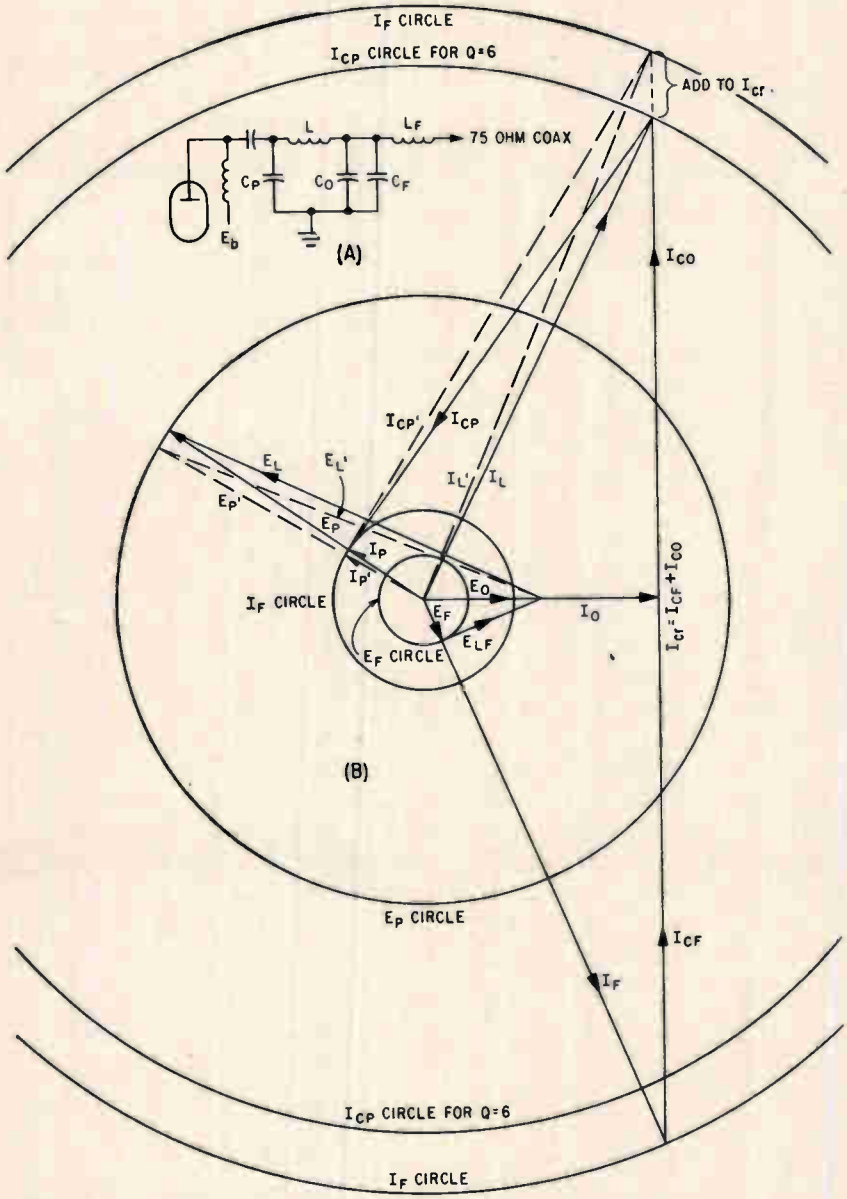

FIG. 2—Impedance step-down ratio from plate to coax of 45.07 is accomplished in two steps of 6.71 to 1. Circuit values are adjusted to give a standard value component for the single capacitor that will be used for $C_o + C_f$

age vector E_L, the voltage across the tank inductance. Vector E_L will lead I_L by 90 degrees and the vector sum of E_o and E_L must equal the E_p vector. From the end of E_o draw a perpendicular to the I_L vector to intersect the E_p circle and draw in the E_p vector. This E_p vector intersects the I_p circle, determining the position of the I_p vector, which must be in phase with the E_p vector. The diagram also proves that there are no errors; the vector sum of I_L and I_{cp} must equal I_p, and I_{cp} must lead E_p by 90 degrees. Draw I_{cp}, which must intersect E_p at the end of I_p.

The working angle a is present because of losses. This angle is small and since $(I_{cp}| = |I_L| \times \cos_a$, $|I_{cp}| \cong |I_L|$.

Reactances could be determined but it is desirable to check C_o. From E_o and I_{co} C_o is 0.0042 μf. Since I_{co} is directly proportional to C_o, a standard 0.006 μf capacitor gives the results shown by the dashed line.

Since I_L is directly proportional to the Q of the circuit, the new C_o gives a Q of 12.7. If this is satisfactory, draw in the new vectors (dashed lines), and establish the reactances, voltages and currents under idle carrier condition: $X_L = E_L/I_L$; $X_{Cp} = E_p/I_{cp}$; $X_{Co} = E_o/I_{co}$. Safety factors are added to component specifications for modulation and possible surge and that diagram shows least possible value of Q.

For high power and high impedance transformations, the circuit of Fig. 2A is often used. Added to the basic π tank are C_f and L_f, which form a low-pass transformer towards the 75-ohm coaxial feeder. In practice C_o and C_f will be one component.

The transmitter has the following operating conditions. Frequency is 1,000 Kc; d-c (unmodulated) plate voltage E_b = 20,000 v; d-c (unmodulated) plate current I_b = 3.15 a; d-c power input is 63 Kw. For an efficiency of 79.5 percent, power output is 50 Kw. Reserving 8 per cent d-c plate voltage for maximum plate voltage swing, E_{max} = 18,400 v. Effective rms r-f plate voltage will be 13,000 v; rms r-f plate current, 3.85 a. Impedance, looking towards the plate-filament of the tube, $Z_p = E_p/I_p$ = 3,380 ohms.

With a 75-ohm feeder, the transformation ratio is 3,380/75 = 45.07. Two downward transformations, each 6.71 to 1, the square root of 45.07, will match tube to coax. Tank load is assumed to be 3,380/6.71 = 504 ohms, in parallel with C_o. To limit circulating curents, choose a relatively low Q of 6. Then $I_{cp} = Q \times I_p$ = 23.1 a. Assuming no loss in the tank, I_o = 9.96 a and E_o = 5,020 v.

Construct the first part of the circle diagram for the C_p L C_o circuit with the 504-ohm load,

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Fig. 2. Raise a perpendicular from I_o to the I_{cp}, (for $Q = 6$) circle. Draw I_L; draw E_L perpendicular to I_L, to intercept the E_p circle. This point determines E_p and I_p; I_p must be in phase with E_p. To check, draw I_{cp}, which must lead its voltage E_p and be tangent to the I_p circle.

Current and voltage to the 75-ohm feeder are calculated: I_f = 25.8 a and E_f = 1,937 v. Draw the E_f and I_f circles. The vector sum of I_f and I_{cf} must equal I_o, which is the input current to the C_f L_f part of the network. Also I_{cf} must lead E_o, which is the input voltage to C_f L_f. Draw a perpendicular from the end of I_o to intersect the I_f circle and thus obtain I_{cf} and I_f. The voltage across L_f, E_{Lf}, must lead its current and the vector sum of E_f and E_{Lf} must equal E_o. Current I_{cf} and I_{co} add arithmetically and the sum is directly proportional to $C_r = C_o + C_f$. Since $I_L \cong I_{cp}$, $I_{cr} = (I_{cp}^2 - I_o^2)^{\frac{1}{2}} + (I_f^2 - I_o^2)^{\frac{1}{2}}$ = 44.7 a and C_r = 1,418 pf.

Assume a standard 1,500 pf capacitor measures 1,510 pf. Since I_{cr} is directly proportional to C_r, change the circle diagram (as indicated by dashed lines) for the new value of C_r. Final circuit values are then: Q' = 6.675, C_p = 315 pf, L = 108 μH, L_f = 28.6 μH. After being cold-tuned by a bridge, only fine tuning, chiefly in C_p, will be required at the antenna site.

The second part of the tuning problem is to match the feeder line to the actual antenna. Except for directional arrays, the two reactance network shown in Fig. 3A will always tune the antenna, providing the radiation resistance is lower than the impedance of the feeder. If the radiation resistance is higher, the shunt element is placed across the antenna to obtain an upward transformation of impedance.

Returning to the first example of a 500-w transmitter feeding a 52 ohm coax, the signal to the cable was found to be 161.5 v and 3.1 a. Assuming a lossless feeder,

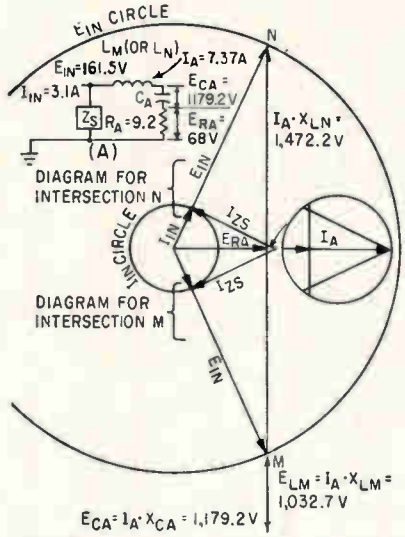

FIG. 3—Two networks are found that will match the feeder to the antenna. The circuit for the M point has practical advantages over the N point circuit

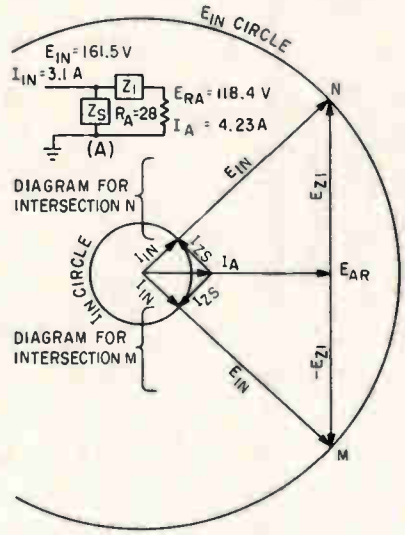

FIG. 4—Circle diagram for matching a feeder to an antenna that is a pure resistance

this same signal is applied to the antenna tuning network. Assume measured antenna impedance is R_a = 9.2 ohms and capacitance reactance is $-jX_{ca}$ = 160 ohms. For 500 w output, antenna current and voltage will be as shown in Fig. 3A.

The circle diagram is set up as shown in Fig. 3. Because of the scales used, the E_{RA} and I_A vectors are nearly the same length but they should not be confused. The E_{in} circle represents 161.5 v and the E_{CA} vector of 1,179.2 will be very large if it is shown.

However the same current I_A is passing through the inductance L_u (or L_N) and will produce a voltage opposite in phase to the voltage across X_{ca}. The resulting voltage must be 161.5 v, the output of the feeder. The perpendicular to E_{RA} intersects the E_{in} circle at points M and N. At M the inductance voltage will be 1,179.2 v less the voltage from the end of E_{RA} to M. Mathematically this voltage is $(E_{in}^2 - E_{RA}^2)^{\frac{1}{2}}$. For intersection N the inductance voltage will be 1,179.2 + $2(E_{in}^2 - E_{RA}^2)^{\frac{1}{2}}$.

Thus, for intersection M the voltage vector will be 1,032.7 v; for intersection N, 1,472.2 v. The line from point M to the center gives E_{in} and I_{in}, since they are in phase. Current I_{Z_M} is perpendicular to E_{in}; the vector sum of I_A and I_{Z_M} must equal I_{in}. Since I_{Z_M} lags E_{in} (for M), the shunt element will be inductance.

For the alternative network of intersection N, I_{Z_N} leads E_{in} and Z_N is a capacitor.

If sufficient harmonic attenuation has been obtained at the plate tank, the M network is preferred because the series inductance is smaller, cheaper and stores less energy, while the shunt inductance is an effective static drain. Thus $X_{Z_M} = E_{in}/I_{Z_M}$ = 161.5/6.7 = 24.1 ohm; $X_{LM} = E_{LM}/I_A$ = 1,032.7/7.37 = 140 ohm. For the N network, X_{Z_N} has the same magnitude but is capacitive and X_{LN} = 200 ohm.

A special case, shown in Fig. 4, is an antenna with resistance but no reactance. The M network, for the same 500 w transmitter, is a series capacitor and a shunt inductance. It is thus a high-pass filter and is discarded because it favors harmonic radiation. The N network for this case is a low-pass filter with excellent harmonic suppression characteristics.

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Dielectric Absorption In Capacitors

By H. L. ARMSTRONG, Queen's University, Kingston, Ontario, Canada

VARIOUS dielectric materials are in common use, and paper shows far more absorption than the others.[1] For instance, mica shows about one tenth the absorption effect that paper does, and, polystyrene about one tenth of that. Thus in paper capacitors the effects are likely to be important.

The two graphs show a few of the observations about the behavior of absorption. A typical paper capacitor was discharged on short circuit for some time, then connected to a voltage supply, and left connected for a soak time ranging from one to about 300 seconds. During this time the charge soaked in. Then the capacitor was quickly discharged, and allowed to sit on open circuit for one minute. During this minute, the absorbed charge became free. At the end of the minute, the capacitor was discharged through a ballistic galvanometer, and the amount of charge which had been absorbed found from the ballistic deflection.

Figure 1A shows the absorbed charge as a percent of total charge, that is, of the charge on the capacitor for voltage equal to the voltage at which the capacitor was let soak. The applied voltage has very little effect on *percent* of charge absorbed, except perhaps at very low voltages. About half the absorption is completed in two or three seconds, but to complete the other half takes hundreds of seconds.

The data of Fig. 1A were taken at room temperature, about 23 C. In Figure 1B, the behavior for various temperatures is shown. Here the applied voltage was always 10 volts. Both the amount of charge absorbed and the rate of absorption increase with increasing temperature.

Speculating briefly on the mechanism involved, it is suggested that these dielectrics contain a certain number of polar molecules. These dipoles are initially oriented at random. When voltage is applied to the

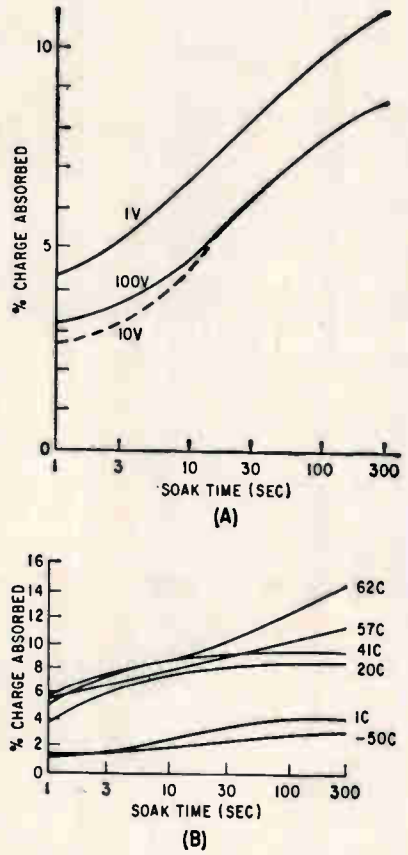

FIG. 1—Percent of charge absorbed as a function of soak time for: (A) different voltages and (B) different temperatures at 10 v

capacitor, the dipoles begin to align themselves under the effect of the field, but, because of the effect of viscous friction, can do so only slowly. When the field is removed, they return to random orientation, and in so doing set free the absorbed charge. On this basis one would expect the action to be quicker at higher temperatures, for the viscosity should be smaller.

These experiments suggest one thing which should be investigated. At room temperature some dielectrics show very little absorption. If, however, their absorption increases with increasing temperature, it could be that at higher temperatures they are just as bad as paper at room temperature. This should be investigated. Also of interest is the matter of electrets, and whether their behavior is an extreme case of dielectric absorption.

The arrangement used for taking the data was set up by Professor Watson of the Physics Department of the University, and is used regularly in an undergraduate course.

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Electronic Ataxiameter

By H. E. GUTTMANN
Heavy Military Electronics Dept., General Electric, Syracuse, N. Y.

MEASUREMENT of involuntary bodily movement (ataxia) is of interest in numerous psychological studies, as well as in studies of anoxia, drug effects, alcohol effects and others. Although physical stability is a relatively gross function, the currently available devices impose an objectionable amount of restraint upon the subject. One widely-used method has a string fastened to the subject's forehead, moving a pen through a series of pulleys. The varying tension of the string tends to cue the subject to his movements, thus impairing the validity of the measurement. The device to be described is entirely free of such back-action, and is sensitive enough to register even wrist-flexions of an otherwise immobile subject.

Figure 1 shows a cross-section

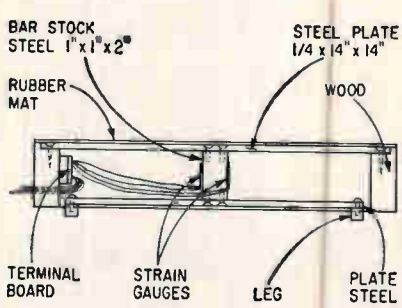
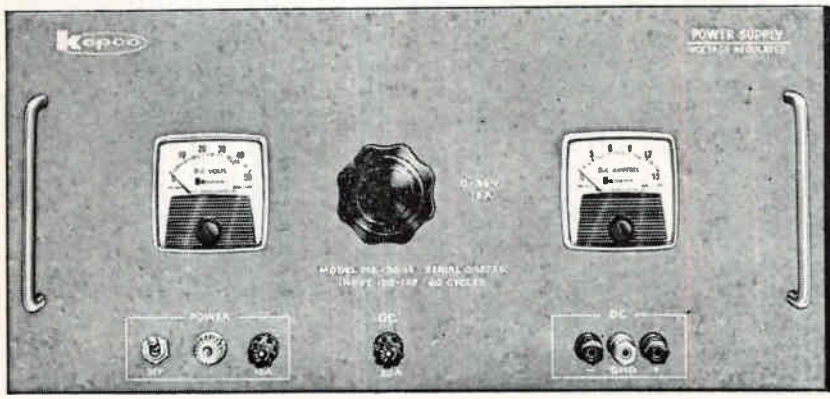


FIG. 1—Cross section of electronic ataxiameter



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SM75-8	0-75	0-8	0.1	3 mv.	0.1	1 mv.	0.01	0.1	19"	8¾"	13⅞"
SM160-4	0-160	0-4	0.1	10 mv.	0.1	1 mv.	0.08	0.8	19"	8¾"	13⅞"
SM325-2	0-325	0-2	0.1	10 mv.	0.1	1 mv.	0.3	3.0	19"	8¾"	13⅞"

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of the device, consisting of a steel platform supported on a central column, which is mounted on a rigid bottom plate. The entire assembly is enclosed in a wood cabinet and covered with a rubber mat. None of the indicated dimensions are critical. Resistance strain-gauges are bonded to two opposing vertical surfaces of the central column, and connected to a conventional strain-gauge amplifier, which drives a graphic recorder,

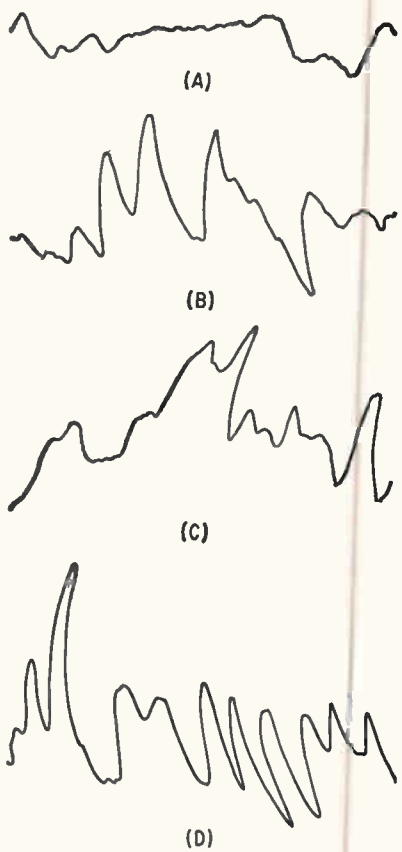

FIG. 2—Half-minute postural sway records of normal adult male: (A) eyes open, premedication, (B) eyes closed, premedication, (C) eyes open, 30 min after 4 oz of 100-proof alcohol per 100 lb of body weight and (D) eyes closed, 30 min after medication

In operation, the subject stands on the platform, and the output circuit is initially centered by means of the balance control on the amplifier. As the subject sways, his shifting center of gravity causes the central column to distort slightly. Although this bending of the column is too minute to be sensed by the subject, it results in a deflection of the graphic recorder. The amount of deflection is approx-

imately linear with the degree of body sway.

Gauges may also be applied to the two remaining surfaces of the central column if it is desired to study longitudinal and lateral sway differentially. From casual observation, however, it appears that most body movements involve deflections in both directions, so that only one plane of movement need be recorded to obtain a measure of general movement.

In one application it was desired to quantify relative measures of the amount of sway of a subject. This was done by using a map-measuring tool to measure the length of the recorded line.

UK and US Coordinate Time-Frequency Signals

BRITAIN and the United States have begun coordinating their time and frequency signal broadcasts. By the end of this year the time signals from all participating radio stations will be synchronized to the thousandth of a second.

The announcement was made jointly in Washington by James H. Wakelin, Jr., Assistant Secretary of the Navy (Research and Development), Allen V. Astin, Director of the U. S. National Bureau of Standards, and in the United Kingdom by the Astronomer Royal, Royal Greenwich Observatory, and the Director of the National Physical Laboratory.

Coordination started early this year in order to provide a uniform system of transmissions, which is needed in the solution of many scientific and technical problems in such fields as radio communications, geodesy and the tracking of artificial satellites on a world-wide basis.

British participants are the Royal Greenwich Observatory, the National Physical Laboratory and the Post Office Engineering Department. The project members in the United States are the U. S. Naval Observatory, the Naval Research Laboratory and the National Bureau of Standards.

The transmitting stations included in the coordination plan are GBR and MSF at Rugby, England; NBA, Canal Zone; WWV, Beltsville, Maryland, and WWVH, Hawaii.

Practicality of Ceramic Micromodules

DURING THE SPRING and early summer months, when displays of recent electronic components bloom in electronic shows around the country, micromodules that are in the realm of the here and now were in wide evidence. And in the past weeks, papers have been presented that not only bring some of these micromodule programs up to date, but also give performance and reliability data for such assemblies[1-6].

Defense and electronics industry personnel are becoming increasingly aware of the significance and capabilities of small ceramic receiving tubes with their thermionic integrated micro-module circuits (TIMMS), and ceramic wafer micromodules that not too long ago were considered revolutionary concepts in the design of electronic equipment.

Although ceramic based circuits are not the ultimate in miniaturization, their value lies in the compromise they afford between the use of conventional circuitry, proven component systems, degree of size reduction, economical mass production, and capabilities of being operated at high ambient temperatures.

Increased acceptance of ceramic tubes and their associated circuitry by equipment manufacturers is reflected in the fact that GE's receiving tube department in Owensboro, Ky. has now expanded its line of these devices. At this time last year only four types were registered. Now the GE line of ceramic tubes types will include some ten types and GE will soon register a new broad-band, low noise triode amplifier; a high-peak inverse voltage medium power diode rectifier; a low mu linear triode power amplifier; and a small high-frequency oscillator and multiplier triode. The broad-band triode amplifier will feature transconductance of 40,000 micromohos.

According to GE, their ceramic tubes with their TIMM circuits can be built to fit almost any electronic requirements, eliminate some 20 percent of the electronic components needed, and reduce by 40 percent the electrical connections which often are the cause of an electronic equipment failure.

The inherent operating characteristics of these circuits make them suited for use in space probes. And since these circuits are resistant to radiation, no excess weight need be carried by the vehicle to shield the electronic equipment from space radiation.

While transistorized digital computer circuits would fail when exposed to conditions equivalent in space to a one-megaton explosion as far as 1,400 miles from the equipment, the TIMM circuits continue operating at least as close as 50 miles from the source of the initial gamma pulse caused by the explosion. And the circuits allow at least six times as much electronic circuitry to be installed on a space vehicle as with presently-used components.

According to Manfred Kahn of Sprague, ceramic based microcircuitry is a heterogeneous approach, considered as an outgrowth of a printed components system which has been used for more than a decade. Printed component plates have been attractive because of the size reduction from conventional circuitry and because of cost savings achieved that results from the elimination of inspection, handling and assembly of individual components.

Materials and devices are utilized which have well-known electrical performance characteristics and it is not necessary to develop completely new component systems. Plate interconnections are made by location of the components, eliminating lead wires and solder joints except for external connections to the assembly, and allowing for mechanized methods of assembling ceramic wafers.

According to D. Mackey of RCA, the first generation of micromodules was deliberately kept simple and unsophisticated, with most microelements designed as

Light Amplifier Sees Individual Photon

The Astracon, a small tube developed by Westinghouse, now makes it possible to see individual electrons released at the tube's input. In astronomy, the tube will increase the light-gathering ability of the largest telescope. In nuclear physics, the tube will permit the viewing of the tracks of high-energy cosmic rays and other particles

imately linear with the degree of body sway.

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The transmitting stations included in the coordination plan are GBR and MSF at Rugby, England; NBA, Canal Zone; WWV, Beltsville, Maryland, and WWVH, Hawaii.

Practicality of Ceramic Micromodules

DURING THE SPRING and early summer months, when displays of recent electronic components bloom in electronic shows around the country, micromodules that are in the realm of the here and now were in wide evidence. And in the past weeks, papers have been presented that not only bring some of these micromodule programs up to date, but also give performance and reliability data for such assemblies[1-4].

Defense and electronics industry personnel are becoming increasingly aware of the significance and capabilities of small ceramic receiving tubes with their thermionic integrated micro-module circuits (TIMMS), and ceramic wafer micromodules that not too long ago were considered revolutionary concepts in the design of electronic equipment.

Although ceramic based circuits are not the ultimate in miniaturization, their value lies in the compromise they afford between the use of conventional circuitry, proven component systems, degree of size reduction, economical mass production, and capabilities of being operated at high ambient temperatures.

Increased acceptance of ceramic tubes and their associated circuitry by equipment manufacturers is reflected in the fact that GE's receiving tube department in Owensboro, Ky. has now expanded its line of these devices. At this time last year only four types were registered. Now the GE line of ceramic tubes types will include some ten types and GE will soon register a new broad-band, low noise triode amplifier; a high-peak inverse voltage medium power diode rectifier; a low mu linear triode power amplifier; and a small high-frequency oscillator and multiplier triode. The broad-band triode amplifier will feature transconductance of 40,000 micromohos.

According to GE, their ceramic tubes with their TIMM circuits can be built to fit almost any electronic requirements, eliminate some 20 percent of the electronic components needed, and reduce by 40 percent the electrical connections which often are the cause of an electronic equipment failure.

The inherent operating characteristics of these circuits make them suited for use in space probes. And since these circuits are resistant to radiation, no excess weight need be carried by the vehicle to shield the electronic equipment from space radiation.

While transistorized digital computer circuits would fail when exposed to conditions equivalent in space to a one-megaton explosion as far as 1,400 miles from the equipment, the TIMM circuits continue operating at least as close as 50 miles from the source of the initial gamma pulse caused by the explosion. And the circuits allow at least six times as much electronic circuitry to be installed on a space vehicle as with presently-used components.

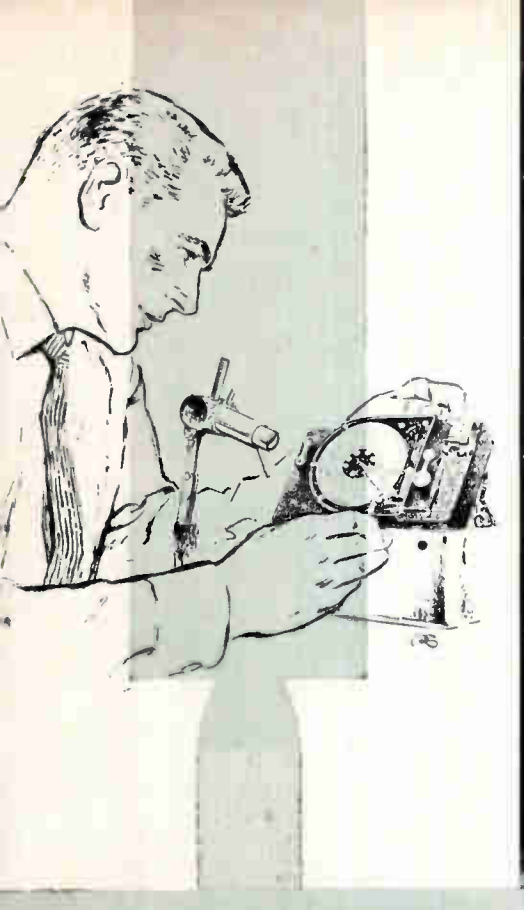
According to Manfred Kahn of Sprague, ceramic based microcircuitry is a heterogeneous approach, considered as an outgrowth of a printed components system which has been used for more than a decade. Printed component plates have been attractive because of the size reduction from conventional circuitry and because of cost savings achieved that results from the elimination of inspection, handling and assembly of individual components.

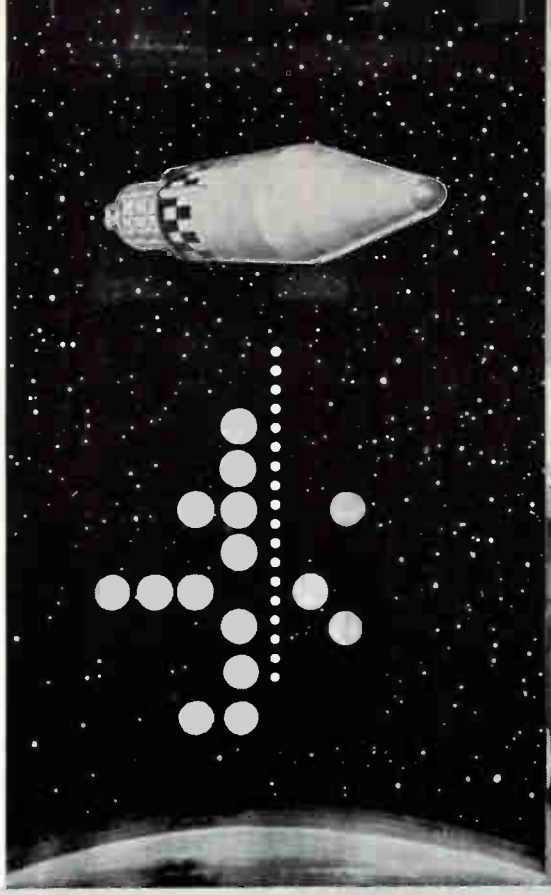
Materials and devices are utilized which have well-known electrical performance characteristics and it is not necessary to develop completely new component systems. Plate interconnections are made by location of the components, eliminating lead wires and solder joints except for external connections to the assembly, and allowing for mechanized methods of assembling ceramic wafers.

According to D. Mackey of RCA, the first generation of micromodules was deliberately kept simple and unsophisticated, with most microelements designed as

Light Amplifier Sees Individual Photon

The Astracon, a small tube developed by Westinghouse, now makes it possible to see individual electrons released at the tube's input. In astronomy, the tube will increase the light-gathering ability of the largest telescope. In nuclear physics, the tube will permit the viewing of the tracks of high-energy cosmic rays and other particles





EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY IN

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Special emphasis is being attached to the research, design and development of improved military electronics systems for communications, including new methods of data transmission, reception and storage. Pioneering work is also being conducted in space vehicle borne computers, DC-AC inverters, non-gyro guidance systems. Studies in oceanography include underwater communication and navigation, and natural phenomena and military aspects of the deep sea.

Lockheed's programs reach far into the future and deal with unknown environments. It is a rewarding future and one that outstanding scientists and engineers are invited to share. If you are experienced in any of the above areas, or in related work, we invite your inquiry. Please write: Research and Development Staff, Dept. F-22, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

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single components. The next step will be the combination of several components within single microelements and the transition of new integrated devices will logically occur bit by bit over a protracted period of time. Thus, we can anticipate a long period of application of these devices in hybrid combination with conventional components.

Two gold-plated ceramic receiving tubes made at the General Electric tube plant in Owensboro, Ky., are used in the transmitting equipment of the Pioneer IV, and the Thor-Able Star missile which put the TIROS 1B into orbit

The Sylvania module is planned to accommodate both present microcomponents and future solid state molecular circuits, and mixtures of both on an economical, reliable basis. Space and volume analysis of current devices come up with an immediate parts density of 600,000 per cubic ft, and long range objectives of 30 to 60 million.

According to G. W. A. Dummer, component head of the Royal Radar Establishment, Malvern, England, maximum attention in Britain is being given to the subminiature tube, the microcircuit or 2D, and the stacked circuit. The interest in microminiaturization in Britain has grown, not necessarily for its potentialities as regard to size reduction, but because of the possible ultimate increase in reliability. Although much work has been carried out in the United Kingdom—since 1956, it has not been possible to carry it out on the scale possible in the U.S.A., and more theoretical

work has been done than practical work.

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Tungsten Coatings

TUNGSTEN is one of the few metals that possess structural strength at temperatures above 2,000 C. Its extremely high melting point (3,140 C), hardness and corrosion resistance make it a desirable material for high-temperature equipment. However, until lately, the high-temperature properties of tungsten couldn't be effectively utilized. Its brittleness and hardness prevented it from being machined by conventional methods while its weight restricted its use in aeronautical equipment. For these reasons, efforts have been made to develop a practical method for depositing tungsten coatings.

High-purity tungsten can now be easily plated on metal surfaces by using a vapor deposition process which the National Bureau of Standards developed for the Navy.

The method, devised by W. E. Reid and A. Brenner of NBS involves reducing gaseous tungsten hexfluoride with hydrogen by passing it over the heated object to be plated. At temperatures above 300 C, tungsten is deposited on the hot surface, and the only other reaction product, hydrogen fluoride, passes out with the excess of hydrogen.

Simple tungsten shapes for use in vacuum tubes have already been fabricated.

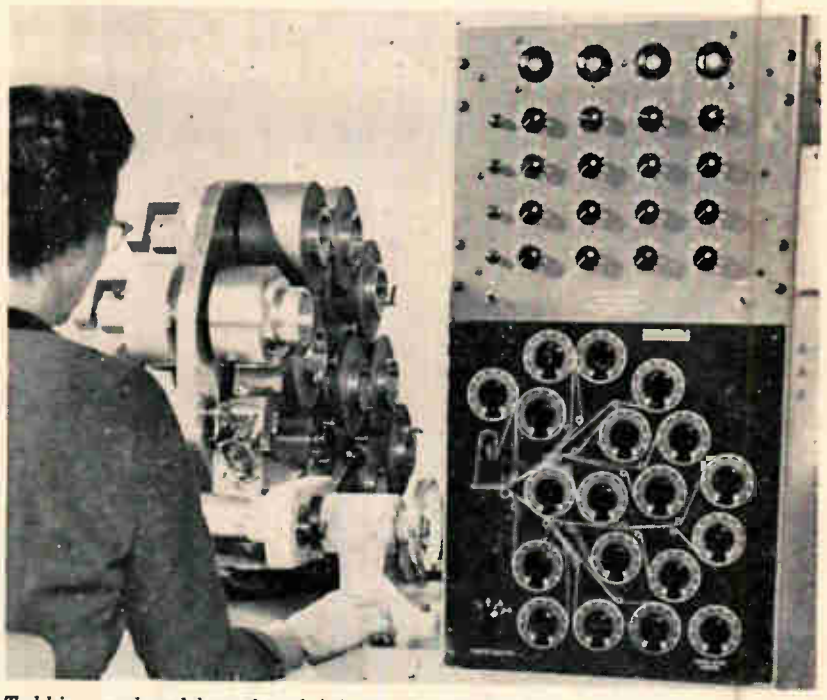
Precision Winder Uses Electronic Controls

SEVERAL FEATURES intended to increase precision while minimizing setup time and operator skill are incorporated in a winding machine recently built for submarine cable capacitor manufacturing. Designed by Wellington Electronics, Englewood, N. J., the machine is reported to have a production tolerance of ±1 percent when used in a temperature-controlled room.

Once materials are loaded and controls set, the operator generally performs only simple switching and normal manual loading, tabbing and unloading operations. Control operation is outlined in Fig. 1.

Elements of the control panel seen in the photo are (top to bottom): counter tubes, decade selector switches (tabbing, tabbing, slowdown and stopping lengths), magnetic clutch adjustments, 4-position switch to select bank of length switches (lower left) and motor speed control (lower right). The clutch adjusting panel simulates position of the feed spools. Paths taken by the foils and papers are shown by the engraved lines.

Tabbing and winding lengths can be preset to 99.99 or 999.9 inches, with logarithmic acceleration and deceleration of the winding spindle drive motor at each starting and stop. The motor has an electronically-controlled overdrive. Its speed is variable from 5 to 100 percent of maximum. After each operation, the operator advances the 4-position switch and presses a foot switch to start the drive motor.



Tabbing and end lengths of foil are preset by decade switches while spool clutch tension control board simulates paths of foil and papers

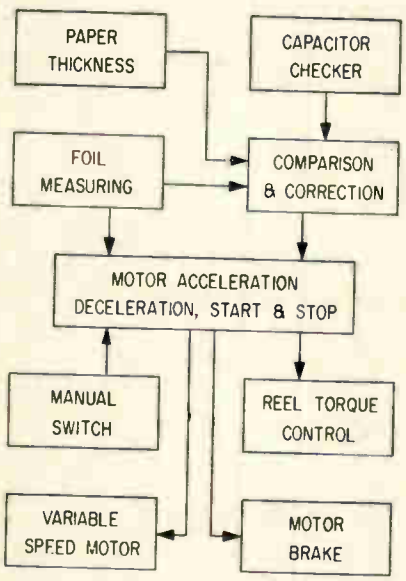


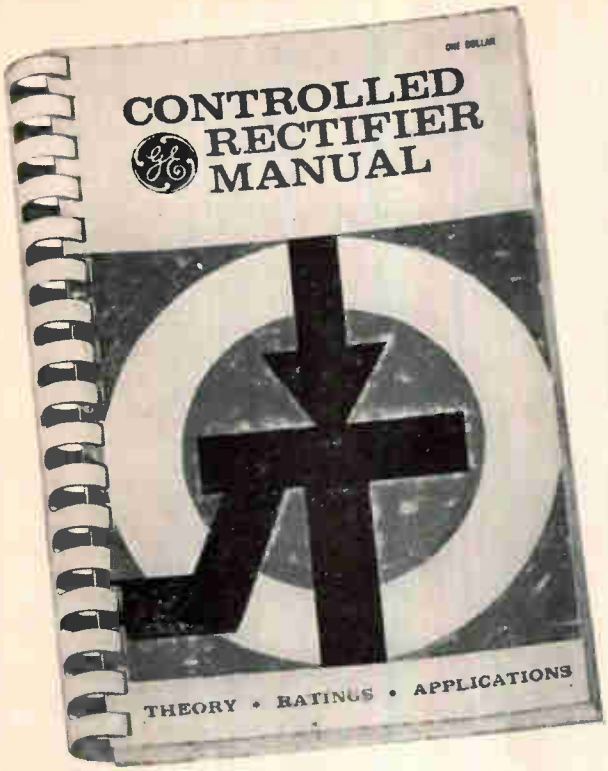
FIG. 1—Flow of information between monitoring and control units

The switches need not be reset if the spools are reloaded with material of different dimensions. Winding units are in inches per gram of width. Change compensation is made for all switches by a multiplier circuit which can multiply original settings by 0.5 to 2.

Feed spools and their respective clutches are mounted on a upright plate. Clutches contain iron and molybdenum dust particles which are spherical to reduce friction and hysteresis. Graphite is added as a lubricant. Breakaway torque on the foil and paper is about 2 percent, but this is reduced almost to zero by a saturable reactor circuit which coordinates motor and clutches.

Paper rolls are clamped on the spools by the inside ends of the papers. Foil rolls are clamped by a collar which snugs the rolls to a reference flange on the inside edge of the spools. The ground foil and papers are aligned with the reference edge of the electrode foil by running all the edges against precision guides as the foils and papers are fed and gathered. The guides keep the edges in position within 0.007 inch. In addition to minimizing the effects of camber, according to Wellington, this one-edge tracking method maintains alignment from one width to another without the necessity of resetting guide channels. All parts contacting materials are polished chrome and all moving parts are mounted in ball bearings.

Length of the electrode foil is measured just before it reaches the winding spindle. The foil passes around a guide roller which turns a large disk. Light beamed to a photoelectric cell is interrupted by 30 pinholes around the edge of the disk. Each pinhole represents 0.01 inch of foil, allowing an accuracy of about 1 ppm in the monitoring of foil area. Changes in thickness are compensated for automatically by the controls. The capacitors are also monitored for shorts and other



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material irregularities during winding, by a bridge and contact brushes on the foils.

A 2-position indexing winding head is used. It has 2 pairs of pin-type spindles since the type of capacitor made is wound on a ceramic rod. The spindles may be replaced with a split arbor. After a capacitor is wound, the gathered papers and foil are clamped between 2 rollers before severing. A snap-action switch prevents the motor from starting while the clamp is closed.

A similar machine has also been built for plastic film capacitors. The principal modification is a destaticizer, to overcome the films' tendency to resist contact at gathering.

Standardized Tooling Cuts Cost, Design Time

TOOLING COSTS can be cut at least 30 percent by using standardized machining jigs, according to estimates made by Eclipse-Pioneer Division, Bendix Corp., Teterboro, N. J. The jigs can be manufactured in quantity, stocked and then fitted as needed to produce a specific part. The tools cost less and require less design time.

The photos illustrate types of drill jigs used by the division. While the bodies are machined to

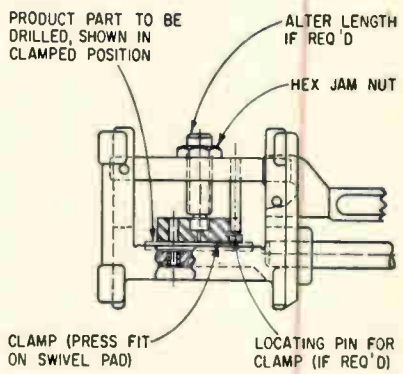
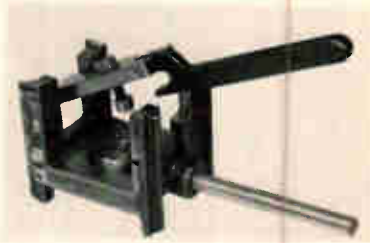


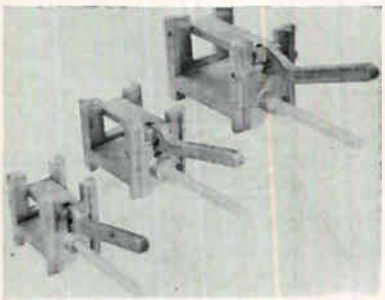
FIG. 1—Cutaway view of drill jig, showing how body is adapted



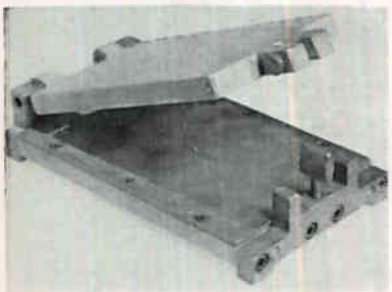
Jig of same type shown in Fig. 1

accept bushings or supplementary jigs, other parts can be reclaimed. For example, the handles, locking plate and fastening pins of the clamp type jig (Fig. 1) can be reused.

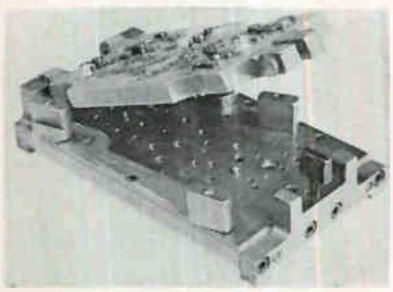
Jigs are standardized around design features found by experience to be the most efficient for loading and use. Features not normally included in this type of tool, because of the limited time usually available for specialized design, can be provided for in the standard design.



Jigs are made in standard sizes



Quick-opening jig, before bushings are fitted

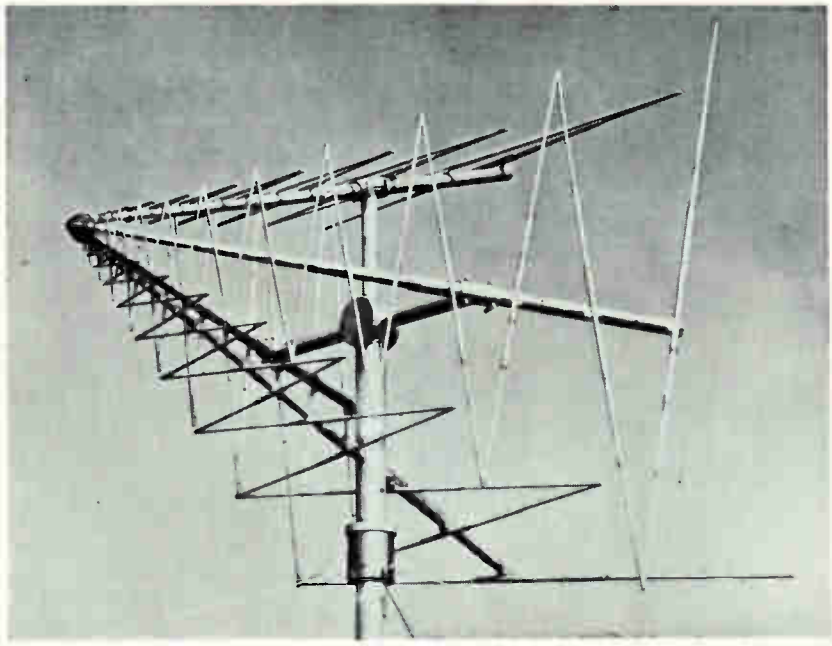


Same jig, fitted for production use

Stackable Parts Bins

SMALL PARTS BINS which can be stacked in a semicircle on work benches are being made of molded plastic by Stackbin Corp., Pawtucket, R. I. The bins are 8 inches long and 1¼ inches narrower at the front than back. The bins have sloping bottoms to keep parts flowing forward.

New On The Market



Log-Periodic Antennas

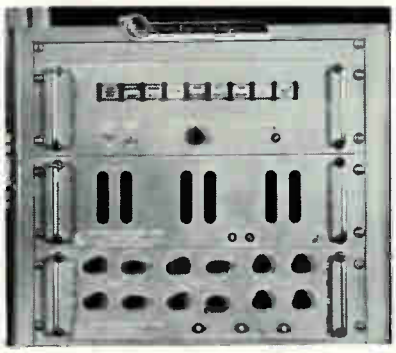
20 TO 1 BANDWIDTHS

TWO 20 to 1 bandwidth antenna arrays are being offered by Granger Associates, 974 Commercial St., Palo Alto, Calif. Model 720 (photo) is a direction-finding antenna with wideband, medium-gain performance characteristics. It offers 60 degree beamwidths in the 50 to 1000 Mc range, and has a vswr of 2.5 to 1 and 50 ohm impedance over its band. Linear, vertical or horizontal polarization may be remotely selected. The antenna is provided with a complete 360-deg azimuth drive at 2 rpm with left-stop-right controls and position indication. The unit is 75 in. high, and wide and 76 in. long, and comes mounted on a 36-in. guyed mast.

Model 721 is a log-periodic array for nonfrequency sensitivity broadband performance and complete azimuth coverage. Its vswr is under 3.6 to 1, relative to 50 ohms over the band. Azimuthal pattern variation is less than 5 db. Remotely selectable vertical and horizontal polarization is provided. This antenna is 176 in. high and 92 in. square.

Both units will withstand 100-mph winds with ½ inch of ice coating.

CIRCLE 301 ON READER SERVICE CARD



Tape Search System

ALL SOLID STATE

AN ALL-SOLID state magnetic tape search and control system with its search function independent of tape speed is now available from the Electronic Engineering Company of California, 1601 East Chestnut Ave., Santa Ana, California. Employing a time code detection technique, the ZA-821 tape search and control system will automatically search and play back at any speed from 1⅞ to 150 ips. A continuous decimal display is made of the time code being searched on the tape. The system rapidly searches (in either direction) the desired tape area, switches the transport to playback speed and provides contact closures for operation of auxiliary equipment during the interval between preset start and stop times. Remote indication and control of transport operation is provided.

The unit occupies 15¾ in. of rack space in a 19 in. standard rack. Maximum chassis depth is 18 in. including connectors. Price is $11,400.

CIRCLE 302 ON READER SERVICE CARD

Wide-Band Noise Source

30 CPS TO 300 KC

A TRANSISTORIZED uniform-spectrum noise source that employs a new principle for producing wide-band noise from semiconductors and that operates from 30 cps to 300 Kc is available from Raytheon Company's Industrial Components Division, 55 Chapel St., Newton, Mass.

Chief use for the module is in laboratory noise generators. Other uses are as a built-in noise source for sensitivity checks in radar and sonar systems, and in production test equipment for measurement of transfer functions of networks, amplifiers and transducers.

No a-c power supply is required so there is no risk of unwanted 60-cps hum. Other advantages are immediate warmup and a power requirement of only 12 ma at −12 vd-c plus or minus 2v.

With proper amplifier circuits, output covers the spectrum from 30 cps to 300 Kc with uniformity to plus or minus 2 db. Output voltage is 0-10 millivolts rms into 1,000 ohms.

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detection, space propulsion systems or related areas. Several of the positions require the ability to present contract proposals to both technical and non-technical officials. Other positions require the ability to do preliminary systems design. There are twenty-three openings in the above areas at the present time.

All of the positions involve close associations with senior engineers. All of the salaries reflect the unusual backgrounds required.

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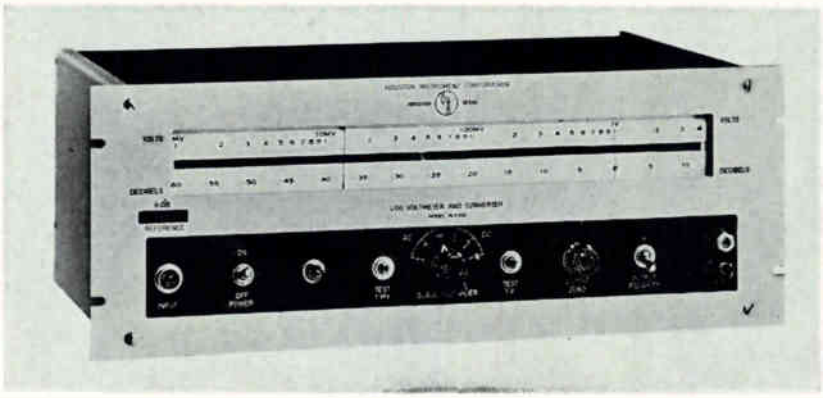


Log VTVM

NO SCALE SWITCHING

A NEW 70-db log voltmeter and converter that is accurate to 0.2 db or 2 percent anywhere on the three-cycle scale has been developed by Houston Instrument Corp., P. O. Box 22234, Houston 27, Texas. Actual voltage and the level in decibels relative to a set reference may both be read at a glance.

Rapidly increasing sensitivity for smaller signals with the moving knife-edge pointer remaining on scale makes the log voltmeter suited for null-seeking as well as electronic testing and sound and vibration measurements.

Very low frequency inputs are handled by the same chopper-stabilized preamplifier used for d-c measurements; r-f inputs are handled with a separate r-f probe. A log-converter readout circuit with separate zero control and floated Zener reference may be used as a source for any conventional d-c recorder for decibel recording. Multiple units may be used for division or multiplication before indication or recording.

More than three decades on the 14 in. scale eliminates scale switching for most measurements. Input attenuator provides for another 40 db extending the total range from 1 millivolt to over 320 volts.

Input impedance is 5 megohms (minimum) on a-c or d-c scales. Frequency response is flat to 0.25 db from 20 cps—50 Kc on a-c scale with full-wave average value detection and rms indication. Extra damping is provided from 1 cps to 10 cps. With r-f probe above 50 Kc the voltmeter is peak reading. Voltmeter sells for $1,250.00.

CIRCLE 304 ON READER SERVICE CARD

High Temperature Switch

CALIBRATED UP TO 1,800F

A SUPER-HIGH temperature thermal switch that can be calibrated up to 1,800 F has been developed by Control Products, Inc., 306 Sussex St., Harrison, N. J. The switch, which is hermetically sealed with ceramic, is a probe type unit with a cap that is locked in place after the final calibration. Serving as a control device for the Nike missile, the unit could be used for temperature control of heat exchangers, gas turbines and rocket engines.

Contacts may be arranged for either close-on-rise or close-on-fall in temperature. Temperature tolerance is 6 deg F; temperature differential and repeatability for a given switch is plus or minus 1 deg F. The unit can tolerate overshoot to 2,200 deg F and undershoot to −100 deg F.

Standard probe length is 4.000 in.; the head configuration with mounting hex is only 1⅛ in. deep including the protective cap. Weight is 2 ounces.

Performance under shock and vibration exceeds MIL-E-5272A standards. Electrical rating is 1.5 amps at 28 v d-c, 110 v a-c, resistive load.

CIRCLE 305 ON READER SERVICE CARD

Semiconductor Switches

HIGH-VOLTAGE

TWO NEW Transwitch *pnpn* switching devices that provide voltage ratings up to 200 have been added to the series of such devices being developed by Transitron Electronic Corporation, 168 Albion St., Wakefield, Mass. All Transwitch devices are being offered in the compact, TO-13 package, as well as in the TO-5 package.

The Transwitch, a bistable silicon device that can be turned off with a gate current, can replace two transistors plus resistors in most bistable circuits.

These new high-voltage Transwitches can be used with digital indicating tubes.

CIRCLE 306 ON READER SERVICE CARD

Data Transceiver

WORKS OVER PHONE LINE

A HIGH-speed binary data transceiver that makes it possible for electronic computers and other high-speed data-handling devices to communicate directly with each other over commercial telephone lines at 2,400 bits a second has been developed by the Stromberg-Carlson Electronics Division of General Dynamics Corporation, Rochester, N. Y. The transceiver uses solid-state circuits exclusively.

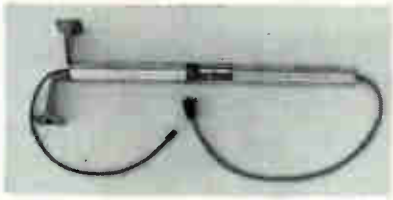
The high speed of data transmission is made possible by a modulation method that minimizes errors due to impulse noise, phase distortion, frequency translation and other transmission problems.

Input signal may be either polar or impulse type binary information. The transceiver accepts the data in the form of a serial train of pulses, shapes the pulses, and modulates a

subcarrier frequency. No synchronizing signals are required, as the receiver portion of the transceiver has an afc system for automatic synchronization at any bit frequency between 2,350 and 2,450 pulses a second.

Higher or lower bit rates can be provided on special transmission facilities by substituting plug-in components in the transceiver.

CIRCLE 307 ON READER SERVICE CARD



Ku-Band Amplifier

SOLENOID FOCUSED

HUGGINS LABORATORIES, 999 East Arques Ave., Sunnyvale, Calif. Frequency range of the model HA-46 amplifier is 12 to 18,000 Mc. Unit employs four anodes. Saturation power is 1 mw; small signal gain, 25 db; noise figure for broad-band operation, 12 db; lower noise figure can be achieved by optimizing for narrow band operation; overall length, 15¾ in., excluding leads; capsule diameter, 1 1/16 in.; weight, 1¾ lb.

CIRCLE 308 ON READER SERVICE CARD

Automatic Tester

FOR FERRITE CORES

A FULLY automatic, production-type memory core feeder that grades and sorts miniature ferrite cores has been announced by Rese Engineering, Inc., 731 Arch Street, Philadelphia 6, Pa., sole U. S. distributor for the Ramsey Model CH-58 automatic memory core handler. Feed rates for standard 80-mil or 50-mil cores are in excess of 10,000 per hour.

High contact reliability is a major feature of the Ramsey machine, with both probe and contacts made of heat-treated Paliney 7 and isolation maintained between the drive and output circuits by the split design of the testing probe. Resistance of the core test circuits is less than ½ ohm and varies less than 100

milliohms during the testing interval. Inductance is less than 3.5 microhenrys and varies negligibly during the testing interval.

Upon completion of tests, external electronic testing equipment or a human operator energizes accept or reject solenoids, and cores are conducted through short sorting tubes to receptacles. If the accept or reject solenoids are not activated, cores are automatically deposited in the no-test receptacle.

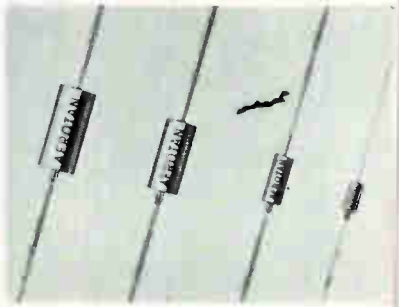
CIRCLE 309 ON READER SERVICE CARD

D-C/D-C Converter

MEETS MIL-E-5272C

POWER INSTRUMENTS CORP., 235 Oregon St., El Segundo, Calif., announces a d-c/d-c converter which features 0.1 percent regulation for ± 10 percent line change as well as 100 percent load change. The nominal input is 28 v d-c and the output is 150 v d-c, 0-250 ma. Ripple is 0.5 percent pp. Size of the unit is 3.75 in. by 4.5 in. by 3.75 in. and it weighs 3.2 lb. Unit meets all requirements of MIL-E-5272C.

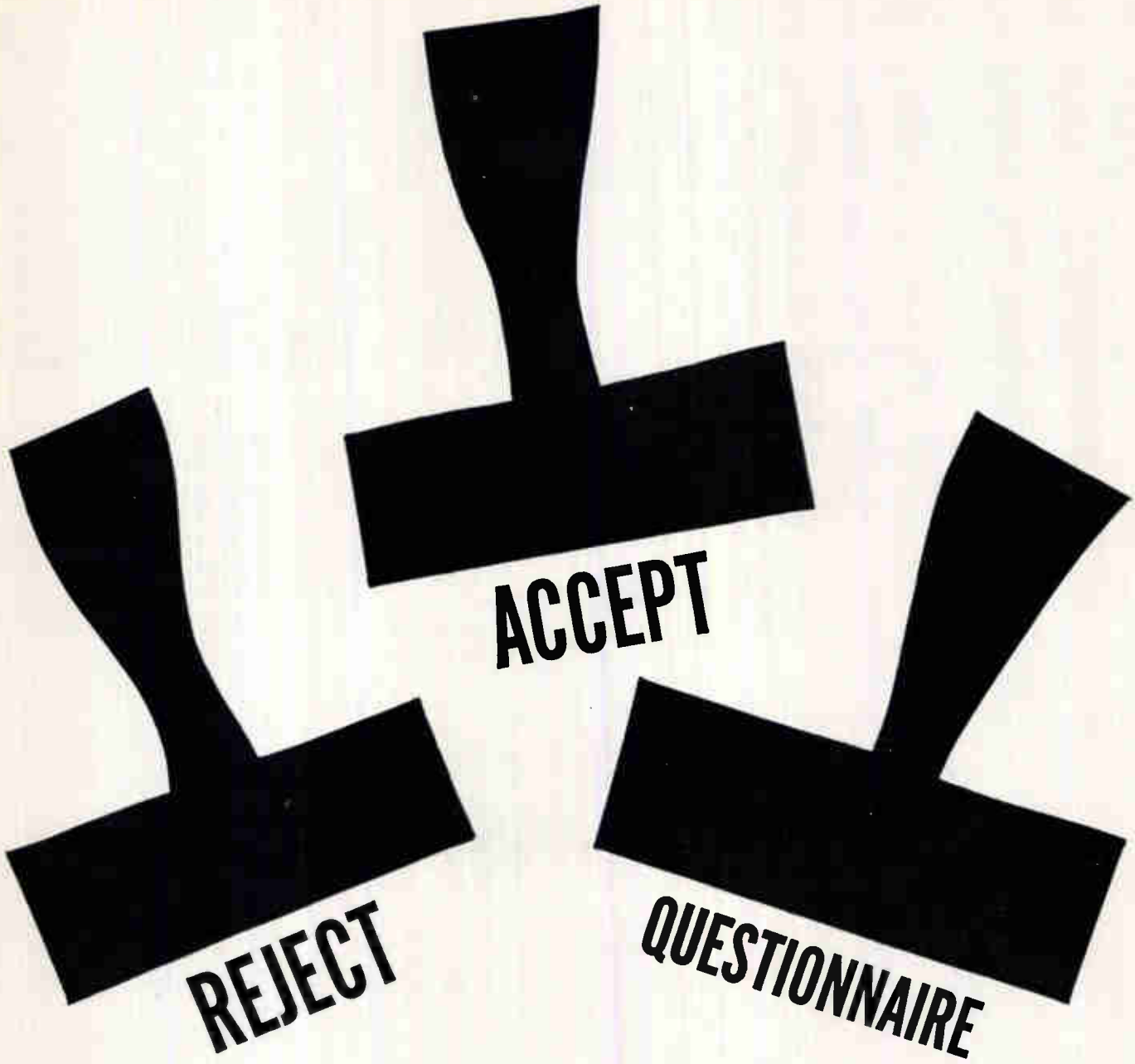
CIRCLE 310 ON READER SERVICE CARD



Tantalum Capacitors

HIGH RELIABILITY

AEROVOX CORP., New Bedford, Mass. These Aerotan capacitors are solid electrolyte units featuring sintered tantalum anodes and hermetically-sealed in subminiature metal cases. The use of semiconductor electrolyte insures a completely dry assembly with absolute freedom from corrosion or electrolyte leakage. Units are designed to meet all the requirements of MIL-C-26655A (proposed). They are available in type ST-12 (uninsulated case) and type ST-13 (insulated case) for continuous operation over the range of – 80 C to + 125 C in voltage



THREE TOOLS FOR QUALITY CIRCULATION

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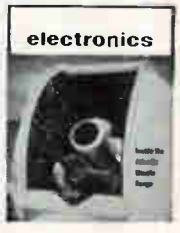
As fast as subscription orders are received they are examined individually—by Hugh J. Quinn, Circulation Manager, who stamps each card:

ACCEPTED—to indicate a subscriber is actually engaged in research-design/production/management as a maker or user of electronics equipment.

QUESTIONNAIRE—to delay acceptance until information concerning the subscriber—his function, his company, his title are definitely known.

REJECTED—whenever the order indicates that the individual is NOT within the editorial field of the publication.

electronics is a member of a select group too—The Audit Bureau of Circulation publications—comprised of those magazines and newspapers whose publishers believe that a reader's interest in a publication is best demonstrated when he pays to receive it—those publishers willing to submit to exhaustive periodic audits in order to prove that their circulation is among those individuals they are pledged to serve, and among screened *selected* individuals ONLY.



The Electronics Man "buys" what he reads in . . .

ABP/ABC A McGRAW-HILL PUBLICATION / 330 WEST 42nd STREET, NEW YORK 36, N. Y.

ratings of 6, 10, 15, 20 and 35 v d-c for + 85 C operation; and 4, 7, 10, 13 and 23 v d-c for + 125 C operation.

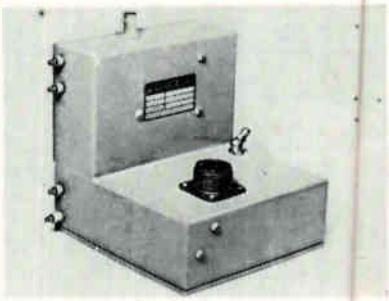
CIRCLE 316 ON READER SERVICE CARD

Epoxy

FLAME-RESISTANT

EPOXY PRODUCTS, 137 Coit St., Irvington, N. J. Epoxy No. 1202 is excellent for such applications as computers, where flame-resistant properties are of vital importance. Properties are as follows: extinguishing time is 0-1 sec; thermal conductivity (cal/sec/cm²/c/cm) is 9.2×10^{-4}; water absorption (24 hours) is 0.04 percent; weight loss (24 hours at 150 C) is 0.26; dielectric constant (1 meg) is 5.6; dissipation factor (1 meg) is 0.028; volume resistivity at 25 C is 1.3×10^{15}, at 125 C is 4.7×10^{13}, at 150 C is 3.1×10^{10}; insulation resistance (96 hours at 90 percent RH and 95 F is 9×10^{10}). E-Cases of molded epoxy No. 1202 have successfully been tested for 1,000 hr at 200 C as packages for electronic components.

CIRCLE 317 ON READER SERVICE CARD



Magnetic Modulator

PLUG-IN MODULES

VOI-SHAN ELECTRONICS, 13259 Sherman Way, North Hollywood, Calif., announces the SCR magnetic modulator. These solid state circuitry plug-in modules operate directly off any available prime power source;

115 v a-c, 60 or 400 cycles, or 28 v d-c. Other prime sources to customer specification. No separate h-v power supply is required with the SCR modulator. Designed for operation from − 65 to + 125 C, with maximum life, reliability, high altitude and performance, the SCR modulator exhibits unit transfer efficiency of approximately 85 percent, and withstands shock and vibration to MIL-T-5422C. Output power up to 2 μsec. Output waveform and coincident trigger pulse to customer requirements.

CIRCLE 318 ON READER SERVICE CARD

Curve Tracer

FOR TUNNEL DIODES

TEXAS INSTRUMENTS INCORPORATED, Geosciences and Instrumentation Division, 3609 Buffalo Speedway, Houston 6, Texas. New tunnel diode curve tracer permits the study of forward characteristics of tunnel diodes made by various manufacturers, including gallium arsenide tunnel diodes recently introduced by Texas Instruments. A plug-in adapter can be changed to accommodate different package configurations. One adapter is included with original equipment; others may be purchased as required. Any sensitive oscilloscope may be used with the instrument to create current and voltage wave forms. The TI instrument creates a sharp representation of the entire critical region of the forward characteristics curve of the tunnel diode under test rather than just a portion of that curve. Through the use of an external decade box shunted across the horizontal terminals, it is practical to read the

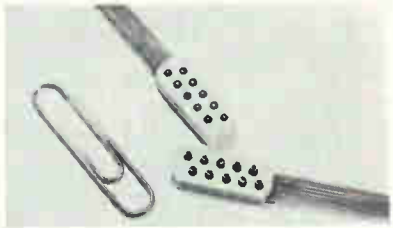
actual negative resistance of the tunnel diode at any point on the curve. This shunt can be provided as an optional feature at additional cost.

CIRCLE 319 ON READER SERVICE CARD

Character Generators
TRANSISTORIZED

SKIATRON ELECTRONICS & TELEVISION CORP., 180 Varick St., New York 14, N. Y., offers the series 2000 and series 3000 Alphadyne character generators. Series 2000 supplies all 10 digits, 9 letters and 3 symbols. All transistorized, the unit is approximately 6 in. by 6 in. by 6 in. and consumes less than 5 w. Characters can be written as fast as 40,000 per sec. Prototype quantities are priced at about $3,000 each. Series 3000 provides full alpha-numeric—all 10 digits, all 26 letters and 4 symbols. Also fully transistorized, it is approximately 6 in. by 6 in. by 8 in. and consumes less than 5 w. Characters can be written as fast as 17,000 per sec. Prototype quantities are priced at about $5,000 each. Both units write numbers, letters and symbols on any crt display.

CIRCLE 320 ON READER SERVICE CARD

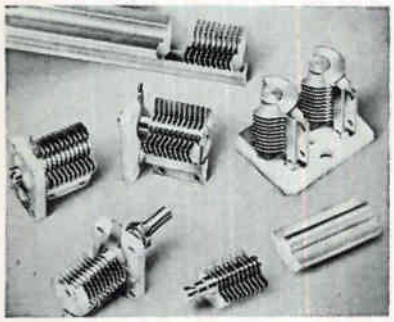


Subminiature Connector
VARIETY OF SIZES

CICOIL CORP., 13833 Saticoy St., Van Nuys, Calif., has developed a subminiature connector designed for use with Cicoil subminiature super-flex stranded wire harnesses. The "138" connectors are molded of high temperature thermal setting epoxy, polyurethanes, silicone rubbers, and other materials to meet customers' requirements. The male pins are recessed and as the female pins engage they are compressed around the male pins to form a secure electrical and mechanical self-locking connection. The materials exhibit excellent di-

electric characteristics and will withstand a wide range of temperature and other environmental extremes. The "138" is made in a number of sizes, with and without the self-locking feature.

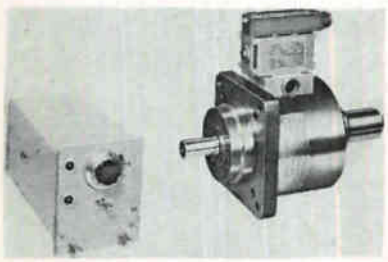
CIRCLE 321 ON READER SERVICE CARD



Variable Air Capacitor
HIGH Q, MINIATURE

JAMES MILLEN MFG. CO., INC., 150 Exchange St., Malden, Mass., announces a new high Q miniature variable air capacitor. Rotors and stators are precision machined from extruded solid brass. Terminal is an integral part of stator block. Shaft is an integral part of rotor. Screw-driver slot adjustment or ⅛ in. extended shaft for knob. Only 6 parts to a complete capacitor. Stock sizes, 15, 25 and 35 pf single or dual units.

CIRCLE 322 ON READER SERVICE CARD



Servo Drive Systems
VARIABLE SPEED

PEGASUS LABORATORIES, INC., 3690 Eleven Mile Road, Berkley, Mich. A notable characteristic of the 540 series servo drive systems is the performance of the drive in the zero speed region where speed regulation, no load to full load, and long term speed stability are typically of the order of 0.1 rpm. This, coupled with the high available torque, enables direct coupling of the servo

drive to such loads as machine tool lead screws without intermediate gear reduction. The no load to full load regulation at the high end of the speed range is approximately 0.2 percent and the actual speed will be within 1 percent of the setting on the speed control dial.

CIRCLE 323 ON READER SERVICE CARD

Video Detector Diode
X-BAND TYPE

SYLVANIA ELECTRIC PRODUCTS INC., Woburn, Mass., announces the type 1N31A, an X-band video detector microwave diode for use in radar, communications systems, countermeasures, and other microwave applications. It meets the full range of military environmental tests including temperature cycle, shock, vibration, centrifuge, and moisture resistance. Type 1N31A is a high temperature (150 C) hermetically sealed diode in a coaxial package. It has a figure of merit of 200 minimum at 9,375 Mc and a video impedance range of 3,000 to 17,000 ohms.

CIRCLE 324 ON READER SERVICE CARD

Power Meter
EXTREMELY STABLE

FXR, INC., 26-12 Borough Place, Woodside 77, N. Y. Model B832T transistorized temperature compensated power meter is a compactly packaged unit which will accurately measure either c-w or pulsed r-f power in five full scale direct reading ranges from 30 μw to 3 mw. Values can be read in mw or dbm. Readings are virtually drift free. Provision is made to calibrate the d-c voltage at all levels and the bridge is self-balancing at 200 ohms. Range switching without recalibration is another advantage. Instrument is energized by a self-contained rechargeable nickel cad-

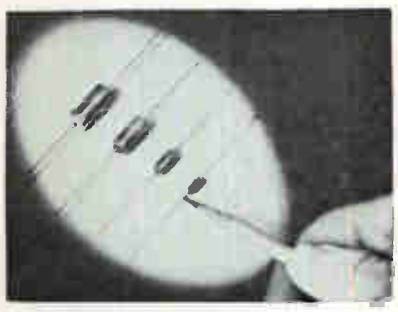
mium battery. The charging circuit operates from a 105 to 125 v a-c, 50 to 400 cps source. The use to charge ratio is 2 to 1. A series 218 thermistor head is a required accessory.

CIRCLE 325 ON READER SERVICE CARD

Oscilloscopes
STABLE TRIGGERING

N. V. PHILLIPS, Gloeilampenfabrieken, Eindhoven, Netherlands, announces two new oscilloscopes for routine measurements in laboratories, production lines and industry. The two types, both being equipped with a 10 cm flat face crt (1.9 Kv accelerating voltage), differ in the design of the vertical amplifier. Type GM5606 is to be used for measurements in the range of 0-200 Kc (−3 db) with 10 mv/cm sensitivity. The GM5601 covers the frequency range 0-5 Mc (rise time 75 nsec; sensitivity 100 mv/cm). Both vertical amplifier and time base generator controls have an accuracy of ± 3 percent. Provided with exceptionally stable triggering of frequencies up to 1 Mc with adjustable trigger level and time base magnification of max. 5 times with 3 percent accuracy.

CIRCLE 326 ON READER SERVICE CARD

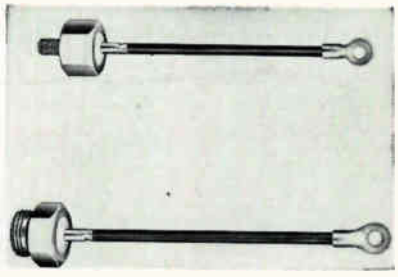


Tantalum Capacitor
HIGH-TEMPERATURE

KEMET CO., 11901 Madison Ave., Cleveland 1, Ohio. Series J solid tantalum capacitors can operate at full-rated voltage at 85 C. They can be operated at as high as 125 C at 2/3 rated voltage, and at room temperature their working voltage is approximately ¾ of the rated value. Units are available in capacitances ranging from 0.33 to 330 μf, and in 6, 10, 25, 35, and 50 v ratings. The 50-v, 85-deg capacitor

is available in capacitance values up to 22 μf. The new capacitors are supplied in four military case sizes, with the smallest measuring only $\frac{1}{8}$ in. in diameter and $\frac{1}{4}$ in. long. All are supplied either with or without insulated cases.

CIRCLE 327 ON READER SERVICE CARD



Power Rectifiers

PIV FROM 100-400 V

SYNTRON CO., 241 Lexington Ave.. Homer City, Pa. Styles ES-33 and ET-33 silicon power rectifiers have peak forward voltages of 1.3 v maximum at 50 amperes. Peak inverse current is 5.0 ma at 100 C and a thermal drop of 1.25 C/w maximum. Mounting torque for style ES is 100 in.-lb maximum and style ET is 800 in.-lb maximum. Over-all length for ES is $3\frac{5}{8}$ in. maximum and for ET is $3\frac{7}{8}$ in. maximum. Piv ranges from 100 to 400 v in 100 v steps.

CIRCLE 328 ON READER SERVICE CARD

Bezel Assemblies

FOR C-R TUBES

JAN HARDWARE MFG. CO., INC., 38-01 Queens Blvd., Long Island City 1, N. Y. Brilliant edge lighting of precision engraved reticules, free of glare, feature a new series of crt bezel assemblies. Exposing the maximally useful area of the tube face, these units facilitate study of the signal display and reduce eye strain. Molded neoprene rubber cushions securely nest the tube and

absorb shock to protect against breakage. Complete assemblies for 3 in., 5 in. and 7 in. curved and flat-faced crt's consist of: Cast aluminum and/or molded plastic bezel, scale calibrated reticule, colored light filter, molded rubber shock cushion and mounting hardware. Bezels are finished in smooth, non-reflecting dull black, baked enamel throughout.

CIRCLE 329 ON READER SERVICE CARD

Lab Power Supply
TRANSISTORIZED

POWER INSTRUMENTS CORP., 235 Oregon St., El Segundo, Calif. New transistorized laboratory power supply features an automatic current limiting circuit as well as precision voltage regulation. Short circuit current can be selected (40, 100, 200, and 350 ma) on front panel. Voltage regulation is better than 0.1 percent. Voltage range 0-32 v d-c. Ripple is less than 1 mv. Output impedance is less than 0.2 ohm. Input 105-125 v, 50-400 cps.

CIRCLE 330 ON READER SERVICE CARD

Oscillator Cavity
FOR PULSE SERVICE

TRAK ELECTRONICS CO., 48 Danbury Road, Wilton, Conn. The miniaturized type 9127 S-band oscillator cavity is end-tuned in the range of 2,650 Mc to 3,650 Mc. Power output is 100 w peak minimum over the band. (0.001 duty cycle, 1 μsec pulse. 1,500 v pulse). Output pulse rise time is less than 0.1 μsec; temperature stability, $\pm$ 0.1 percent from 0 deg to + 71 C; shock, 100 g for 3 millisec in each of 3 major axes; vibration, 15 g to 3,000 cycles; size, 1 in. in diameter by 4½ in. long, excluding mounting brackets and output connector; weight, approximately 7 oz; output impedance, 50 ohms; output connector, type TNC.

CIRCLE 331 ON READER SERVICE CARD

Literature of

DIGITAL CONTROL SYSTEM Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif. Bulletin No. 350-2 illustrates and describes a punched card-programmed digital control system. System components are listed and a block diagram is included.

CIRCLE 380 ON READER SERVICE CARD

COMPRESSION TERMINALS Electrical Industries, 691 Central Ave., Murray Hill, N. J. Bulletin SCT-60-101 lists a wide variety of glass-to-metal compression terminals. Electrical specifications and installation data are included.

CIRCLE 381 ON READER SERVICE CARD

VOLTAGE DIGITIZERS Adage Inc., 292 Main St., Cambridge 42, Mass. Applications information concerning Voldicon voltage digitizers has been compiled by the company and released as a bulletin entitled, "What Adage Voldicons Are Doing."

CIRCLE 382 ON READER SERVICE CARD

DIODE EVALUATION Flite-Tronics, Inc., 3312 Burton Ave., Burbank, Calif., has published a 4-page catalog on its recently introduced diode testing system. Catalog is designed for all manufacturers and users of diodes.

CIRCLE 383 ON READER SERVICE CARD

E-FORM PELLETS Epoxy Products, 137 Coit St., Irvington, N. J. A 4-page technical bulletin discusses the advantages of E-Form epoxy pellets; the variety of pellet compounds available; and various epoxy packaging techniques such as encapsulating, sealing, impregnating, ruggedizing, potting, and sealing, embedding and bonding. All are illustrated by simplified diagrams.

CIRCLE 384 ON READER SERVICE CARD

COAXIAL CONNECTORS Kings Electronics Co., Inc., 38 Marbledale Road, Tuckahoe 7, N. Y. Complete technical data on the TNC series of threaded coaxial connectors are contained in a new 12-page catalog.

CIRCLE 385 ON READER SERVICE CARD

GERMANIUM DIODES Ohmite Mfg. Co., 3683 Howard St., Skokie, Ill. Bulletin 158C lists 223 "IN" germanium diodes produced by the

the Week

company as well as the 390 types "OMC" diodes. With all important parameters given, users can make a ready comparison between different types to select the best unit.

CIRCLE 386 ON READER SERVICE CARD

PRECIOUS METALS Texas Instruments Incorporated, Metals & Controls Division, 34 Forest St., Attleboro, Mass. Gold, silver, and platinum-group metals in various solid, clad, and cored mill forms are described in a new 6-page brochure, "Precious Metals for Industrial Applications" (GP-22).

CIRCLE 387 ON READER SERVICE CARD

PHOTOELECTRIC TAPE READER Photocircuits Corp., 31 Sea Cliff Ave., Glen Cove, N. Y. Data sheet No. 2120 outlines in detail the operation of model 100 photoelectric tape reader which employs a printed armature motor.

CIRCLE 388 ON READER SERVICE CARD

WAVEGUIDE SWITCH Don-Lan Electronics, Inc., 1101 Olympic Blvd., Santa Monica, Calif. A recent bulletin covers the Delta miniature waveguide switch model No. W-6KS and W-115KS designed for 12,400 to 18,000 Mc.

CIRCLE 389 ON READER SERVICE CARD

GEARHEADS & SPEED REDUCERS Guidance Controls Corp., 110 Duffy Ave., Hicksville, L. I., N. Y., has available a data sheet on the new line of Series 11, 400 cycle servomotor gearheads and speed reducers.

CIRCLE 390 ON READER SERVICE CARD

TRANSISTORIZED CHOPPER Victory Engineering Corp., 524 Springfield Road, Union, N. J. The new VECO Chopperette solid state transistorized chopper is described and illustrated in a 4-page data sheet now available.

CIRCLE 391 ON READER SERVICE CARD

T-W OSCILLOSCOPES Edgerton, Germeshausen & Grier, Inc., 160 Brookline Ave., Boston 15, Mass. Data sheet 7070 contains features, applications and specifications on models 707 and 708 traveling wave oscilloscopes.

CIRCLE 392 ON READER SERVICE CARD

Don-Lan Expands Facilities

IN AN EXPANSION into manufacture of complete ultraminiature high-efficiency radar antenna systems, Don-Lan Electronics Inc., Santa Monica, Calif., has acquired an additional 17,500 sq ft in a new plant.

The expansion, according to general manager Harold W. Arlidge, has grown from the firm's position in making various components used in antenna systems, including coaxial switches, attenuators, and radar antennas.

Engineering, sales offices and enlarged manufacturing facilities will be located in the new building which is adjacent to the firm's present quarters. In addition, the firm has acquired a site for an antenna pattern range, Arlidge said.

All this follows a broad plan of development into complete antenna systems, says chief engineer Donald Lanctot, who founded the company three years ago. Don-Lan now makes all types of parts used in antenna systems, but markets them separately as components, Lanctot said.

Now a subsidiary of Regan Industries, Inc., of Burlingame, Calif., Don-Lan was purchased through a stock transfer in July, 1958.

Products of the firm are aboard the Talos, Tartan, Atlas, Falcon, Sidewinder and Pioneer V, and are engineered into many others, the company says.

General Ceramics Promotes Manley

JOHN P. MANLEY has been named vice president and general manager of the General Ceramics Division of Indiana General Corp., Valparaiso, Ind.

In his new post, Manley will be responsible for all operations of the Keasbey, N. J., division, producer of ferrite material, components and memory products. Formerly vice president of sales, Manley came to the General Ceramics Division in 1955 from The Indiana Steel Products Co., where he served as eastern regional sales manager.

Alloys Unlimited Appoints V-P

JOHN J. DRANEY has been named vice-president in charge of the newly created Chemical Products Division of Alloys Unlimited, Inc., Long Island City, N. Y. He will supervise the development and production of chemicals and intermetallic compound materials for the semiconductor and related electronic industries.

Draney announces that one of the new products scheduled for early production will be gallium arsenide in polycrystalline and single crystal form for use in tunnel diode production. A complete range of other

Announce Formation Of New Corporation

ELECTRONIC LABORATORIES CORPORATION was recently formed in Torrance, Calif., to manufacture close-tolerance crystal filters, crystal oscillators, and related communications equipment.

Wolfgang G. Prenosil has been named executive vice-president and general manager of the company. He was formerly director of transistor marketing for the Semiconductor Division of Hoffman Electronics Corp.

Robert G. Kinsman has been appointed director of engineering. Prior to joining ELC, Kinsman was in charge of design and development of crystal filters for the Industrial Systems Division, Products Group, of Hughes Aircraft Co.

Prenosil said ELC plans to acquire other firms in related fields of communications, communications components and equipment in the immediate future. Such acquisitions will broaden the product needs of the company and will be made on a cash basis.

Connector Company Changes Name

KEN-TRON CORPORATION is the new name of the Waltham Horological Corporation of Lynn, Mass. According to Paul Goldstein, firm president and general manager, the new name reflects the new look of this manufacturer of r-f connectors and telephone plugs and jacks.

This "bazooka" type cannon of 1395 fired lead, lapidary and finned missiles. Their main disadvantage — practically impossible to aim or guide to its target. The missile was named after Henry VIII because he was considered a connoisseur of walking sticks which were often used to conceal weapons.

Today, as a vital part of one of the world's largest electronics companies, Raytheon's Missile Systems Division is making significant contributions to the art of missilry. The exciting new Pin Cushion Project for selective missile identification, the constantly advancing Navy's air-to-air SPARROW III and Army's HAWK are examples of their outstanding creative work.

We are seeking highly creative people to maintain Raytheon's leadership in this challenging field. For these people, Raytheon's Missile Systems Division creates a climate for talent — perhaps *your* talent.

14th CENTURY: WALKING STICK

ENGINEERING WRITERS . . . will be responsible for writing operating & maintenance manuals. Should have a strong technical background. Experience should include 4-to 6 years in the preparation of manuals for complex electronic systems, such as missile guidance and/or radar. Men with proven administrative ability find this experience put to good use.

EDITORS . . . to bring text and illustrative material together at the production stage of instruction & maintenance manuals and also to make certain the content of the manuals conforms to government specifications and terminology.

Please send detailed resumés or letters to: Mr. Robert T. Hodges, Employment Manager, Missile Systems Division, Raytheon Company, Andover Plant, Andover, Massachusetts.

19A

RAYTHEON MISSILE SYSTEMS DIVISION

. . . creates a climate for talent.

intermetallic material is being scheduled for future production.

Before joining Alloys Unlimited, Draney managed the technical service department of Grace Electronics, Baltimore, Md. Prior to that he was engaged in inorganic chemical research at Merck & Co.

Fleming Moves to New Position

DONALD C. FLEMING has joined Spectrol Electronics Corp., San Gabriel, Calif., as senior project engineer in charge of the company's reliability and standards program for precision wire-wound potentiometers.

Fleming comes to Spectrol after 7 years at the AC Spark Plug Division of General Motors, where he supervised a staff of parts engineers. Previously, he worked for the Naval Ordnance Lab., White Oak, Md., as an R&D engineer testing motors, synchros, and small electromechanical devices.

Nytronics Appoints Two to Board

APPOINTMENT of John M. Templeton of Englewood, N. J., and Ervin Pietz of Watertown, Mass., to the board of directors of Nytronics, Inc., has been announced by Joseph B. Schaefer, chairman of the board. At the same time it was announced that Schaefer, Bernard M. Goldsmith, president, and Kenneth Llewellen, secretary-treasurer, will continue as members of the Ny-

tronics board of directors.

Nytronics, Inc., manufactures miniature electronic devices. Its divisions include Essex Electronic Division of Berkeley Heights, N. J., Essex Electronics of Canada, Ltd., of Trenton, Ontario, and Lexington Electronics Division of Lexington, Ky.

Brush Instruments Hires L. B. Dunn

BRUSH INSTRUMENTS, Division of Clevite Corp., Cleveland, Ohio, has appointed L. Briggs Dunn as quality control manager.

Since 1951 he has been employed by General Electric Co., most recently serving as quality control engineer. His experience at GE also included engineering and manufacturing assignments.

IRC Opens West Coast Engineering Lab

A NEW West Coast Engineering Laboratory for customer service on precision potentiometers has been opened by International Resistance Co. in Hollywood, Calif.

The new facility will be under the direction of Robert Zarnosky who has joined the firm as applications engineer.

Zarnosky was most recently manager of specifications and standards for Collins Radio Co., Burbank, Calif., and was formerly affiliated with the San Fernando Electric Mfg. Co., San Fernando, Calif., as a project engineer.

EMPLOYMENT OPPORTUNITIES

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

Positions Vacant	Civil Service Opportunities	Employment Agencies
Positions Wanted	Selling Opportunities Wanted	Employment Services
Part Time Work	Selling Opportunities Offered	Labor Bureaus

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Subject to Agency Commission.

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ACF ELECTRONICS DIVISION — ELECTRO-PHYSICS LABORATORIES

OUR NEW NAME REFLECTS . . . . . . the ever-growing importance of this unit of ACF—a major, multi-division organization . . . the bringing together of our talents into a highly-regarded, cohesive force in Electronics . . . the expansion of activities simultaneously in a number of broad areas of research, design and development, in modern new facilities.

TO THE ENGINEER, IT MEANS . . . . . . diversification, with choice assignments in the fields of RF Communications Systems, Digital Data Processing Systems and Data Transmission Systems . . . and identification of your contributions to challenging projects of unusual interest.

OUR IMMEDIATE NEEDS ARE FOR:

Research Consultants . . . PhD or MSEE degree, with up to 5 years' experience including background in data transmission, solid-state electronics, data systems development, and systems and circuit design.

—Advanced degree in EE, with experience in communications packaging, including: micro-miniaturization, thin-film, and other solid-state development.

SENIOR ELECTRONIC ENGINEERS

—MSEE or BSEE with background or interest in data transmission, solid-state development, systems and circuit design, or communications packaging.

—MSEE or BSEE with background in miniaturization and transistorization of RF circuitry.

ELECTRONIC ENGINEERS

—EE degree, for solid-state digital circuits and systems design. Background in data processing and wireline transmission desirable.

The Electro-Physics Laboratories are located in the suburban Washington, D.C. area, where post-graduate study is available in several nearby universities. Housing is plentiful in attractive, well-established neighborhoods. Our relocation allowance is liberal.

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For Mid-West and Pacific Coast Locations

At least 2 years experience in design and production engineering of electronic wave filters.

Excellent opportunity for growth with major nationally-known company Comprehensive fringe benefits and pleasant working conditions. Our employees know of this advertisement. All replies confidential.

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P. O. Box 12, N. Y. 36, N. Y.

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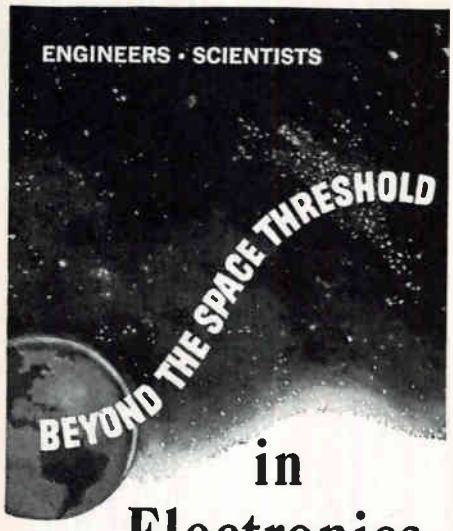

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Requires background in missile propulsion systems analysis as it relates to reaction controls. Must be able to establish reaction control requirements by analysis of vehicle dynamics and have an understanding of propellant fuels and oxidizers for specific systems; handle heat transfer problems to optimize and compare several concepts for a given duty cycle; determine optimum over-all performance characteristics, thrust response with given inputs, and chamber pressure and oxidizer-fuel ratios for various nozzle heat sink designs; assist on all proposal efforts requiring propulsion system analysis.

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Requires background in rocket engine design, specifically bipropellant type. Must be capable in valving design techniques for injection mixing, oxidizer to fuel ratio adjustment, positive shut-off and valve actuation methods, determining thrust at sea level and vacuum with various fuels and combustion chamber designs. Must have working knowledge of high temperature materials and materials compatible with exotic fuels and oxidizers; ability to determine the optimum configuration (nozzle, valves, torque motor, injectors, etc.) for given applications; ability to work with design and layout draftsmen, model makers, and evaluation engineers in following through with a design development.

If you are a qualified engineer, we would like to hear from you. Just drop a line including pertinent information on your background, interests, and accomplishments to Mr. James C. Burg, Dept. 664C, Honeywell Aeronautical Division, 1433 Stinson Blvd. N.E., Minneapolis 13, Minn.

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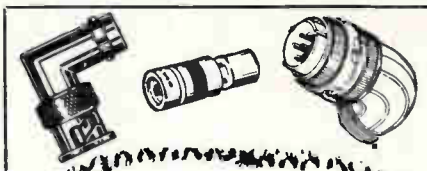

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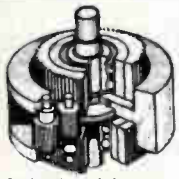

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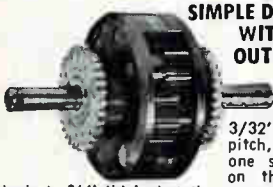

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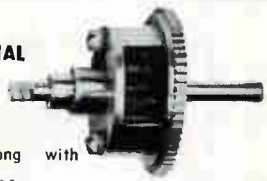

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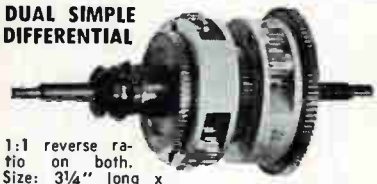

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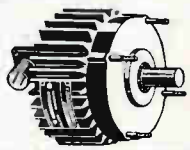
400 CYCLE, 3 PHASE GENERATOR
BY MASTER ELECTRIC

Type AG, frame 364Y, 7.5 kw, 342B rpm, pf .95 Star connected 120/208 3 phase, 22 amps. Delta connected 120 volt single phase 66 amps. Self excited. Complete with control box, voltage regulator, AC voltmeter and frequency meter. Shaft 1" dia., 2" long; overall dim. of unit: 21"x18"x 20".
Price $395.00 each

400 CYCLE PM GENERATOR

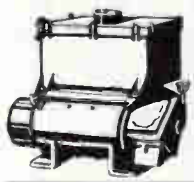


115/200 volts A.C. 1- or 3-phase, 200 watts. 4,000 r.p.m. Approx. dimensions: 4¾" dia.; 3" long; ½" shaft, AN connector. $75.00

400 CYCLE MOTOR GENERATOR

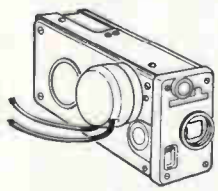
Mfgd. by General Electric
Model #5ATB324E5
Output 120/208 volts AC, 400 cycle, 11.75 kva, 32.6 amp., pf .85. Input 220/440 volts AC, 60 cycle, 3 phase, 15 h.p. Unit complete with motor starter and controls.
Price $750.00

ONAN MOTOR GENERATOR SET
MG 075-G-1



Generator 115 VAC; 480 cycle; 5.3 amps; .6KW; PF 1.0; also 26 VDC; 100 watt; 3.8 amps; Driven by 115-230 VAC —2hp motor; 60 cycle; single phase; 3450 rpm; 10.5 amps.
Price $135.00

16mm SINGLE FRAME CAMERA



mfgd. by Bell & Howell (200 series) 50 ft. magazine load operates on 12 volt DC, has rotary solenoid, standard C mount, less lens and view finder; excellent for photographing records, nature study, etc.
Price $35.00 each

CIRCLE 464 ON READER SERVICE CARD

SEARCHLIGHT Equipment Locating Service

NO COST OR OBLIGATION

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used electronic equipment and components *not currently advertised.* (This service is for USER-BUYERS only).

How to use: Check the dealer ads to see if what you want is not currently advertised. If not, send us the specifications of the equipment wanted on the coupon below, or on your own company letterhead to:

Searchlight Equipment Locating Service
c/o ELECTRONICS
P. O. Box 12, N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

Searchlight Equipment Locating Service
c/o ELECTRONICS
P. O. Box 12, N. Y. 36, N. Y.

Please help us locate the following equipment components.

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NAME .....

TITLE .....

COMPANY .....

STREET .....

CITY 6/10/60

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*

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

ADVERTISERS INDEX

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Our Bigger, Better Buyers' Guide

ON THE 4TH OF FEBRUARY, questionnaires were mailed to 6,238 manufacturers serving the electronics industry, and since then we've been hard at work compiling our 20th annual Buyers' Guide and Reference issue. We've mailed a second questionnaire to those who failed to answer the first, and letters and telegrams have been pouring out —and in—to finish the job. As is the case every year, multiple revisions and hundreds of product classification changes must be made to keep up with our fast-growing industry. The Guide is a monumental piece of work, and we're particularly proud of its completeness and accuracy.

This year the Guide has its own editor, George Sideris of the ELECTRONICS editorial staff, who has been performing this specialized duty since last December. His job has been the compilation of the many pages of engineering and industry reference material that make the Guide far more than a catalog of products and manufacturers, and to assist in the determination of needed new classifications.

This year, also, the Guide will contain the name, address and telephone number of every manufacturers' agent or field office for each of the companies whose products are listed.

Incidentally, we make no charge for any of our listings. To do so would impair completeness. And we insist that we be supplied with catalogs or other tangible evidence that items listed are actually available. Not to do this would impair usefulness.

The 1960 Buyers' Guide and Reference issue will be sporting a hard cover this year. In production, we are employing for the first time a new photographic process of reproducing listings which preserves previously proven accuracy and still enables us to make last-minute changes.

We've scheduled the Guide this year to appear in July, rather than in June.

If you are a subscriber to ELECTRONICS, your copy will be delivered next month. And, by the way, if you are reading a company copy of the magazine, and the Guide is spirited away or sent to the library, you may want your own copy. If so, check the appropriate box on our reader service postcard and enter your own, non-pilferable subscription to ELECTRONICS and the Guide—sent to your home, or your office. If your subscription order reaches us before July 1st, the 1960 Buyers' Guide will be mailed to you as part of the subscription.

James Gilwood

PUBLISHER

TALL TALE FROM TEXAS

A few years after the Battle of the Alamo, a Texan was showing a friend from Oklahoma around the famed battle site.

Everything was preserved just as it had been on the historic day. The donkey still plodded patiently on his treadmill, making the great radar antenna turn round and round.

"What's that?" the man from Oklahoma asked.

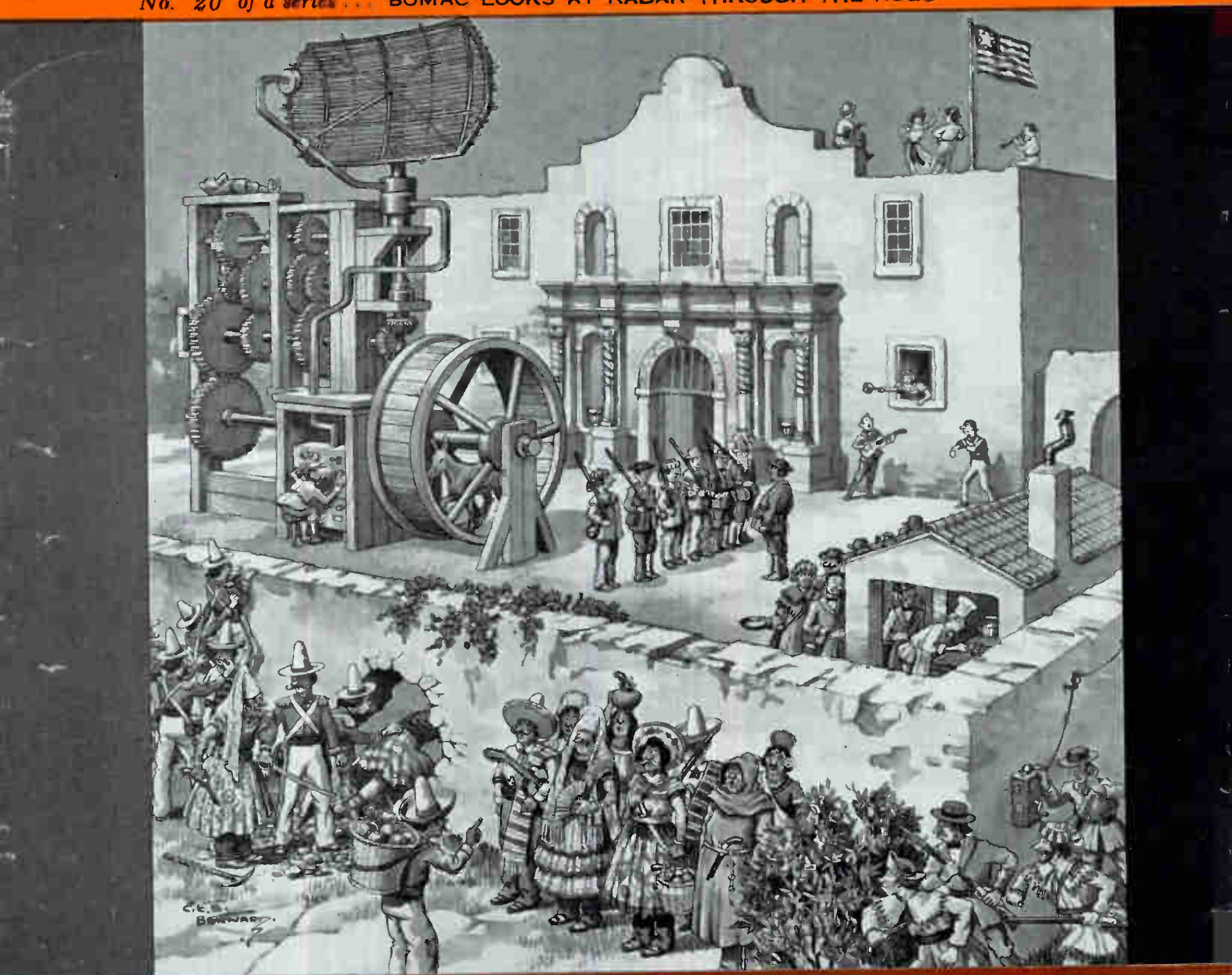
"Why anybody knows what that is!" the Texan said. "That's radar. Invented right here in Texas. It can see in the dark, this radar can. You can't make a move without its knowing it, no matter if you're two miles away."*

"If that's what radar is — some ass on a treadmill, goin' nowhere . . . for something that can see in the dark and you can't get away from — we've had them in Oklahoma for years."

"You've had radars for years?"

"Sure," the Oklahoman said. "Only we call 'em husbands and wives."

No. 20 of a series . . . **BOMAC LOOKS AT RADAR THROUGH THE AGES**



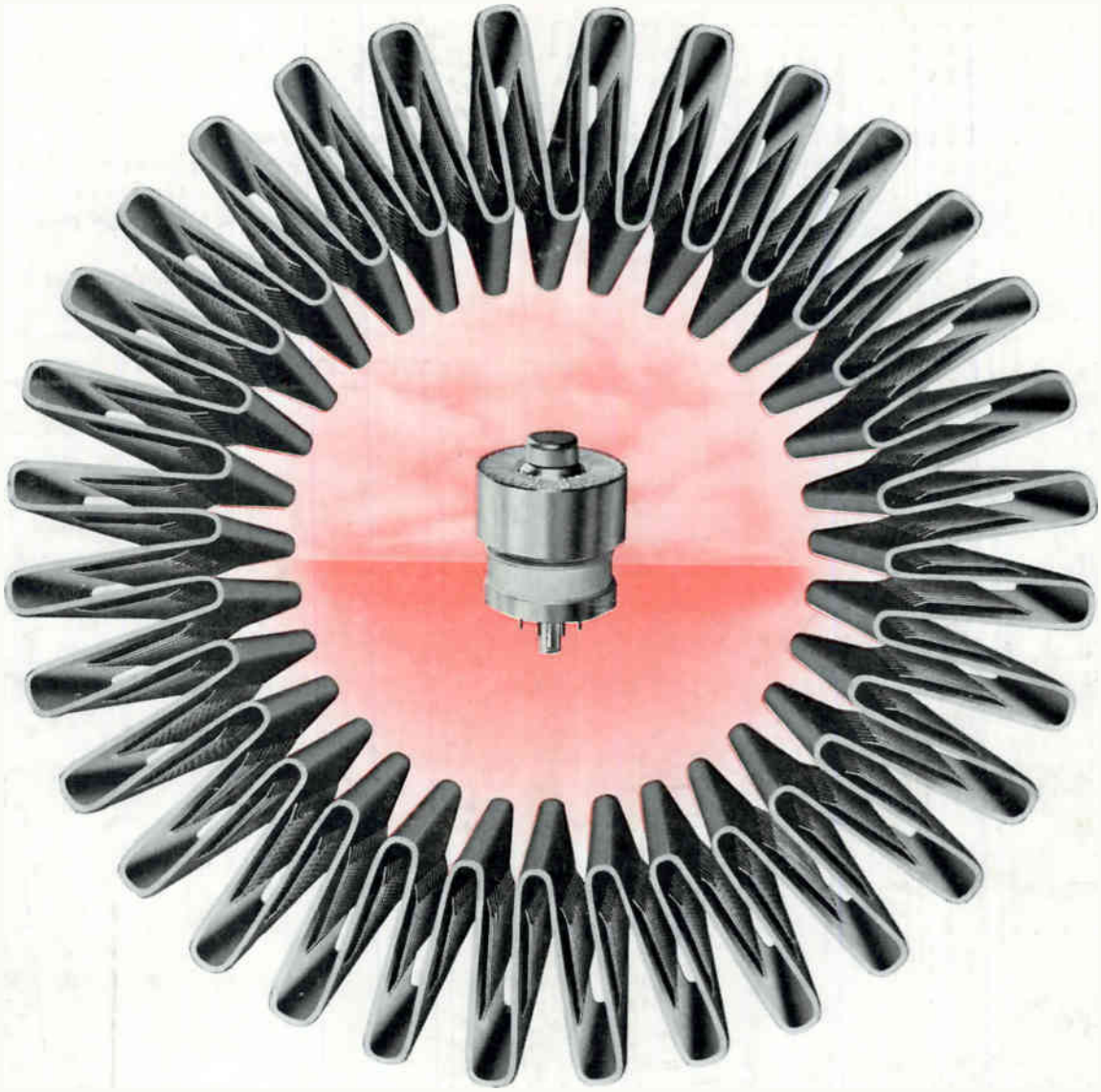
* *Today, Bomac makes the finest microwave tubes and components since the Texans invented radar.*

BOMAC laboratories, inc.

SALEM ROAD • BEVERLY, MASSACHUSETTS

Leaders in the design, development and manufacture of TR, ATR, Pre-TR tubes; shutters; reference cavities; crystal protectors; silicon diodes; magnetrons; klystrons; duplexers; pressurizing windows; noise source tubes; high frequency triode oscillators; surge protectors.

Offices in major cities—Chicago • Kansas City • Los Angeles • Dallas • Dayton • Washington • Seattle • San Francisco • Canada: R-O-R Associates Limited, 1470 Don Mills Road, Don Mills, Ontario • Export: Maurice I. Parisier, 741-745 Washington St., N. Y. C. 14, N. Y.



RCA radiator efficiency allows you to cut blower horsepower in half

Resulting space and weight savings permit more compact packaging, greater design versatility

Recently a leading manufacturer of communications equipment ran a comprehensive series of tests comparing the heat dissipating capabilities of RCA-7203/4CX-250B, with integral radiator, to a standard JAN/4X-250B. The results: the JAN/4X-250B required twice as much blower horsepower.

The integral radiator on RCA-7203 is an exclusive RCA development. It is used on many types of RCA tubes for air-cooled operation. Its remarkably efficient louvered construction is a logical development in radiator design . . . but only RCA has mastered the complex manufacturing problems involved.

This high-efficiency integral radiator is one of the things that makes RCA power tubes so popular in designs where space and weight are critical considerations. For further information about this and other pace-setting features of RCA power tubes, including the new Cermolox* line, write:

The Marketing Manager, RCA Electron Tube Division, Industrial Tube Products Department, Lancaster, Pa.

***RCA's line of coaxial, precision-aligned grid, beam power tubes of ceramic and metal construction. See RCA's forthcoming advertisement on this complete line.**

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