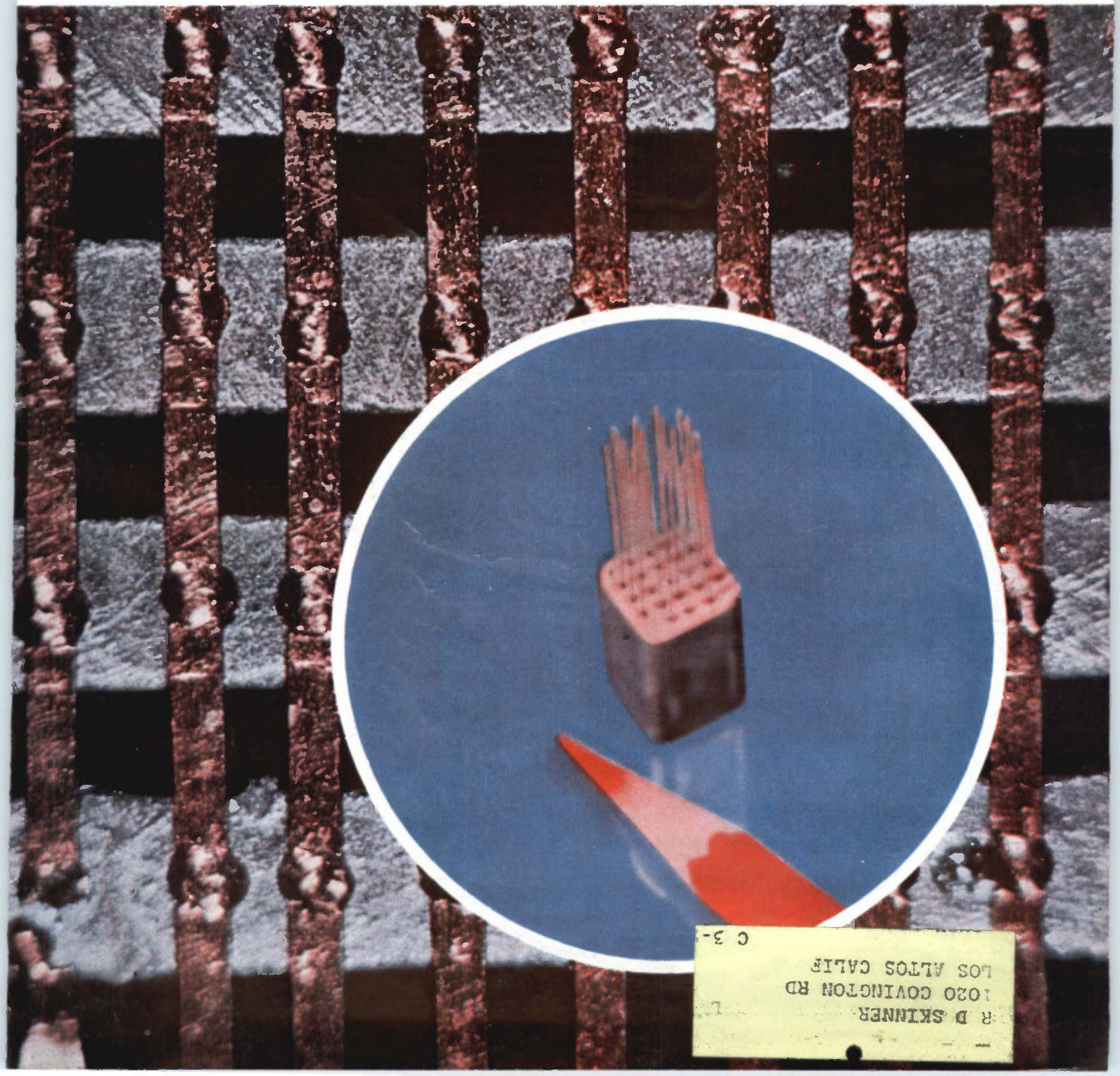
A McGraw-Hill Weekly 75 Cents May 24, 1963

electronics®

FIRST COLOR RADIOPHOTO SENT BY SATELLITE

Color inset was sent from New York to London by Relay satellite and returned over Atlantic cable, p 51

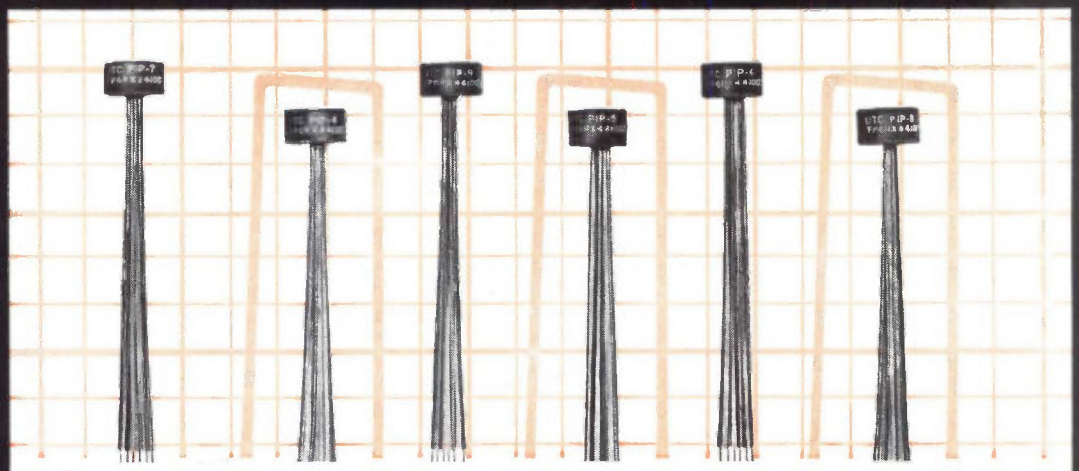
New micromodule (inset below) incorporates thin-film and integrated circuits. Welded ribbon matrix (background) interconnects wafers, p 78



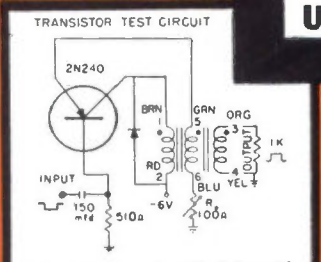
NEW PIP SERIES

ULTRAMINIATURE TRANSISTOR PULSE TRANSFORMERS

PIONEERS IN MINIATURIZATION



UNITS SHOWN ACTUAL SIZE—IMMEDIATE DELIVERY FROM STOCK



All units individually checked and adjusted, in transistor circuit illustrated, to parameters in table.

DEFINITIONS

Amplitude: Intersection of leading pulse edge with smooth curve approximating top of pulse.
Pulse width: Microseconds between 50% amplitude points on leading and trailing pulse edges.
Rise Time: Microseconds required to increase from 10% to 90% amplitude.
Overshoot: Percentage by which first excursion of pulse exceeds 100% amplitude.
Droop: Percentage reduction from 100% amplitude a specified time after 100% amplitude point.
Backswing: Negative swing after trailing edge as percentage of 100% amplitude.

- RUGGED—COMPLETELY METAL CASED
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- 5/16″ Dia. x 3/16″ Ht.; Wt. 1/20 oz.
- Ratios—4:4:1 and 5:3:1
- Anchored leads, withstands 10 lb. pull test
- Printed circuit use, plastic insulated leads
- Can be suspended by leads or clip mounted

	APPROX. DCR, OHMS			BLOCKING OSCILLATOR PULSE					COUPLING CIRCUIT CHARACTERISTICS						
Type No.	1-Brn 2-Rd	3-Org 4-Yel	5-Grn 6-Blu	Width μ Sec.	Rise Time	% Over Shoot	Droop %	% Back Swing	P Width μ Sec.	Volt Out	Rise Time	% Over Shoot	Droop %	Back Swing	Imp. in/out*
RATIO 4:4:1 MIL TYPE TP6RX4410CZ															
PIP-1	.18	.20	.07	.05	.02	0	0	37	.05	9	.018	0	0	12	50
PIP-2	.47	.56	.17	.1	.025	0	0	25	.1	8	.02	0	0	5	50
PIP-3	1.01	1.25	.37	.2	.03	2	0	15	.2	7	.035	0	0	5	100
PIP-4	1.5	1.85	.54	.5	.05	0	0	15	.5	7	.06	0	0	0	100
PIP-5	2.45	3.1	.9	1	.08	0	0	14	1	6.8	.15	0	0	5	100
PIP-6	3.0	3.7	1.1	2	.10	0	0	15	2	6.6	.18	0	2	10	100
PIP-7	4.9	6.05	1.8	3	.20	0	0	14	3	6.8	.20	0	2	10	100
PIP-8	8.0	9.7	2.9	5	.30	0	0	3	5	7.9	.22	0	13	25	200
PIP-9	13.1	15.9	4.7	10	.35	0	5	12	10	6.5	.4	0	15	20	200
PIP-100	Transistor pulse transformer kit, consisting of PIP-1 thru PIP-9 in plastic case.														
RATIO 5:3:1 MIL TYPE TP6RX5310CZ															
PIP-10	.55	.41	.15	.1	.01	0	0	20	.1	8	.01	0	0	5	140/50
PIP-11	2.9	2.2	.82	1	.02	4	4	6	1	6.6	.05	0	6	12	280/100
PIP-12	9.4	7.1	2.6	5	.05	0	12	12	5	8	.09	2	12	25	560/200

* Input winding leads Brn-Rd (1-2); output winding leads Org-Yel (3-4); leads Grn-Blu (5-6) open.

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May 24, 1963

electronics

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Contents Continued

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CONTENTS Continued

DEPARTMENTS

Give ComSat a Chance

WE MAY never understand lawyers and legislators. Just when we think they have a problem nicely ironed out, they sometimes manage to introduce fresh complications.

Take the new Communications Satellite Corporation. We thought that once the government set it up, the government would let it make its own way in the world as a private corporation.

But some Washingtonians are now chewing over the possibility that the government won't sever the umbilical cord, that it will effectively run the corporation by directing its choice of system, equipment suppliers, and so on.

Proponents of government control fear that unless the government does mother the corporation, one or two companies represented on the corporation's board could use their position and their experience in space communications to monopolize the space communications equipment business. Opponents fear that unless the government keeps out of the corporation's internal affairs it will lead the U.S. further towards socialism.

Talking is part of the Washington way of life. From it, all laws flow. But we do hope that the talk now going on about the Communications Satellite Corporation doesn't lead to premature changes in the law or to application of strong government control early in the corporation's life.

The law setting up the corporation was passed after a lengthy debate that supposedly settled basic issues. The free-enterprise and antimonopoly provisions in the existing law should be given at least a few years to prove their worth. All the government should do for now is concern itself with the rate, service and profit structures of the corporation as they affect the using public—the same as any other utility—and let the corporation and its stockholders worry about the details.

If the government takes too vigorous an interest in the corporation's affairs, it might as well run it like a "Space TVA." This would be contrary to Congress' decision last year.

If, on the other hand, the corporation or its personnel should use their positions in a manner contrary to the public interest, the government can quickly put a stop to such practices by exercising its present regulatory powers.

By leaning as far as possible towards a hands-off policy, the government will give free enterprise a chance to demonstrate whether it can adapt to the space age.

WHAT A FIELD TRIP! Telemetry's fascination has just been multiplied by some promotional literature on the International Telemetering Conference. After the sessions end in London on September 27, the conferees have the option of returning home or of taking "an extended tour of European telemetering facilities" lasting a dozen days. The tour brochure mentions facilities several times. And it also mentions about 50 or 60 such advances in the state of the art as the Paris Opera House, Rembrandt's house in Amsterdam, the Eiffel Tower, Schloss Heidelberg, Capri, the Vatican Gallery and the Palace of the League of Nations. We were ready to leap at this opportunity to see the latest in European techniques, when we were reminded that McGraw-Hill World News staffers in Europe have already inspected these facilities and that there was no point in repeating all their legwork.

Coming In Our May 31 Issue

NEW DEVICE, NEW CIRCUITS. Something new in the solid-state showcase is the nonlinear-resistance element. This isn't a single component—it's a couple of transistor amplifiers put together into one neat, versatile package. Among its applications are monostable multivibrator, d-c switch, Q multiplier.

The details on the NRE and its uses are just one one of the circuit-design topics next week. Others are:

- New approach to wideband integrated-amplifier design, using closed-loop, open-loop analysis. This technique isn't confined to any one packaging style. It's been used for conventional, miniature and microminiature three-stage amplifiers.
- Reference sheet, with chart that gives RLC values for critical damping.
- The communications system that sent Mariner II data back from Venus will be thoroughly detailed in another article, pointing up what is in store for future long-range space communications systems.

COMMENT

Negative Resistance

I have read Mr. Sproull's *Comment* (p 4, April 26) on negative resistance, and I would like to suggest that the subject gets more and more involved, and the term more ambiguous, as time goes on.

I suggest that the term "negative resistance" be relegated to the wastebasket and the old standby, "conductance", be used in its place.

One of the confusions commonplace in electronics articles is the misuse of the term "resistance." It is not uncommon to find it stated that this or that happens when there is resistance in a circuit.

Since resistance, if carried to infinity, becomes a close relation to nothing, it can be conclusive that any amount of resistance in a circuit is a degree of nothingness determined by the value of the resistance.

In all correctness, current flows in a circuit due to a degree or value of conductance, and not to a degree or value of resistance. In addition, some interesting observations are derived experimentally by making current measurements in terms of conductance.

HARRY ALDEN LYON
Lyonart Industries
Taos, New Mexico

Rabbit's Foot Communication

[Regarding the April 5 *Crosstalk* item (p 3) about the following week's article, New Transducers For Communicating By Seismic Waves, by K. Ikrath and W. Schneider], every country-boy rabbit hunter is familiar with that animal's earth-thumping signal system, although its code is something else again, akin to crow language.

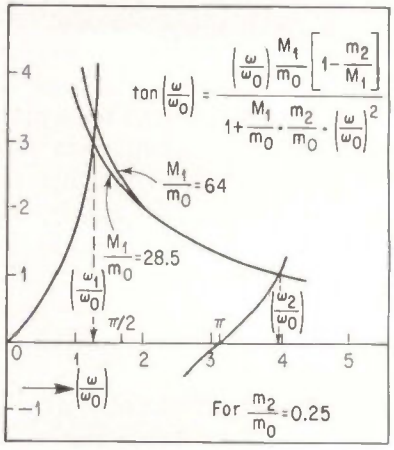
If brain-to-brain signaling, as some would have us believe again, is real, then its transmission speed is inordinately slow. Some five or more years ago, in response to, as I recall, the head of the Rome, New York, laboratories' request for new ideas in communication, I suggested the resurrection of Tesla's old idea for setting the earth into electrical oscillation at its own natural frequency as one such; another involved use of deep, abandoned or dry oil wells with a closely-coupled, impedance - matching, powerful vibration-excited and a remote receiver well, as an R&D starter for a seismological system, either by discrete pulses, or by resonating a laterally boundaried, diametrical, solid layer. This is done now undersea by SOFAR, and it might work in earth layers too.

B. F. MIESSNER
Miessner Inventions, Inc.
Miami Shores, Florida

Seismic-Wave Communication

In the article, New Transducers For Communicating By Seismic Waves (p 51, April 12), an error was made in the sign in Eq. 1 (p 52).

The negative sign preceding the numerator of Eq. 1 and in Fig. 2A should be a plus. Figure 2A should also be altered:

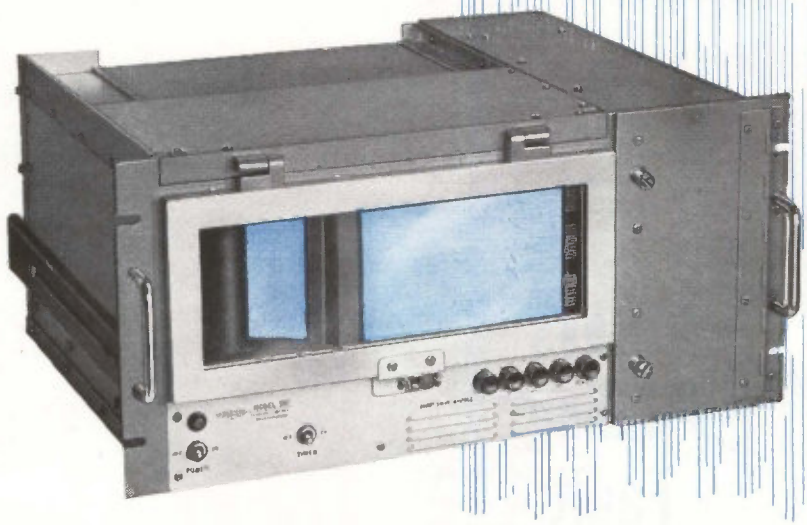


On p 52, the next-to-last sentence before Eq. 1 should read, "We then determined the dynamic stiffness, indirectly by experiment, with approximately *four percent off* the static stiffness."

On p 53, the first sentence should be, "Equation 1 also reveals that by extreme reduction of the drive-coil mass m_2, a *higher* resonance frequency will be obtained." In the third paragraph, the last three sentences should read, "In this case $\omega_1/\omega_0 = 1.28$ . . . so that $\omega_0 = 500/1.28 = 390$ . . . This yields . . . $0.64 \times 15 \times 10^4 = 0.96 \times 10^5$ . . . This is *four percent off* the static stiffness . . .

KURT IKRATH
U.S. Army Electronics R&D Lab.
Fort Monmouth, New Jersey

New SANBORN 30-channel EVENT RECORDER



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This economical new 30-channel operations monitor provides immediate, permanent recording of on-off events on dry, electrosensitive charts — using "pulsed writing" for maximum clarity, stylus life and economy of power, Six different *interchangeable*, plug-in 10-channel *solid-state* Writing Control cards are available to match your signal voltage and recording requirements. Included are types which operate with logic levels between +6 and +40 volts or −6 and −40 volts. Also, "precision types" for monitoring low level signals are available with adjustable threshold or balanced input (with respect to signal return). Model 361 system, for rack mounting or portable case, is 8¾" x 19" wide x 14½" deep, weighs approx. 50 lbs. Complete 30-channel system, with either +6 v to +40 v or −6 v to −40 v Writing Control, is $2050 F.O.B. Waltham, Mass. Prices with other Writing Controls on request.

FOR UP TO 120 CHANNELS of on-off recording, Model 360 uses 16" wide, 450-foot charts; has 9 standard and 9 optional additional speeds; takes only 14" of panel space complete with integral cooling system. Solid-state plug-in Writing Control cards described above are optional. Model 360 120-channel Recorder alone, $3900; prices with various Writing Controls on request.

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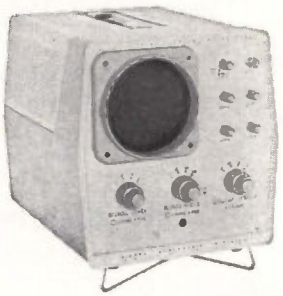

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After Cooper's Flight, What?

CAPE CANAVERAL—With the success of Astronaut Gordon Cooper's 22-orbit MA-9 shot resounding in their ears, NASA officials were this week trying to decide if a MA-10 launch is called for. An announcement is expected shortly.

Conflicting viewpoints on the MA-10 were evident at Cooper's news conference Sunday. Cooper himself backed a MA-10 flight, saying that it would gather much valuable data. But NASA's associate director, Robert Seamans, said the MA-10 is "unlikely" as additional manpower is needed to speed up the Gemini program.

The electronic failures which made millions of persons hold their breaths for Cooper's safety are sure to play a big part in the MA-10 decision, even though Cooper and Astronaut John Glenn denied there was any serious danger from them. A latching relay which locked when it shouldn't have caused the by-now-famous "05G" light to come on late in the flight, officials said, also preventing the attitude gyros from operating. More trouble ensued in the last orbit when the inverter used to change d-c to a-c for the whole autopilot system broke down.

Cooper's flight checked out two electronic systems developed for Gemini. They were a direct communications line to Hawaii permitting the Cape capsule communicator to talk directly to Cooper while he flew above the Hawaii area, and a remote operation capability of the electrocardiogram receiving equipment at three range stations.

The direct-talk line used a phase-shift-keying technique with a special notch tone filter at both ends of a standard communications circuit. It worked perfectly, it was reported. The ekg operation worked well and a remote set-up around the world for this and other data is feasible, NASA said. A dual tv-telemetry channel (p 18, March 22) also worked well, Astronaut Cooper said.

Japanese Firm Selling Know-How to Rumania

TOKYO—Hokushin Electric Works says that the government will allow it to extend technical assistance to Rumania for the production of electronic controls. Hokushin has signed a $1.33-million contract with Masinimport of Bucharest, the state machine import corporation.

The agreement covers the company's automatic control apparatus, self balancing recorders, and data processing equipment. It gives Masinimport exclusive production and sales rights in Rumania and provides for use of patent rights and delivery of know-how and technical information necessary to construct plants to make the equipment. Hokushin will also supply technicians and the necessary parts and instruments.

Hokushin has a 25-year cross-licensing agreement with Fischer and Porter, an American firm, but Hokushin says the Rumanian agreement covers only instruments independently developed by Hokushin. Because Hokushin's relations with F&P are very close, Hokushin obtained a gentlemen's agreement with F&P for export of Hokushin's technology to Rumania.

West Ford Going Strong —So Are Its Critics

CAMBRIDGE—Propagation measurements and communications experiments conducted with the partially formed West Ford dipole belt are proving successful as "construction" of the passive-repeater belt in space continues at the rate of about 1,000 miles a day (p 8, May 17, and p 7, May 10).

The West Ford transceiver terminals manned by MIT Lincoln Laboratory researchers at Millstone Hill, Mass., and Camp Parks, Calif., are daily measuring such propagation characteristics as signal distortion in time delay and frequency. Experiments are believed to include both digital data and voice trans-

Disarmament Agency Pushing for Status

ARMS CONTROL and Disarmament Agency is seeking status equal to that of other government agencies. First change would be elimination of the $10-million authorization ceiling to "such sums as may be necessary and appropriate." The request for 1964 amounts to $15 million, of which $11 million would be spent for contracts outside the agency. Industry contractors thus far include Bendix, Raytheon, Hudson Institute, Sylvania, and Aerospace Corp. The agency also wants to relax security requirements for contractor personnel.

Contracts in fiscal 1964 will include studies on integration of techniques in inspection systems; elements in an inspection system (aerial inspection, satellite inspection techniques, specific sensors of aerial or satellite inspection, analysis of records and finance data, training requirements); verification of specific armaments and activities such as nuclear tests, clandestine activities, space exploration, R & D activity, production of strategic delivery vehicles, and retained levels of conventional and tactical nuclear weapons; inspection of field test program; computer services, and methodological studies

How About Smith?

STOCKHOLM—IBM 1401 and 7070 data processing machines have been put to use to create almost a million new family names for Swedes. Hundreds of thousands of Andersons, Carlsons, Pettersons, Svensons and Johansons cause no end of confusion and the government is encouraging persons with such common names to choose new ones. A committee, after winnowing the million names by hand, is expected to authorize about 50,000 of them for adoption

mission similar to those conducted by moon bounce by Lincoln Lab while waiting for a dipole belt.

Commenting on West Ford, Prof. Fred T. Haddock, director of the University of Michigan Radio Astronomy Observatory, said:

"The test belt itself isn't damaging to radio astronomy but radio astronomers are still mighty concerned about the precedent established and about the possibility of future growth of experiments of this type—when a large number of objects are put into orbit."

Medium-Altitude System Seen ComSat's 1st Goal

CONSENSUS among space experts queried by ELECTRONICS is that the Communications Satellite Corp. will probably go for a medium-altitude satellite system initially, and gradually phase into a Syncom-type synchronous system as the latter technique is perfected.

A corporation spokesman confirmed that this is its thinking, but a formal announcement won't be made for many months.

Meanwhile, the Air Force has selected GE and a Philco-Space Technology labs team to compete in a "program definition" study of a medium-altitude, random-orbit military communications satellite system. After two months, each contractor will make a technical and cost proposal.

Voice System Lowers Power, Bandwidth Needs

NEW YORK—A voice communication system that would decrease the bandwidth and power requirements of some types of voice channels was described by Louis Focht of Philco at last week's meeting of the Acoustical Society of America.

Incoming speech would be analyzed for: pitch or frequency, envelope shape, whether voiced (vocal cords in motion) or unvoiced (a whisper is unvoiced), and for dominant or recessive formant (determines vowels). A digital equivalent for each factor is derived and the combined signal transmitted at about 500 bits per second.

The synthetic speech signal is reconstructed at the receiver.

Injection Laser Transmits Audio Data

IBM DEMONSTRATED Tuesday transmission of audio information signals over a light beam generated by a gallium arsenide injection laser. When the voltage of the delay line in the modulation circuitry reaches a preset level, a 4-layer diode at the end of the line breaks down, discharging a 0.2-μsec, 5-amp pulse through the laser. The charge time of the delay line, and therefore the frequency of the laser pulse train, is controlled by the amplitude of the information signal through a variable resistance element. Average prr is 12 Kc.

British IRE Assails Electronics Industry

LONDON—The British Institution of Radio Engineers has criticized this country's radio and electronics industry for lack of direction, no coordination in research endeavors, too much emphasis on "fashionable" subjects and too much security. The BIRE wants to set up a Radio and Electronic Research Council to remedy these defects. Fields being neglected include radio propagation, ultrasonics, network color tv, automation and satellites.

In Brief . . .

SOVIET UNION says it has lost radio contact with its Mars-1 automatic interplanetary station. The last regular radio transmission was sent on March 21 when the probe was 106 million kilometers from earth.

U. S., BRITISH and Bahamian officials have finally reached agreement for the construction of a giant $100-million underwater submarine warfare testing range to be built by the Navy in the Bahamas near Andros Island (p 12, April 26).

RCA IS WORKING on a "metal sheet memory with extreme temperature tolerance" that is completely different from thin film and conventional memories. RCA would not elaborate on this.

TWO of every fifteen tv sets produced in Japan during March had a screen size of 12 inches or less, says EIA-Japan.

INSERTION into polar and elliptical orbits and other mission variations will be incorporated into future Tiros launches. One will carry Nimbus subsystems including an infrared recorder and automatic cameras.

RCA EXPECTS to receive $100-million in contracts for the Lunar Excursion Module. It is understood this will include power supplies and telemetry equipment, plus items mentioned earlier (p 8, May 17).

PERKIN-ELMER will build a miniature infrared carbon-dioxide sensor for monitoring manned space vehicle cabin atmospheres.

ELECTRO-OPTICAL Systems, Inc. won a $2.2-million contract for electrical power systems for the Ranger 6 through 9 lunar spacecraft.

AIR FORCE gave Geotech a $1,479,775 contract under the Vela-Uniform program to improve the detection of underground nuclear explosions, using its new borehole seismometer that can operate two miles below ground.

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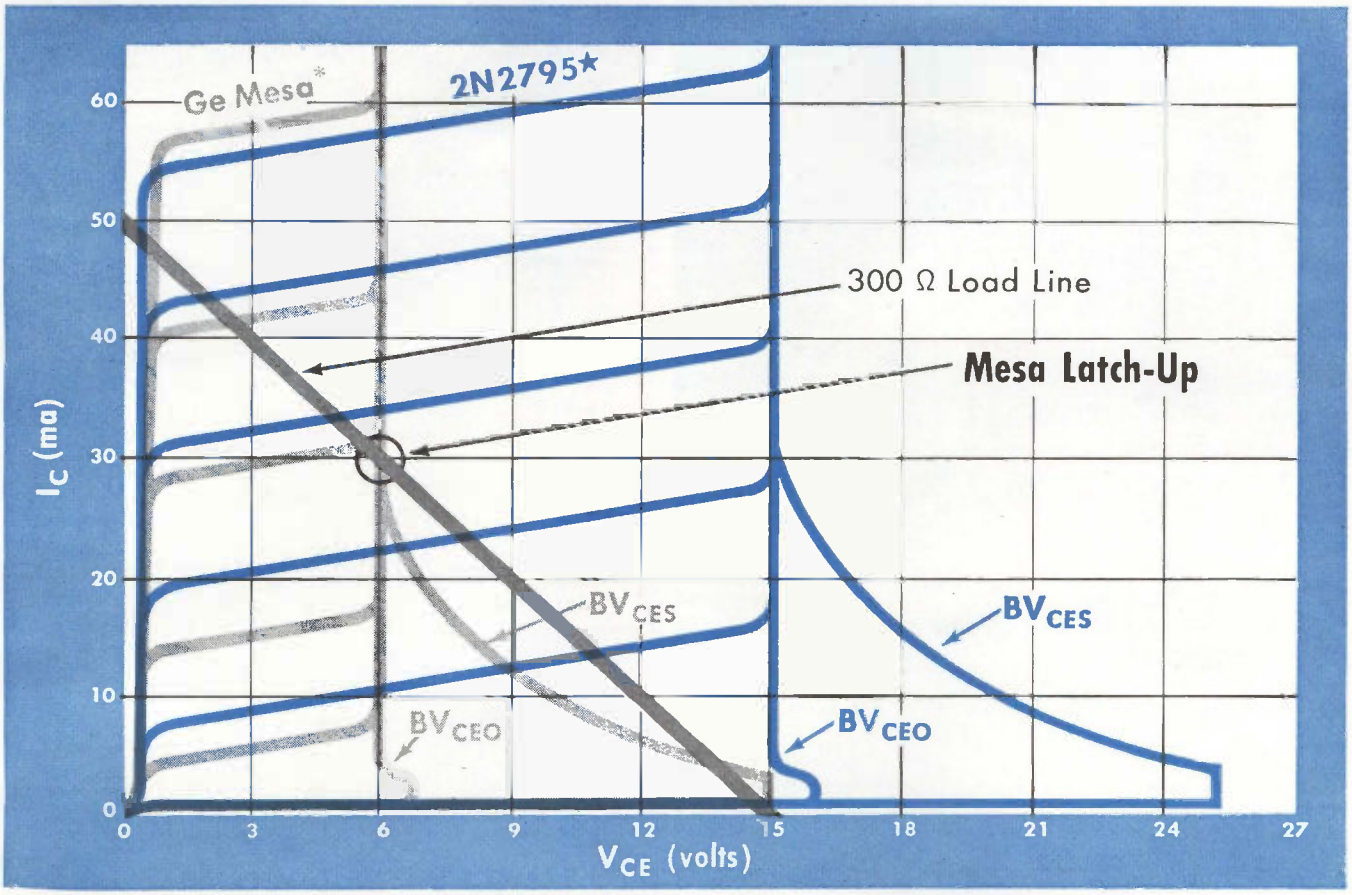

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2N979	150 mc	20 volts	15 volts
2N980	150 mc	20 volts	12 volts
2N2048†	250 mc	20 volts	15 volts

(†TO-9 Case)

● For additional information on Sprague High Voltage Logic Transistors, write to the Technical Literature Service, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

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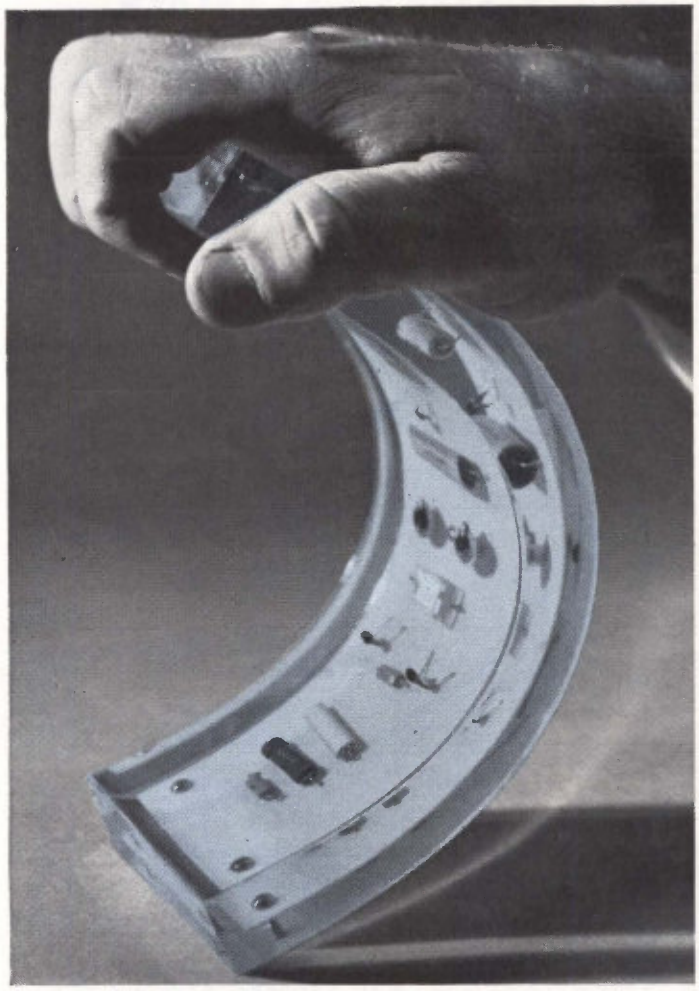

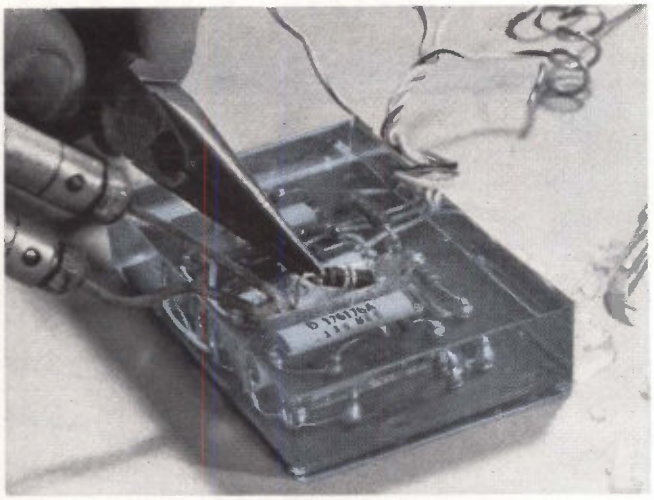

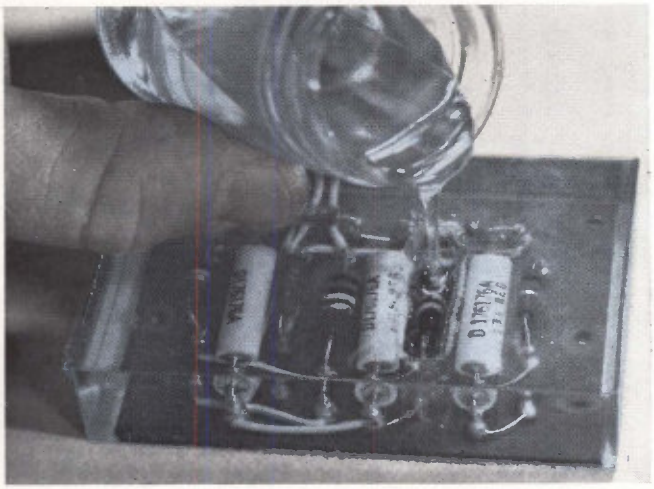

New casting resin–Sylgard® 182–is tough, flexible and repairable

Visual inspection . . . environmental protection . . . ease of processing . . . simplicity of repairs — these and other features make Sylgard 182 an important new tool when engineering for value.

Tough yet flexible, this solventless silicone casting resin cushions against shock and vibration from —70 to 225 C . . . assures constant dielectric strength in any environment . . . resists the effects of ozone, voltage stress, heat aging and thermal cycling.

Processing is simplified since Sylgard 182 and its curing agent are not toxic to the skin . . . nor do they give off toxic fumes or heat during blending or curing. Curing time can be controlled by the external heat applied — from as little as 15 minutes at 150 C to four hours at 65 C.

Deep sections cure thoroughly. There are no solvent fumes to be trapped . . . and visibility is excellent. Applied as a fluid, Sylgard 182 resin flows readily around intricate shapes . . . cures even in deep sections without damage from internal stresses or exothermic heating.

Repairability is assured when circuits are embedded in Sylgard 182. Defective components can be removed and replaced after cutting away the cured resin with a sharp knife. New resin, poured over the repaired area, adheres to the existing encapsulant restoring the entire unit to its original condition.

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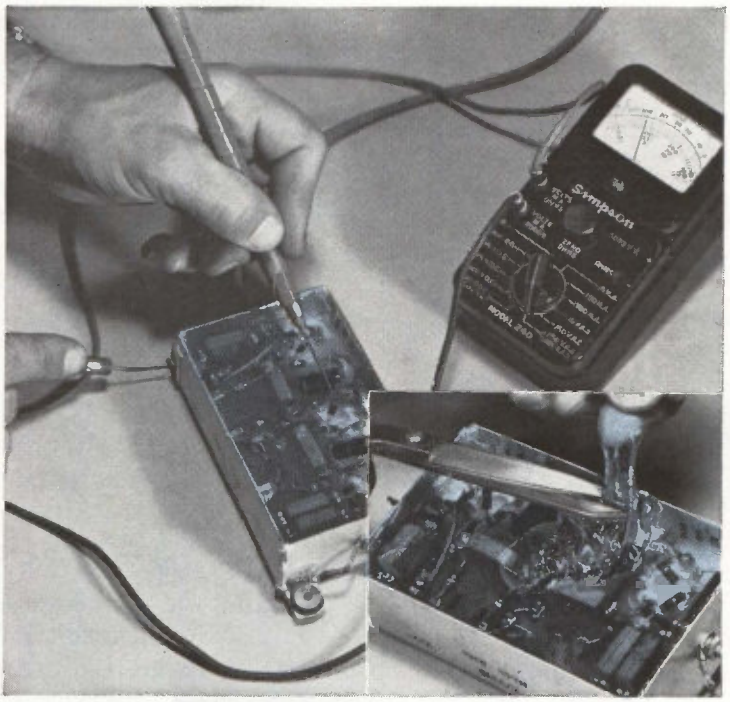
Dielectric Gel permits both visual and instrument inspection of potted circuits and components. Poured as a liquid, Dielectric Gel fills all voids, then sets up as a transparent, heat-stable, resilient mass. No significant stresses or exothermic heating develops during cure. Even the most delicate electronic components are safe. Instrument probes can be inserted and withdrawn repeatedly without damaging the outstanding dielectric properties of this Dow Corning silicone potting material.

Circuit Repair is easy to accomplish. Simply cut away the gel surrounding a defective component with knife or scissors. After the circuit is repaired, simply pour new gel into the repaired area to restore original high quality protection.

CIRCLE 290 ON READER SERVICE CARD

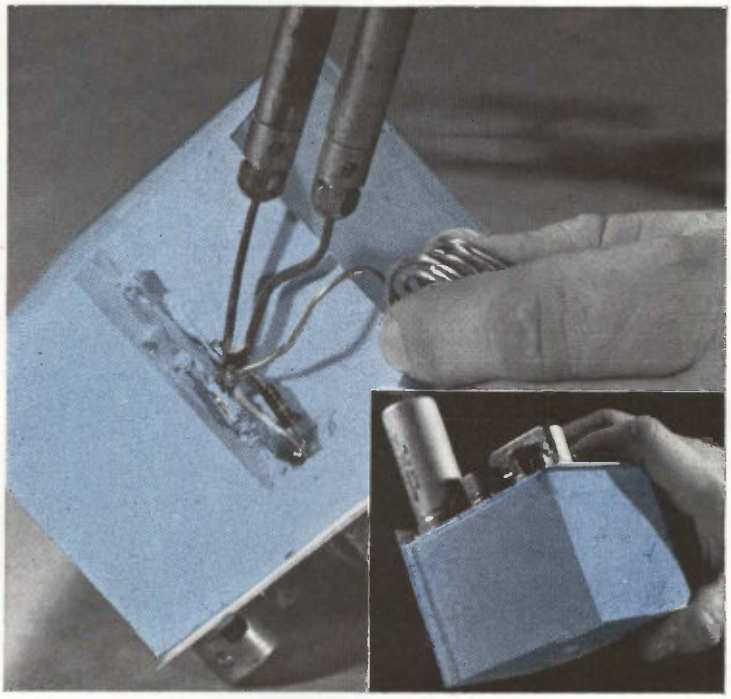


Deep section . . . rugged protection with repairable Silastic® RTV

Silastic RTV, Dow Corning's fluid silicone rubber that vulcanizes at room temperature, is available in several variations. Select the best one suited for your application or processing requirements. All have excellent dielectric properties, low water absorption, stability under extreme temperatures, resistance to thermal cycling and aging. The newest Silastic RTV cures in thick sections in 24 hours at 77 F. Variations in thickness have no significant effect on curing rate or material uniformity.

Vulcanized Patch. Defective parts embedded or encapsulated in Silastic RTV . . . even where thick sections are used . . . can be replaced. The cured Silastic RTV is cut away with a knife, the component replaced, and new Silastic RTV applied to the repair area. The fresh material bonds to the original, restoring the encapsulant's integrity.

CIRCLE 291 ON READER SERVICE CARD



Free 12-page manual, "Silicones for the Electronic Engineer". Write Dept. 3917, Electronic Products Division, Dow Corning Corporation, Midland, Michigan.

WASHINGTON THIS WEEK

PENTAGON SHARPENS RED-TAPE SCISSORS

DEFENSE DEPARTMENT is considering lifting or relaxing some of its management controls on military development and production projects. Included are requirements that contractors obtain approval on whether to subcontract, subcontract prices, changes in "make-or-buy" schedules, payment of overtime to employees, and the like.

These controls developed when cost-plus fixed-fee (CPFF) type contracts dominated defense contracting. The Pentagon viewed CPFF contractors as, in effect, agents for the use of government funds, and wanted tight controls to restrict contractors' expenditures.

However, the controls have since been routinely carried over even to incentive-type contracts where contractors assume costs at their own risk. The shift to incentive contracting and assumption of risks by many contractors have induced Pentagon officials to take a new—and more sympathetic—look at management controls that irk defense producers. An industry-Pentagon study is identifying the specific controls contractors want relaxed. But an official decision is still a long way off.

WHO'S WHO ON FCC NOW?

OUTLOOK IS that FCC's new chairman, E. William Henry, will be tougher on broadcasters than Newton H. Minow has been. Henry thinks FCC should not be just a neutral arbiter, but should look after the public interest aggressively. Lee Loevinger, now head of the Justice Department's Antitrust Division, will fill the vacancy left by Minow's resignation. His influence is expected to be felt as FCC moves more deeply into the communications satellite program—in fact, this is why he got moved to FCC, said Attorney General Kennedy. Loevinger was active as an administration spokesman during the bitter Congressional debate on the satellite program last year.

SENATE TUNES UP FOR PATENT LAW DEBATE

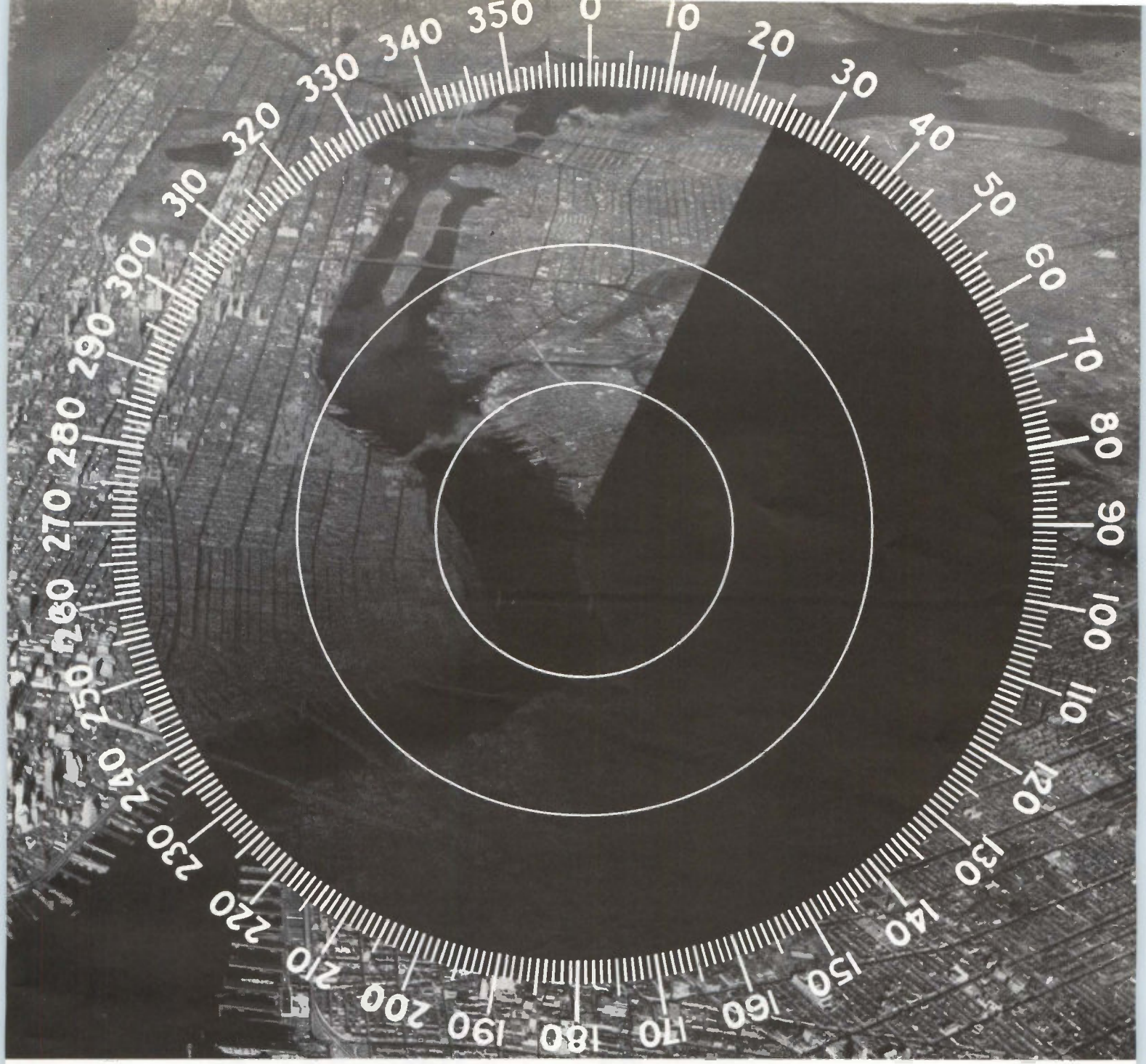
PRESSURE IS BUILDING in the Senate for another debate on government patent policy. Chief vehicle will be a bill proposed by Sen. John L. McClellan (D-Ark). Except for specified areas of acute national interest, contractors would get patents they develop. Views of industry and government agencies are being sought preparatory to a Judiciary Committee recommendation to the Senate. Other legislation, particularly that of Sen. Russell B. Long (D-La.), for greater government ownership rights, will probably be reflected in amendments tightening the McClellan bill.

In balance, the measure will meet White House suggestions for an effort to protect public rights to public-financed inventions, while not being over-restrictive about ownership.

The House, where similar opposing proposals have been made, approved a loose policy for NASA two years ago, but last year decided to await Senate initiative on a broader, government-wide measure.

FAA MAKES RTCA UNHAPPY

FEDERAL AVIATION AGENCY is preparing to defend itself against charges that its air traffic control system is a patchwork, growing excessively costly for its effectiveness. That report will be made in June by the unofficial government-industry Radio Technical Commission for Aeronautics. After that, Senate Hearings are expected to explore the broad range of criticisms the group levels against FAA.



Raytheon storage tube puts realism into Marquardt's radar trainer

The AN/APQ-T10 Radar Trainer, produced by the Marquardt Corporation, Pomona, California, trains USAF crews in navigation and bombing procedures. Raytheon two-gun storage tube, CK1383, operates as a scan converter to provide realistic PPI simulation of airborne radar. By converting video signals to a real time base, the CK1383 provides such realistic effects as shadows and slant range and eliminates the need for stereo picture projection. Thanks to the Raytheon CK1383, the AN/APQ-T10 has higher resolution, faster writing and erasing capabilities than similar equipment.

Raytheon storage tubes are serving in many other advanced applications such as FAA air traffic control systems and the Coast Guard RATAN radar-to-tv scan conversion display of lower New York harbor. Interested in the development of equipment and systems utilizing stop motion, integration for signal-to-noise improvement, information storage for data processing, slow-down video, time delay or phase shift? Call on the unmatched capabilities and vast experience offered by Raytheon's storage and display devices department.

For more complete technical information or application assistance, write today to: Raytheon Company, Industrial Components Division, 55 Chapel Street, Newton 58, Massachusetts.

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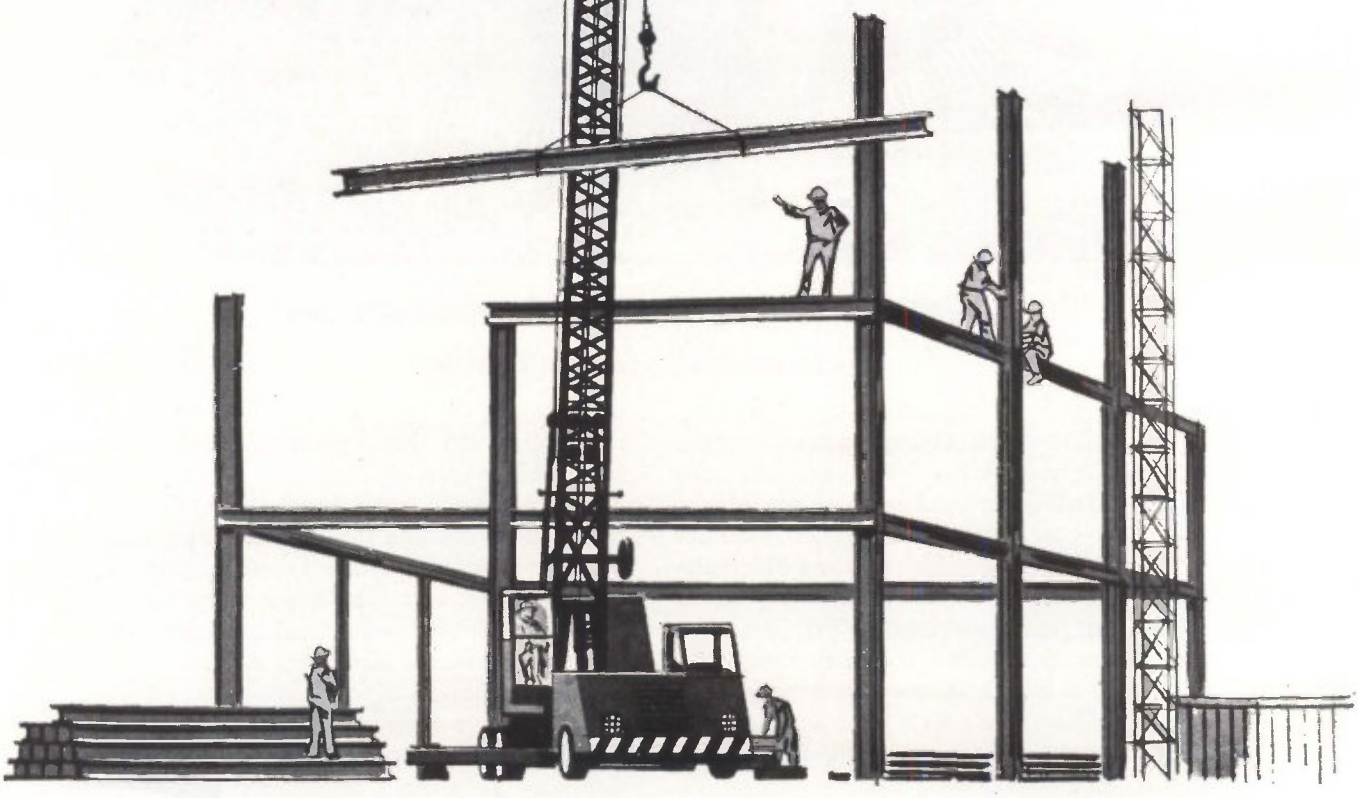


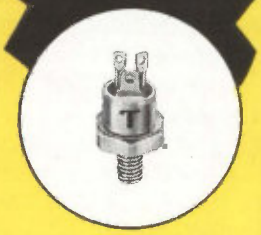
SILICON PLANAR POWER TRANSISTORS

PNP 2N2875

Features remarkably high beta linearity over wide range of collector currents. Dissipates up to 15 Watts of power at 100°C case.

Type	DC Current Gain @ I_C= 500mA (β)	Typical Collector Saturation Voltage @ I_C= 500mA (Volts)	Minimum Sustaining Voltage @ I_C= 50mA (Volts)	Typical Cut-Off Frequency @ I_C= 100mA (Mc)	Power Dissipation Rating @ 100°C Case (Watts)
2N2875	20-60	1.0	50	30	15

IN A 1/16" STUD-MOUNTED PACKAGE



NPN 2N2866-7

Features extremely low RCS of 0.75 Ohms Max. Dissipates up to 20 Watts of power at 100°C case. High beta linearity.

Type	DC Current Gain @ I_C= 500mA (β)	Typical Collector Saturation Voltage @ I_C= 1 Amp (Volts)	Minimum Sustaining Voltage @ I_C= 50mA (Volts)	Typical Cut-Off Frequency @ I_C= 100mA (Mc)	Power Dissipation Rating @ 100°C Case (Watts)
2N2866	20-60	0.4	80	15	20
2N2867	40-120	0.4	80	15	20

TRANSITRON'S NEW STATE-OF-THE-ART SILICON PLANAR TRANSISTORS FEATURE GREATER RELIABILITY, LOWER RCS, AND PERMIT FURTHER CIRCUIT SIMPLIFICATION IN DEMANDING POWER CATEGORIES.

Drawing heavily upon its broad experience in silicon power transistor development and stud-mounted packaging, Transitron introduces its new PNP 2N2875 and NPN 2N2866-7 intermediate power silicon transistors. They combine all the recognized advantages of planar construction with the efficiency of 1/16" hex base stud-mounted packaging, which solves a variety of annoying mounting problems. And, because they complement each other, extensive circuit simplification is now practical within power applications.

These highly reliable silicon planar power transistors are the product of the same intensive Transitron Total Reliability Program that produced the popular 1/16" NPN 2N1647-50 and 2N2018-21 series for modern military ICBM systems. Continuous lot control from ingot stage, thorough product improvement documentation, and comprehensive failure analysis have enabled Transitron Product Engineering to develop units which will satisfy the strictest requirements.

The 2N2875 and the 2N2866-7, and other complementing PNP and NPN silicon power transistors, are available through your Transitron Distributor.

For complete information, write Transitron's Wakefield, Mass. installation.

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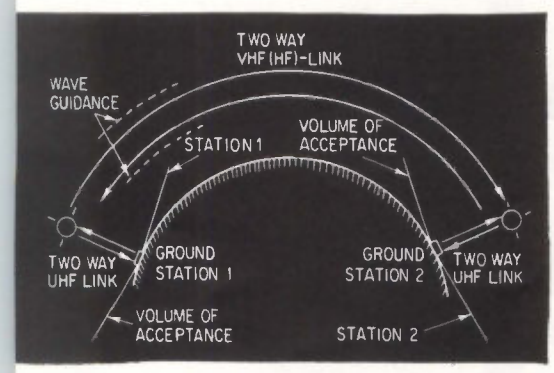
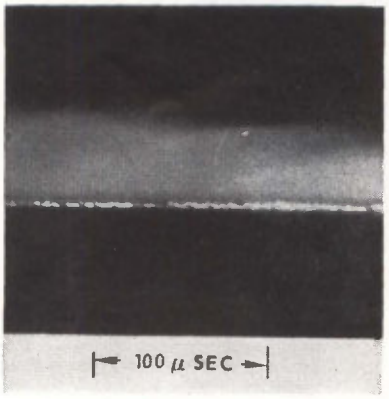
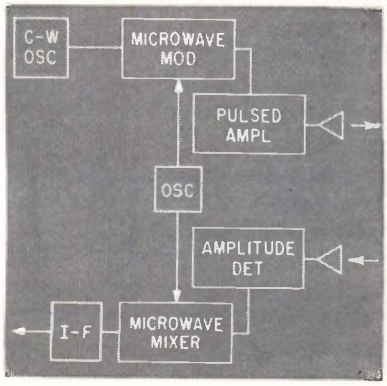
JAMES DENNIS, *NAECON president; Ferdinand Hamburger, Johns Hopkins U.; Ernst Weber, IEEE president, and Alexander Bereskin, U. of Cincinnati, at conference.*



CONCEIVABLE *h-f vhf link for communicating via ionospheric ducts described in paper by J. I. Barker, of ASD, and M. D. Grossi, of Raytheon, would have nondirective antennas and low-power transmitters*



RUBY LASER *beam passing through simulated reentry plasma with no measurable attenuation shown in smear photo by R. C. Sykes of Douglas*



OPTICAL HOMING *might be accomplished with subcarrier system in which transmitter c-w laser output is microwave-modulated (Raytheon)*

Air Force Outlines Latest R&D Plans

In-house research and evaluation programs will be expanded

By MICHAEL F. WOLFF
Senior Associate Editor

DAYTON — Air Force research plans in key areas of electronics were outlined by Aeronautical Systems Division spokesmen at the 15th annual National Aerospace Electronics Conference last week. Here are the highlights:

AEROSPACE INTERCEPT — Complex technical requirements for aerospace fire control were cited in a paper by J. Pasek as:

- Long-range detection and tracking of hot and cold targets at closing speeds up to tens of thousands ft/sec under severe external e-m interference
- Guidance subsystem accuracy consistent with performance of other interceptor system components
- Vastly improved life, reliability.

The paper said considerable effort is being expended on microwave and optical radar techniques and a variety of passive optical sensors for guidance parameters. An e-m sensor equipment using molecular electronics to the greatest extent possible is in the final stages of development.

BIONICS—Extensive program for the next three to four years that will hopefully lead to "playing the games" identified by present *L* and ballistic space systems was outlined by Lt. Col L. M. Butsch. Some of the work in progress includes ear and cellular analogs, visilog, artifical muscle, booster for the arm under high-g conditions, tactile sensors, neurotron nets, and systems able to form their own components and circuits. More than 20 other tasks are planned.

COMMUNICATIONS — Pointing out that demands will continue to increase, particularly for anti-jam systems, G. H. Scheer called for:

- Systems that can automatically adapt to conditions of the link
- Elimination of doppler shift by methods not subject to jamming
- Modulation resistant to jamming, interception and decoding
- Emphasis on message synchronization
- Microminiature, reliable equipment.

E-M WAVE TECHNIQUES — Though millions of dollars and

many man-years have been expended on efficient ways to transmit through reentry plasma, P. W. Springer said only limited solutions exist, such as transmitting above 10 Gc. Spike antennas protected by ablative or gas cooling, plasma seeding or strong magnetic fields look promising on paper and in shock-tunnel experiments.

Use of solid-state devices integrated into antenna structures shows great promise for rapid scan and omnipolarization antennas. For satellite-to-satellite communications ionospheric ducts, magnetic-field aligned scatter propagation and other new modes promise extreme efficiency and long range.

E-M VULNERABILITY — R. G. Stimmel said emphasis is shifting radically to concern with man-made interference. Areas of current major interest for vehicular electronics include quantitative measurements between 10 and 100 Mc, and above 20 Gc, computer and simulation techniques, and noise and other reentry effects.

DEVICES TECHNOLOGY — Air Force will expand its in-house applied research and evaluation programs in order to enhance its internal technical capability, reported A. H. Dicke.

In other developments at the meeting:

• ASD experiment next year to determine feasibility of microwave communications from an aircraft by way of an orbiting belt of resonant dipoles was announced by Charles Gauder.

• Anticipated improvements will allow using lasers in future acquisition, tracking and homing systems, said Irving Goldstein, of Raytheon. He cited the subcarrier scheme illustrated as a promising homing system if conversion losses in twt photocathode amplitude detectors could be improved.

• Reports from six companies on liquid laser research showed that materials are still the big problem, with more fundamental studies needed so that energy transfer, chemical purity, homogeneity, stability, temperature gradients and other factors can be controlled.

• Several sessions on transitioning to the supersonic transport plane brought out that electronic systems can probably develop in an evolutionary way except perhaps in reliability where major improvement was called for. Some also felt a central electronic management may be needed, either of the central computer type, or for sampling.

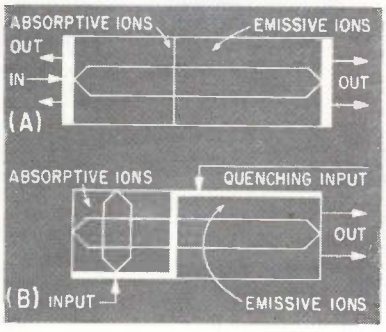
• Forty-pound laser ranging unit with a Q-switched ruby and maximum range of 9,990 meters was demonstrated by Martin/Orlando. Martin said it has demonstrated feasibility of a similar device as an illuminator to direct a beam at at a target so semiactive missiles could home on the reflected light. This illuminator would be a Q-spoiled device with a prism centered between several laser cavities. As the prism rotates it sequentially triggers each cavity in Gatling-gun fashion.

• Wideband (7 to 13-Gc) laser demodulators employing microwave phototubes announced by Douglas.

• Hoffman Electronics' prototype digital frequency synthesizer derives frequencies in 10-cps steps between 1.4 and 7 Mc and in 50-cps steps between 7 and 35 Mc. It's built around a variable frequency oscillator and digital frequency dividers, fits into 3½ inches of space.

• Nanosecond pulse power switch by Martin/Baltimore handles 2½ w of r-f power for pulses with 0.2-nsec risetimes and 1-nsec width. Switch was developed for hard-to-jam secure communications systems with 1-Gc pseudo-random codes of several thousand bits. It has also been tried out in radar with 6-inch range resolution.

• Westinghouse Electric is starting to make *n*-on-*p* web silicon solar cells 1 ft long, 1 cm wide. Efficiency is 9 to 10 percent.



NEURISTOR LASER *computer concepts described by W. F. Kosonocky, of RCA Labs, include slow-wave neuristor line obtained by cascading optical resonator (A) and bistable circuit by using resonator as in (B)*

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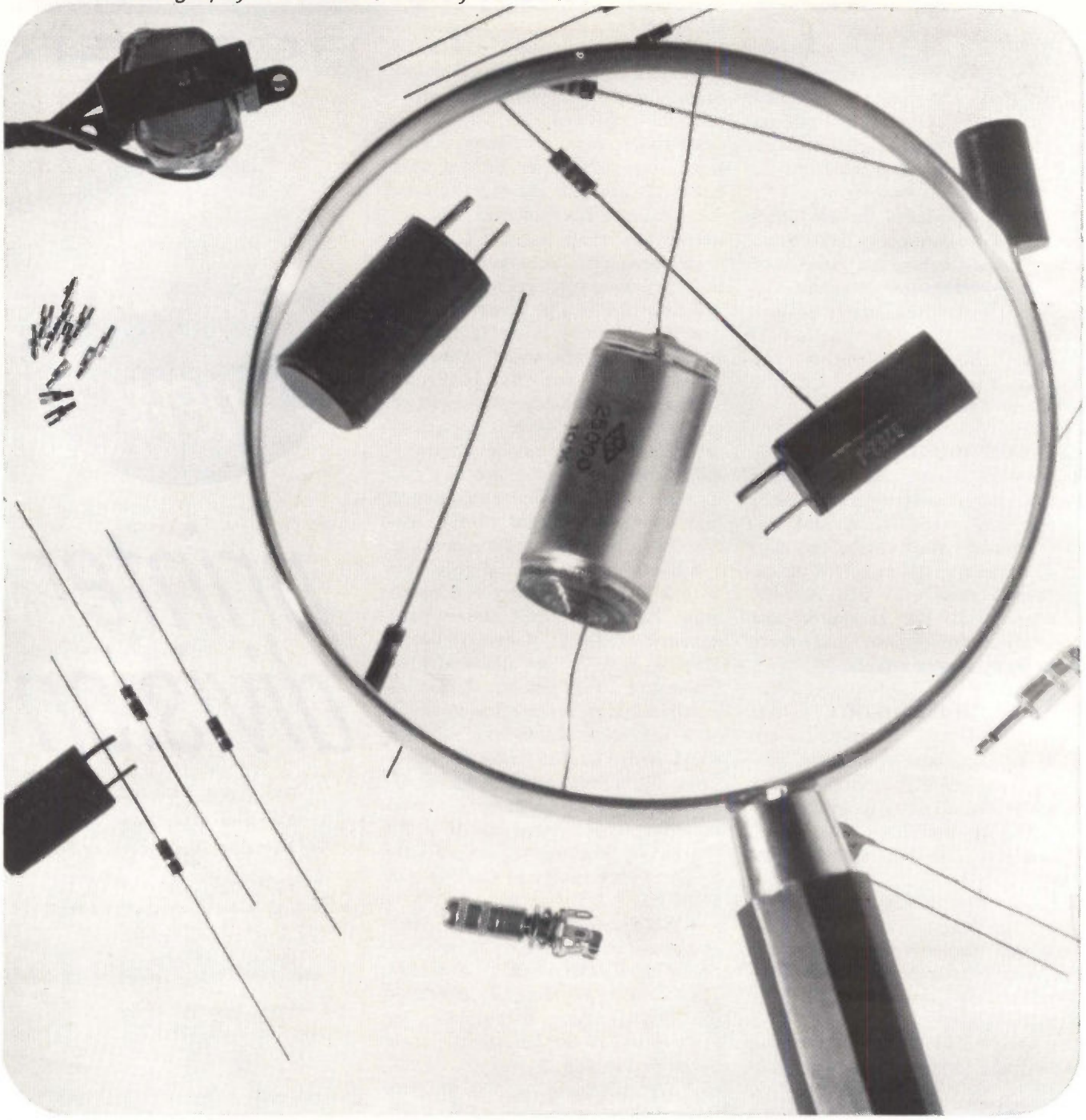

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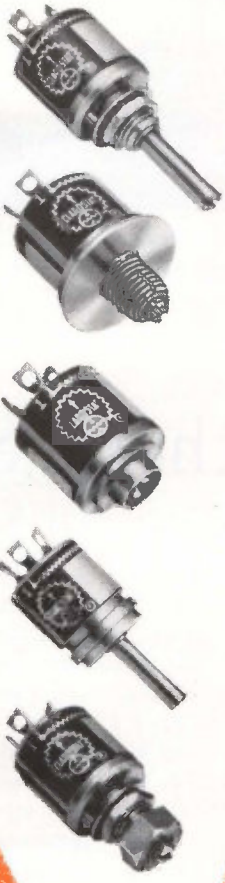

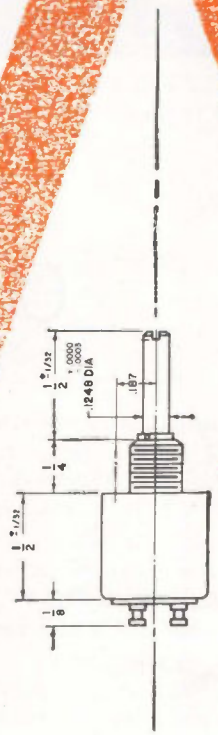

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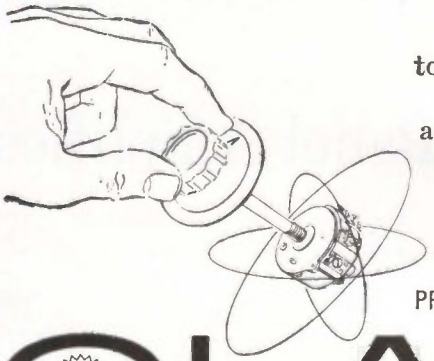

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Can Synthetic Sleep

Pulse-induced slumber appears deeper, also has therapeutic value

By LEON H. DULBERGER
Associate Editor

SLEEP-PRODUCING *instrument developed by National Patent Development Corp. from Russian design is being tested by U.S. physicians*

NEW YORK—An electronic instrument that induces "sleep" in humans and animals by slowly applying an electrical pulse to the subject's head is now being clinically tested at several hospitals.

The instrument produces sleep in most persons. Indications are that the induced sleep is deeper than normal slumber and may also be of value in the treatment of certain mental and physical diseases.

The possibility that a few hours of instrument-induced sleep may be substituted for eight hours of normal sleep has aroused the interest of the Air Force and NASA. Air Force has inquired about possible applications, such as helping SAC pilots perform on limited sleep. NASA reportedly is considering using sleep instruments for its astronauts, possibly in the Gemini program.

RUSSIAN DESIGN—Now being tested in the U. S. is a transistor version of a vacuum-tube design developed and being used in the USSR. Russian doctors have experimented with the instrument for four years and use it for medical treatment in hospitals. The Russians are reported to be producing 5,000 of the instruments a year, including one model that has multiple output jacks for simultaneous treatment of several patients.

National Patent Development Corp., of New York, which has a licensing arrangement with the USSR, funded the design of the transistor version by Prof. Omar Wing, of Columbia University. NPDC expects to produce the instrument, now in the prototype stage, within six months.

The NPDC version measures $6 \times 3 \times 5$ inches, weighs about 4 pounds and uses a rechargable battery. Connection to the subject is made by a head harness with eye pads and a pad for the rear of the skull. For low-resistance coupling, cotton moistened with salt water or a conducting jelly is used with the pads. Pulses are 0.1-msec long and are repeated every 3 seconds. Voltage level is roughly 20 v and current passage 0.5 ma. A built-in timer controls treatment time.

SLEEP EFFECT—In humans, the instrument may produce a restful sleep, comparable to the second or third hours of slumber experienced by persons who sleep eight hours.

Since these hours of sleep are the most efficacious, some doctors believe instrument-produced slumber may reduce human sleep needs to a few hours. Russian work on this is reportedly very encouraging. So far, instrument-produced sleep does not appear to be habit-forming like barbiturates and no side effects have been reported.

While it is not known precisely how the instrument produces sleep, one concept is that a sleep-inhibitory center in the brain is probably paralyzed by electric currents. However, there is disagreement about this.

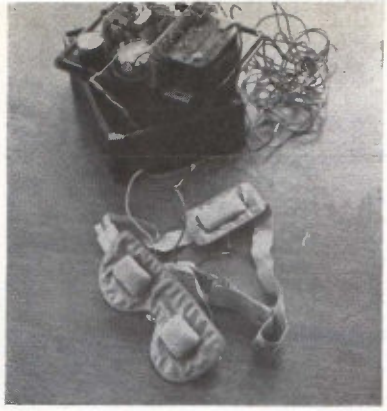
Dr. Bernard Post, of Downstate Medical Center, New York, who has been working with sleep instruments for more than two and a half years, still has not proven to his satisfaction that the electric currents actually pass through the brain.

He thinks that a field of electrical potential set up in the brain's casing may produce sleep. He

Solid Panel Amplifies

Resolution is reported as better than tv set, and it's easy to make

TOKYO — Matsushita Research Institute Tokyo, Inc., reports it has developed an easily fabricated, high-resolution, electrostatic-type light-amplifying panel that will operate as either a positive or negative image intensifier. The panel consists of a solid sandwich between two plates of glass whose inside surfaces are coated with SnO to form transparent conductive electrodes (see diagram on



EYE AND SKULL PADS *couple pulse source to subject*

Save Time?

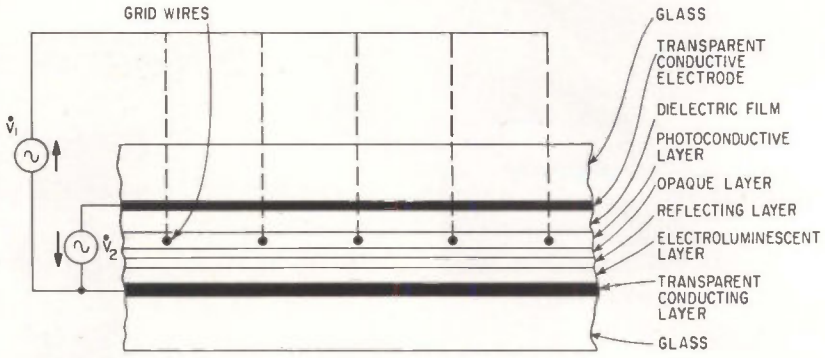
plans an experiment, using pulse-staggering techniques, in which a subject's brain waves are recorded by an electroencephalograph while the instrument is also coupled to the patient. So-called "spindles" that usually precede slumber have been observed on EEG traces. Dr. Post will look for these and other EEG indications of sleep.

TREATING DISEASES — Treatment of various illnesses with sleep instruments has been reported here and in the USSR. These include certain aspects of paraplegia, cerebral palsy and multiple sclerosis. High blood pressure has been successfully treated and indications are the instrument can be used to treat insomnia, ulcers and other conditions.

Dr. Post is now using NPDC's transistor version in experiments such as relaxing spastic patients before physical therapy.

Images

p 22). Total thickness of experimental panels is 3.2 mm; all but 0.2 mm of this is taken up by the glass plates. Two a-c power supplies are used: one connected between the two transparent conductive layers and one connected between the rear transparent conductive layer and the photocon-



CROSS SECTION *of electrostatic light-amplifying panel indicates arrangement of layers, location of grid wires and power inputs*

ductive layer. In the lab, power supplies used were signal generators and amplifiers, with frequencies of 50 to 5,000 cps. The higher frequencies give better efficiency. Voltage was approximately 200 to 1,000 volts.

Positive or negative image is selected merely by changing the phase or amplitude of the two power supplies. Image contrast can also be controlled. Matsushita calls the panel a triode or electrostatic type image converter.

Input image need not be visible light but can also be infrared or an x-ray image. It can be used to show either a positive or negative image from a projected film negative. It can also be used as a solid-state amplifying fluoroscope screen that will directly convert a negative image to a positive image—something not done before, the company says.

EASY TO MAKE—In addition to its other advantages the new light amplifier is extremely simple to fabricate. No difficult machining operations are required.

Electroluminescent, light reflecting and opaque layers are coated on the rear transparent conductive layer in that order. A tungsten wire grid is wound over this coated glass plate and then covered with CdS photoconductive material on top of the insulating layer side. Silver paint is used to make contact to the grid along the edge of the glass plate, and the unneeded portion of the grid on the back surface of the glass plate is cut off and discarded. Over this are cemented Mylar film and the front electrode. The panel looks like an oversize film slide.

RESOLUTION—Resolution of prototype panels is limited by spacing of grid wires, which are 10-micron tungsten wires with center-to-center spacing of 300 microns. Measured resolution is about 10 lines per millimeter, or better than tv. Ultimate resolution is limited by the granular nature of the electroluminescent layer, which consists of ZnS particles approximately 20 to 30 microns in diameter.

RADAR SEES CLEAR-AIR TURBULENCE

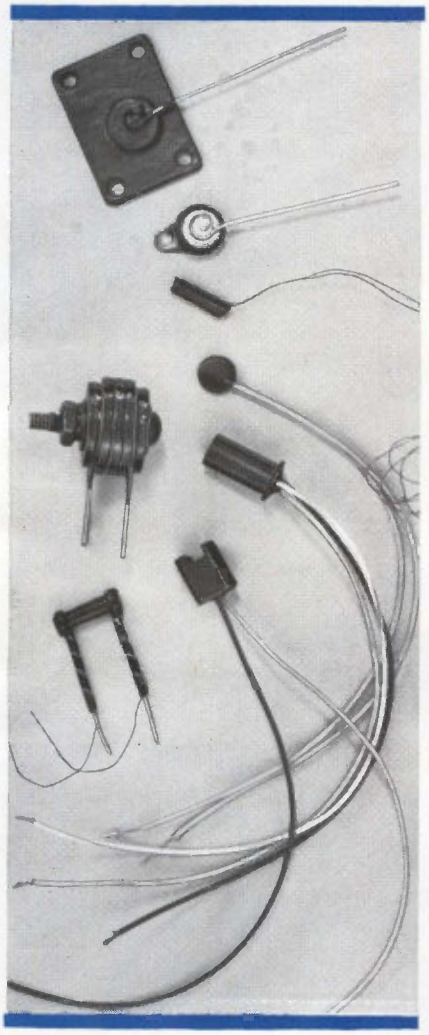
RCA reports consistent detection of clear-air wind shear with a C-band precision tracking radar that has a peak power of 3 Mw.

The wind shear was seen as backscatter from refractive areas—a limitation in tracking radar, but of interest to weather radar. The returns correlated with readings obtained by Army rawinsonde balloons.

RCA's Surface Radar division is now developing clear-air radar techniques that could be used for forecasting or to warn aircraft pilots of turbulent air

NEWS

Thermistors?—Nobody makes a wider variety than Carborundum.



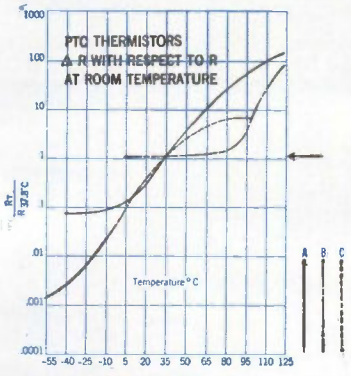
Carborundum is turning out thermistors in varieties undreamed of a short time ago—from sub miniature discs to complete assemblies.

Special assemblies can be manufactured to fit chassis and operating requirements. You can specify your electrical and dimensional needs and we'll design the assemblies to meet them. They meet precise tolerances for temperature coefficient, dissipation constant and resistance at reference temperature. Can be potted in epoxy. Provide long-term stability.

Discs and washers are available in sizes from 1/10″ to 1″ in diameter. We supply them soldered to mounting plates or with special terminals to solve assembly problems. They're made of high-stability compositions. Beta values range from 2700 to 4800.

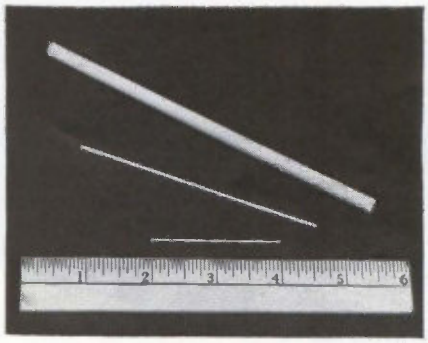
Rods can be purchased from Carborundum in the widest range of body sizes and temperature coefficients available to industry—in lengths from 1/4″ to 12″ and diameters from .05″ to 1″. Beta values from 1100 to 4600.

PTC Thermistors are new, positive-temperature-coefficient units with high sensitivity. Sensitivities as high as 12 percent per °C can be achieved. Use PTC's in combination with NTC's (negative coefficient units) and with linear resistors to construct an astonishing variety of temperature compensation curves for your circuits. We also manufacture PTC assemblies and probes for special needs.



The graph shows resistance of three different PTC thermistors over a range of temperatures as a multiple of resistance at room temperature.

For more information on this complete thermistor line, write to: Electronics Division, Globar Plant, Dept. ED-6T, Niagara Falls, N. Y.



Magnesium oxide crushable preforms now in longer lengths

High-purity (99.4%) MgO tubing is now available in lengths up to six inches. This is double the previous size available. Now you can produce swaged, high-precision thermocouple assemblies faster. Cut costs at the same time.

These ceramic preforms are available in 2″, 4″ and 6″ lengths depending upon O. D. size. In addition, O. D., hole size, and camber tolerances have been tightened. They have an AQL (acceptable quality level) of 2.5% for O. D., hole size and camber. Using the longer lengths, you can produce thermocouples with fewer air gaps, better resistivity and lower fatigue factor. They're just what you need wherever rigidity, resistance to vibration and high reliability are a must. For our new literature on ceramic insulating tubing, write to: Electronics Division, Latrobe Plant, Dept. EL-5, Latrobe, Pa.

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We are particularly interested in programs on which this experience was obtained, and the extent of your technical responsibility. Address information to our Manager of Engineering at the location of your choice for immediate attention.

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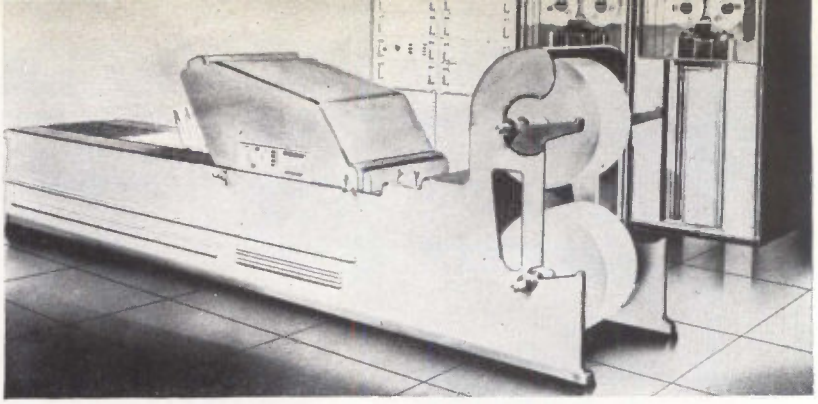
600,000 WPM Printer Races Computer



SUPERSPEED *alphanumeric page printer produces a printed record at paper speeds up to 3½ feet per second*

But what do you do with all that paper?

By LAURENCE D. SHERGALIS
Associate Editor

MELBOURNE, FLA. — Printer capable of keeping pace with high-speed computers—with an output of more than 60,000 characters per second—has been developed by Radiation, Inc. for Lawrence Radiation Laboratory.

The rate of 30,000 lines of type per minute, each line containing 120 letters and numbers, breaks all records for printing speed, Radiations says. First public demonstration was held yesterday.

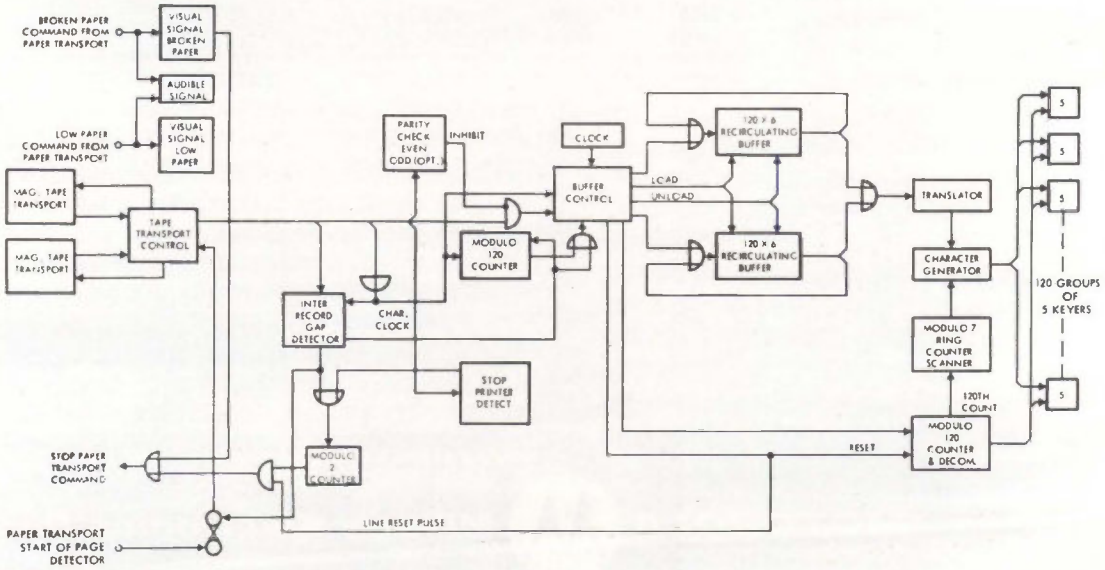
Secret of the printer's high speed operation is a printing method that eliminates mechanical motion. Electronic control of a series of electrical stylii permits fast line-at-a-time recording on Teledeltos paper.

Input to the printer is 6-bit data from a pair of IBM 729V magnetic tape units. Two tape transports permit continuous printing with automatic switching between the tape units.

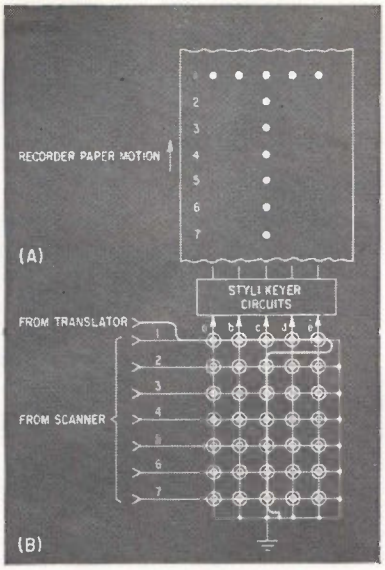
OPERATION—Seven input data lines are combined in an OR gate that provides a character clock pulse train for routing to a buffer control unit and a counter. The data is also fed to an AND gate and to a parity check circuit. After parity checking, input data is directed, by the buffer control unit, to one of two recirculating buffers capable of storing a complete line of data in 6-bit binary form. If a parity error is detected, the gates will be inhibited by the parity check unit and an error code will be loaded into the buffer.

When one recirculating buffer has been filled, input data is transferred to the second, and printout of data in the first buffer is started. Each 6-bit binary code is translated sequentially into a 35-bit matrix code to operate character generators that drive 600 recording stylii. Stylii are arranged in 120 sets of five each, with a decommutator selecting the appropriate five.

CHARACTERS — Characters, 0.1-inch high by 0.06-inch wide are formed from 5 × 7 matrix of dots, and printed one horizontal row of dots at a time. Five of the 35 matrix code bits are printed for each circulation and the data is circulated through the buffer seven times to



TWO TAPE INPUTS enable continuous operation of the system



PRINTING OUT *of the letter T is accomplished a line at a time (A), with dots printed by energizing the stylii with a magnetic-core character generator (B)*

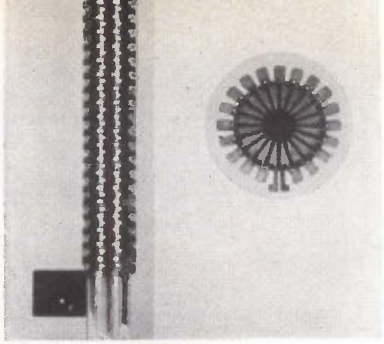
complete printing of one line of characters.

Four 5 × 7 magnetic core generators are used. Cores are arranged in rows of five horizontally and seven vertically. Character set windings are connected in a physical pattern representing each of the 64 characters or symbols. When an input pulse is decoded by the translator as a specific letter, a pulse sets each of the appropriate cores to positive magnetization. To print the character, the readout windings on all cores in the top horizontal row are pulsed and shifted back to a negative state. Output sense windings on each core produce an output pulse to a stylus keyer. Thus, the top row of dots for one character are printed. The translator goes to the next character and repeats the process until the top row of dots for all characters in that line are printed.

Next, the core readout windings in the second horizontal row are pulsed and the second row of dots is printed. The process is repeated until all seven horizontal rows are read out and the entire line of type printed.

Preprogramming the input data controls the format of the output. Automatic stopping, partial page format, program identification and other control functions are accomplished by recognition of certain input data codes.

No-Chop IR Detector Cuts Size



THERMOPILE *configurations include 120 elements in a 1x8-mm active area and 20-element radial with a 2.5-mm-diameter active area*

Evaporated thermopiles for space systems don't require beam modulation

STAMFORD, CONN.—Barnes Engineering Company unveiled a new type of infrared detector last week—a thermopile—that doesn't require ir beam modulation.

The company says the device will provide for infrared space systems without moving parts, generally halving size and weight, reducing power requirements to a third, and raising life expectancy to three years or better.

The radiation thermopile consists of bismuth-antimony junctions vacuum-deposited on a Mylar insulating strip mounted on an anodized aluminum heat sink. The single-junction thermocouples are combined to form thermopiles.

THE DIFFERENCE — In bolometer detectors, the microvolt signals due to infrared radiation must be separated from random variations in the large d-c polarizing voltage; the infrared is coded by optical chopping.

The thermopile itself generates an emf directly proportional to the small temperature differential generated by the infrared radiation on the active junction. The signal can be detected and amplified without polarizing or bias voltage. Solid-state photoconductive modulators, using neon-bulb relaxation oscillators, convert the submicrovolt d-c signal to an a-c signal for further amplification without adding noise.

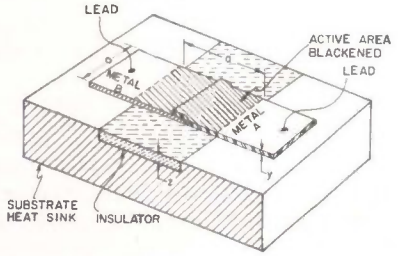
Another advantage is the detectors sensitivity to long wavelengths without liquid-helium cooling.

Barnes says the longest life of moving-part space instruments was one year for the Barnes 5-channel radiometer in Tiros. With the new device, systems under development are expected to last three years, and longer with improved or redundant circuits.

APPLICATIONS — The thermopiles will complement and not displace ir detectors such as thermistor bolometers, according to Eric Wormser, Barnes vice president, and will present new applications in space vehicles.

At present, immersed thermistor bolometers are more sensitive for an equivalent time constant and therefore are better suited for systems using radiation chopping or optical-mechanical chopping.

Principal space applications for thermopiles are expected to be horizon-sensing and scientific and meteorological radiometric measurements. A radiometric comparison-type horizon scanner for a classified low-altitude space vehicle is now in limited production. Horizon sensors are being developed for the Fairchild Micrometeoroid Measurement Satellite, and for Jet Propulsion Laboratory's lunar and planetary orbiting vehicles.



THERMOCOUPLE *detector is evaporated on solid backing*

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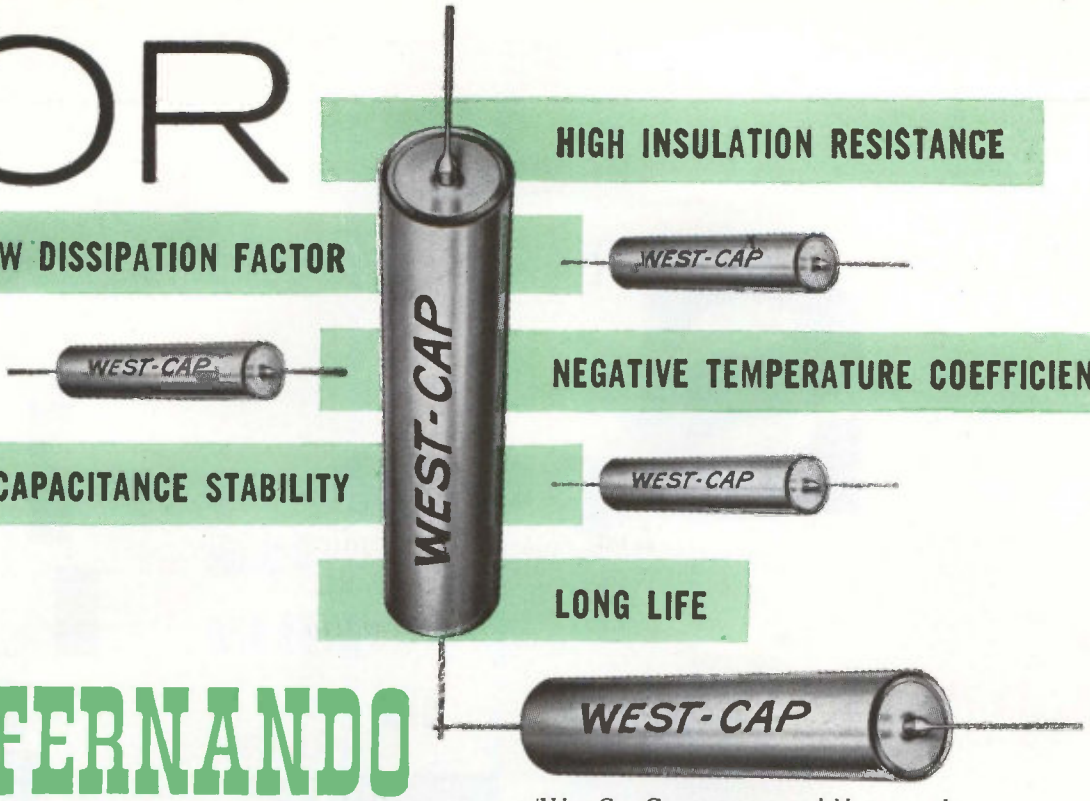
LONG LIFE



'West-Cap Capacitors are available in a wide range of capacities—in glass-to-metal, hermetically sealed, tubular and bathtub types, made to MIL Specs such as MIL-C-19978 (Ships) and MIL-C-26086/3 (USAF). Natvar Styroflex is used as the dielectric.

SAN FERNANDO USES NATVAR Styroflex® Film

San Fernando Electric Manufacturing Co., San Fernando, California and their subsidiary, Caribe Capacitors, Inc., Cataño, Puerto Rico, manufacture West-Cap capacitors for use in timing circuits, filter network components, test equipment and secondary standards of capacitance, and other critical circuits for computers and certain weapons programs where stability and close tolerances are essential.

Natvar Styroflex is used as the dielectric, first because of its excellent dielectric properties, and second, because its complete flexibility makes it easy to handle, and its consistent uniformity makes it possible to manufacture to extremely close tolerances.

Natvar Styroflex Film is made in thicknesses from 0.00025" to .0060", and in widths from ⅛" to 10" depending on thicknesses and manufacturing requirements.

Styroflex is the registered trade name for Natvar's biaxially oriented flexible polystyrene film.

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- Isoteraglas** sheets, rolls, tapes
- Epoxy coated glass sheets, rolls, tapes
- Isoglas® sheet and tape
- Isolastane® sheet, tape, tubing and sleeving
- Vinyl coated and silicone rubber coated Fiberglas tubing and sleeving
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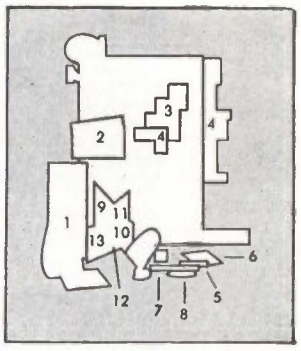
What 5 things do these Speer electronic components have in common?

that will increase your equipment reliability)

All components shown here are made by electronics divisions of Speer Carbon Company. In addition to research facilities at each division, Speer maintains a centralized research and development center in Niagara Falls. There, a staff of scientists is engaged exclusively in improving performance characteristics of present products and developing new types of electronic components. Each division shares Speer's multi-million dollar investment in research and development, in-plant reliability and quality control testing facilities. At Speer Resistor, for example, reliability is backed up by over 100 million hours annual capacity for life testing. When you discuss your circuit design problems with a representative from any Speer division, you can count on the technical support of a company that employs more than 2,000 people to design and manufacture the highest quality products you can buy.



How many of the above electronic components can you identify? They're all manufactured by divisions of Speer Carbon Company: **1.** Jeffers Type 19 molded inductors; **2.** Speer ¼W fixed composition resistors; **3.** Jeffers clear-coated PAC's; **4.** Jeffers phenolic-coated PAC's; **5.** Speer 680Ω leadless resistors; **6.** Speer 68Ω leadless resistors; **7.** Speer 5.6Ω leadless resistors; **8.** Speer 5000Ω leadless resistors; **9.** Speer coil forms; **10.** Speer 2W, 1W & ½W resistors; **11.** Jeffers Type 09, 15, 19, 22, 24, 28, and 30 molded inductors; **12.** Jeffers JM 110 & JM 160 capacitors; **13.** Jeffers special inductors.

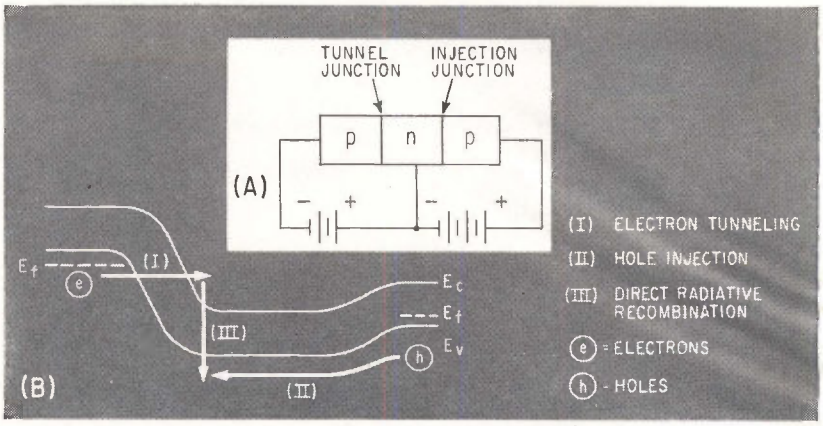
SPEER Carbon Co.

SPEER RESISTOR

JEFFERS ELECTRONICS

Dept. 425, St. Marys, Pennsylvania

Speer Carbon Co. Is A Division Of Air Reduction Company, Inc.



EMITTER JUNCTION *of transistor is biased as the injection junction (A). Electrons tunneling from the left side and holes injected from the right side recombine (B)*

Try for Triode Lasers

Tunneling expected to give intense output from germanium, silicon

SAN FRANCISCO—Attempts are now being made at the University of California, in Berkeley, to build a semiconductor triode laser that would employ the tunneling effect to achieve an intense output.

If the experiments are successful, they could lead to a new, transistor-like configuration for solid-state lasers and enable lasers to be fabricated from materials not yet usable, including germanium, silicon and aluminum antimonide.

The work is being done by S. Wang, associate professor of electrical engineering, and associates. The team has already used the tunneling effect to obtain radiation from a high-frequency germanium mesa transistor (2N700).

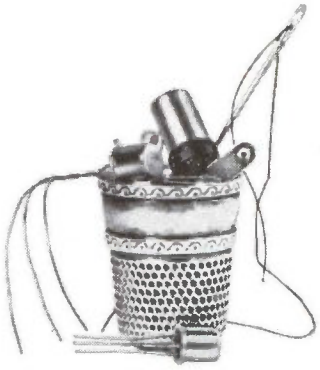
Wang told ELECTRONICS last week that he is optimistic about achieving coherent output from the new devices. He feels the proposed two-stage scheme for laser action is "quite feasible." Anticipated wavelength is 1.5 microns, in the infrared.

Preliminary experiments with the 2N700 transistors were performed at liquid-nitrogen temperature (77 K) with direct current and the transistors quickly burned out. Wang expects pulse operation to be very difficult to achieve in the new devices at room temperature. Attempts will also be made to control frequency and amplitude of operation.

LASING PROCESS—In gallium arsenide, commonly used for diode lasers, excess electrons and holes can rapidly recombine with each other, giving out intense electromagnetic radiation. Semiconductors like germanium do not have this property. The required transitions are slow and recombination radiation is much weaker.

An efficient way of speeding up the recombination process, Wang says, is to supply electrons into the conduction band by tunneling. Electrons are tunneled into the base region from the left-hand tunnel junction while holes are injected into the same base region from the right-hand injection junction (see figure). This permits rapid recombination.

In the experimental devices, impurity concentrations will be designed to enhance radiative recombinations. A resonant structure will also be attempted. In the mesa transistors, the emitter junction was biased as the injection junction. The preliminary reports on that work appeared in *Applied Physics Letters*, April 15, and *Transactions on Electron Devices*, May.



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Why so many?

We admit it.

Amphenol, more than any other connector manufacturer, accepts responsibility for confronting you with a seemingly endless selection of rack and panel connectors.

There's a good reason.

For some uses, a ten-contact connector the size of an Idaho potato will do just fine. In others, ten connections must be squeezed into a space no bigger than a jelly bean. Still other applications have unique requirements that relate to environment or mating force—even the technical skill of the operator.

WHY WE DO IT

We make a lot of different rack and panel connectors because it takes a lot to satisfy the wide range of applications.

For example: the Amphenol Blue Ribbon® rack and panel connector is widely used in "blind" mating applications. Part of Blue Ribbons' popularity is due to the fact that they mate with a smooth and gradual wedge-like force. Because they mate so smoothly, the "feeling" of correct alignment is unmistakable.

Another advantage of the Blue Ribbon design is the wiping action that occurs as connectors mate. Each time Blue Ribbons are mated, contact surfaces are wiped clean. Combine wiping action with high mated contact pressure, and the result is an extremely low-resistance connection.

THINKING SMALL?

As fine a connector as we know the Blue Ribbon is — it's just not right for the real tiny stuff. Thus, as miniaturized electronic equipment became popular, Amphenol engineers developed the Micro Ribbon®—a rack and panel connector utilizing the ribbon contact principle, but in as little as one-half the space. Further development produced a circular Blue Ribbon connector which crammed 50 contacts into a diameter just under 3 inches.

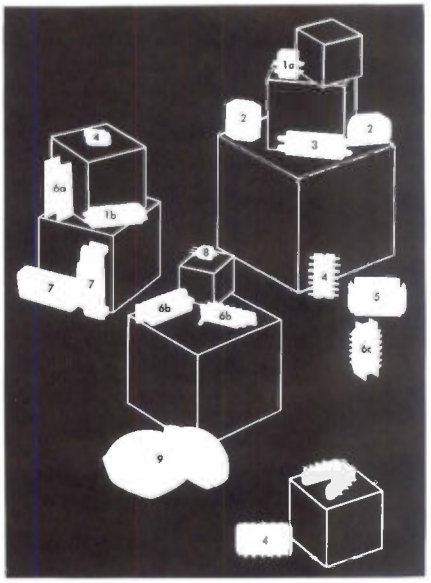
Also, there's the question of terminating rack and panel connectors. Often, confined quarters or complex wired harnesses can tax the dexterity of even the most skilled worker

To solve this problem, Amphenol engineers developed rack and panel connectors with Poke-Home® contacts. Poke-Home contacts make it possible to terminate conductors independent of the connector. Contacts are crimped, soldered, or even welded to conductors, then inserted into the connector. Besides simplifying assembly, Poke-Home contacts can be easily removed *after* assembly should circuit changes or repairs later become necessary. Needless to say, Amphenol rack and panel connectors with Poke-Home contacts (Min-Rac 17®, 93 and 94 Series, for example) are popular items with engineers who are forced to think small, spacewise.

BEATING THE ELEMENTS

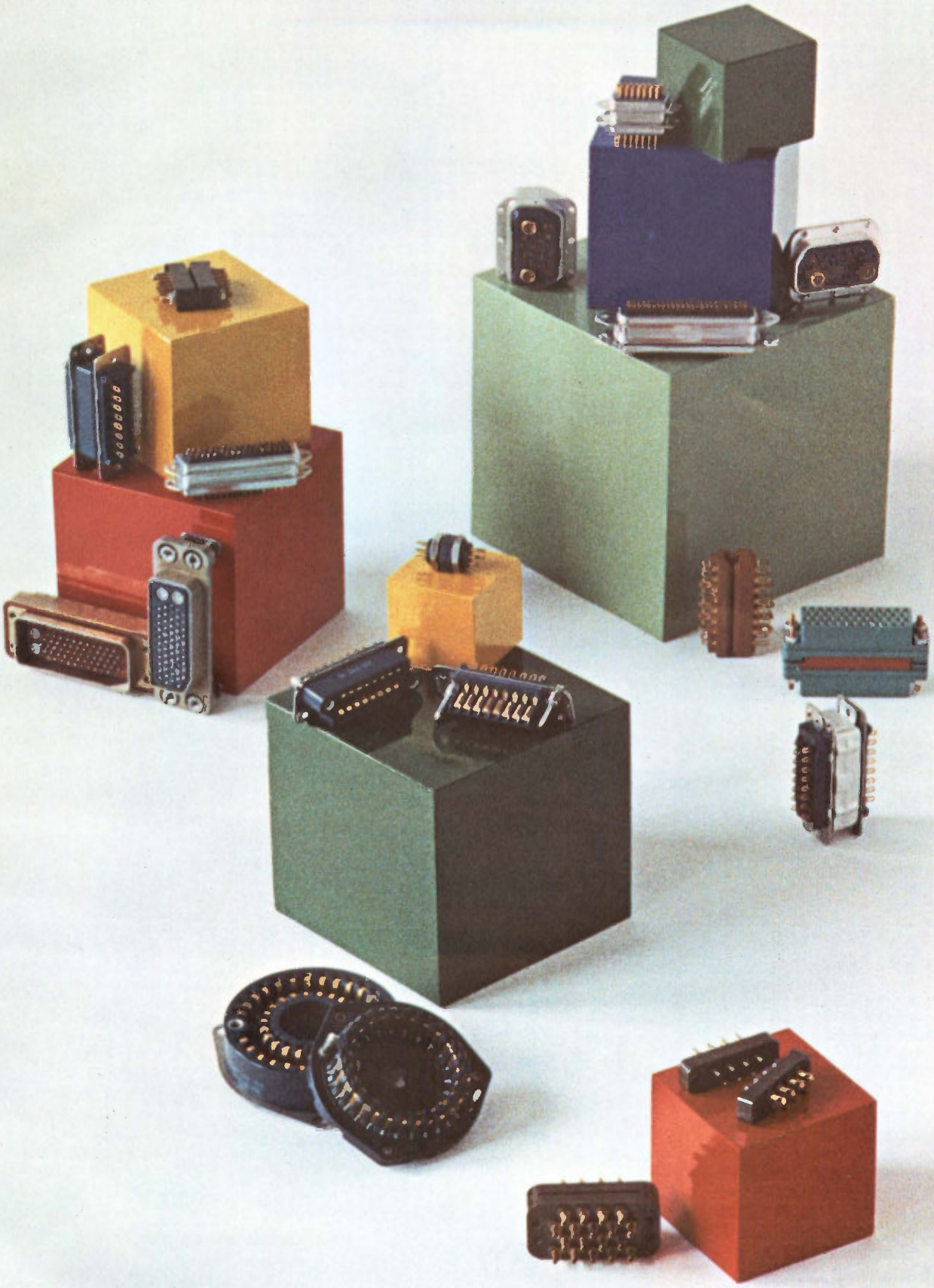
There's a need for environmentally resistant rack and panel connectors, too. High performance aircraft, missiles and space craft led to the development of Amphenol 126 and 217 Series environmentally sealed rack and panel connectors. (The 217 offers the added feature of Poke-Home contacts.) Other Amphenol rack and panel connectors can accommodate coaxial connectors; many can be supplied with hermetically sealed contacts. There are rack-to-cable connectors available in every series. There are super-economy types and super-reliable types.

So, when you have a rack and panel connector problem, contact an Amphenol Sales Engineer (or an authorized Amphenol Industrial Distributor). With the broadest line of rack and panels in the industry—if he can't solve it, no one can. If you prefer, write directly to Dick Hall, Vice President, Marketing, Amphenol Connector Division, 1830 South 54th Avenue, Chicago 50, Illinois.



Amphenol connectors shown on the opposite page are: **1**—Min-Rac 17 with (a) crimp-type contacts and (b) solder-type contacts **2**—94 Series **3**—Micro-Ribbon **4**—126 Series Rectangular **5**—93 Series **6**—Blue Ribbon with (a) barrier polarization, (b) pin polarization and (c) keyed shell and barrier polarization **7**—126 Series "CNI" **8**—126 Series Hexagonal **9**—Circular Blue Ribbon

AMPHENOL ***Connector Division*** / Amphenol-Borg Electronics Corporation



Shown above are the CORNING resistors which have failed in more than 135,000,000 (MOSTLY OVERSTRESSED) unit test hours.

We may have a failure any year now.

In the meantime, we have calculated statistical failure rates which may change your thinking about high-reliability resistors . . . whether you are working with MIL-R-22684 (NAVY), MIL-R-10509D or *MIL-R-55182*. The rates look like this:

Less than 0.0015%/1000 hours. CORNING has failure rate data based on continuous life testing for periods up to 50,000 hours; nearly six years. This test is for 1800 resistors that have been on continuous life test for 60,000,000 unit hours at powers up to *140% of rated*. The confidence level is 60%.

Less than 0.0012%/1000 hours. This one is based on 75,000,000 unit hours at *250% of rated power and* 25°C.

CORNING resistors live through high-stress reliability programs like these because of the inherent reliability of the tin oxide and glass that go into them. They demonstrate *flat* load-life characteristics for the same reason.

High-reliability CORNING resistors are available in general purpose C-style, precision RN-type, and hermetically sealed precision NF-type. A bulletin on CORNING "Resistor Reliability" is now available. Write for your copy.

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CIRCLE 37 ON READER SERVICE CARD

Safer Power Plants:

They can be fail-safe with relatively cheap analog systems, ISA told

By JOHN GRUENBERG
McGraw-Hill World News

PHILADELPHIA — Although solid-state analog controls have moved into a dominant position in the control of large-steam-electric generating units in the last three years, most installations are not sufficiently fail-safe nor operator-safe, declared Thomas M. Nourse, marketing manager of Daystrom's Control Systems division, at ISA's Power Instrumentation Symposium last week.

He said that a fail-safe analog control would add only 0.1 to 0.5 percent to the cost of a new generating unit—a "bargain." Nourse and R. R. Ruett presented designs improved by such features as redundancy, automatic balancing, and logic networks for monitoring and preventing unsafe conditions.

Nourse told ELECTRONICS after presenting his paper that "until industry reevaluates what it will invest . . . in analog controls—and lets safety precede price—the number of truly safe systems will remain in the minority." Nourse added that "a reevaluation of what industry will invest (in safe operation controls) is coming," and saw greater awareness of such a need now.

DIGITAL COMPUTERS—R. A. Russell, of Black & Veatch, Kansas City, Mo., predicted that 1963 will be "by far" the biggest year for installations of on-line digital computers in steam-electric generating stations. But 1964 and 1965 will be slow years.

An ISA-sponsored survey of 42 generating stations with capacities over 50 Mw showed that from 1958 through 1962, 20 computers were installed for data service and 9 for data and control.

For 1963, 15 data and 11 data-control installations are reported—representing 63.5 percent of the stations. In 1964 and 1965, a total of only 19 installations are anticipated. However, Russell said, the number may swing up again in the late 1960's.

Russell said that increased safety and fuel savings were the primary reasons why computers were purchased. Input transducer equipment is generally standard power plant instrumentation equipment, and "should be improved or replaced with other equipment designed to take advantage of computer capabilities," he added.

BOILER CONTROL—Control of steam generation, a basic power process, was called increasingly difficult. Control system demands for boilers have not changed funda-

Who Needs a Laser?

FRYING PAN *made of 39-mil steel is burned through in Westinghouse Electric demonstration of intense, but incoherent, plasma-jet light source. Light is focused by elliptical mirror through quartz lens. Input is 50 Kw, radiant output 15 Kw*

Why Not?

mentally through the years, but the speed and magnitude of load changes make it difficult to meet requirements today, said R. E. Van Derway, of Commonwealth Edison, Chicago.

Better-coordinated control systems, coupled with computers and other modern equipment, is the "key to successful boiler operation in the future," since control systems now have more functions.

Commonwealth Edison's automatic dispatching equipment and other computer and control facilities enable it to handle twice as much boiler load with half as many boilers as 10 years ago, he said.

Solid-State Controls To Boost Appliance Sales

CHICAGO — Will home appliances make wholesale use of semiconductor-device controls? Yes, if the innovations excite and intrigue the customer. The appliance industry is seeking a cure for recent sales declines.

Among promising items discussed last week at the 14th Annual Appliance Technical conference were: continuous speed controls, proximity switches, and switches that couple temperature, water, pressure, humidity and light sensors directly to inexpensive power-switching modules.

One point made by F. P. Stearns, of Texas Instruments, is that circuits should be packaged as modules that can be pulled and replaced for $5.

John Mungenast, of GE, cited a number of uses for silicon controlled rectifiers. In one, an inexpensive miniature scr amplifies a thermistor signal and timing function. Another is a light-activated scr for a home laundry's static programmer. A universal control can be used by a number of appliances, spreading the cost and making the unit price more attractive.

Inner-space, outer-space, or lack of space — wherever size, weight, and shielding of coax is a criteria, Hitemp's new cables provide design advantages not previously available!

Engineering, production, and Q.C. techniques advanced by Hitemp make it possible to hold shielding to a wall thickness of 1.5 mils, or less. For example, on a RG-196A/U teflon insulated coax cable, Hitemp holds the O.D. to .040" or half the O.D. of conventional wire braid construction (.080"). Subsequently, there's a weight savings of 21%. And this miniaturized cable can be wrapped around a 3/8" mandrel.

Naturally, the 100% shielded construction improves attenuation characteristics, reduces cross-talk to a minimum, stabilizes capacitance, and lowers VSWR.

100% shielding offers you assembly economies, too. It eliminates many termination problems associated with braided shields, and increases the reliability of the terminations, themselves.

Wherever your circuitry requires lower attenuation, improved VSWR, and so forth — wherever shielding, weight, size, flexibility, *and* reliability are critical, that's where it will pay you to use Hitemp's new miniature 100% shielded.

SEND FOR A SAMPLE if you'd like to run some checks on it yourself. Or, send us a piece of what you're currently using. We'll evaluate it and advise you of the savings you can make with Hitemp's new miniature coax. Why not take advantage of *either* offer today!

HITEMP WIRES CO.
a Division of Simplex Wire & Cable Co.

1200 SHAMES DRIVE, WESTBURY, NEW YORK
1532 S. CALIFORNIA AVE., MONROVIA, CALIF.

CIRCLE 41 ON READER SERVICE CARD→

I HEAR **GENERAL ELECTRIC TWT's** ARE NOW COMMERCIALLY AVAILABLE FOR MULTIPLE SOCKET TRANSMITTERS AT **LARGE COST SAVINGS!** WHAT'S THE SECRET?

NO SECRET, SIMPLY THE USE OF A

IN THEIR

C'MON-TALK **WORDS**

O.K! THESE NEW G-E **TWT's** HAVE A **HIGH POWER RING-BAR R-F CIRCUIT** THAT MAKES POSSIBLE **SAVINGS UP TO 50%** IN VOLUME LOTS.

IT'S USE permits automated manufacture not possible with conventional designs. Results: Manufacturing savings, plus improved tube uniformity that means more savings in test and alignment—all passed along to the customer.

Available in designs from L to C-band with typical 20% bandwidth, all tubes feature PPM focusing to eliminate bulky solenoids, and are sufficiently light and compact to be ideal for phased-array radar and other multi-socket applications.

Here's data on typical C-band types . . .

Min. Peak Power	Saturation Gain Min.	Max. Duty Cycle	Cooling	Size	Wt.
12 KW	40db	0.028	water	24" x 2.79"	13 lb
5 KW	51db	0.002 0.01	air water	21.5" x 2.79"	13 lb
1 KW	40db	0.01	air	13.25" x 2.38"	6 lb

Inquiries on scaling these parameters will be welcomed at any G-E sales office listed here.

NOW YOU'RE TALKING MY LANGUAGE!

GE ELECTRONICS
PROGRESS IN MICROWAVE TECHNOLOGY

INCLUDING IGNITRONS, HYDROGEN THYRATRONS, MAGNETRONS, METAL-CERAMIC TETRODES, HIGH-POWER DUPLEXERS, HIGH-POWER WAVEGUIDE FILTERS, KLYSTRONS AND THERMIONIC CONVERTERS. FOR INFORMATION ON THESE PRODUCTS, WRITE SECTION 265-26, POWER TUBE DEPT., GENERAL ELECTRIC CO., SCHENECTADY, N. Y. OR TELEPHONE TODAY: **SCHENECTADY, N. Y.** FRanklin 4-2211 (Ext. 5-3433) • **WASHINGTON, D. C.** EXecutive 3-3600 • **DAYTON, OHIO.** BAldwin 3-7151 • **LOS ANGELES, CALIF.** BRadshaw 2-8566 **SYRACUSE, N. Y.** 652-5102 • **CHICAGO, ILL.** SPring 7-1600 • **CLIFTON, N. J.** GRegory 2-8100 • **NEW YORK, N. Y.** WIsconsin 7-4065 • **ORLANDO, FLA.** GArden 4-6280

GENERAL ELECTRIC
POWER TUBE DEPARTMENT

265-26

MEETINGS AHEAD

PRODUCT ENGINEERING & PRODUCTION NATIONAL CONFERENCE, IEEE-PTGPEP; Continental Hotel, Cambridge, Mass., **May 27-28.**

FREQUENCY CONTROL ANNUAL SYMPOSIUM, U. S. Army Electronics Research and Development Laboratory; Shelbourne Hotel, Atlantic City, N. J., **May 27-29.**

RADIO FREQUENCY INTERFERENCE NATIONAL SYMPOSIUM, IEEE-PTGRFI; Bellevue Stratford Hotel, Philadelphia, Pa., **June 4-5.**

ARMED FORCES COMMUNICATIONS & ELECTRONICS ASSOCIATION CONVENTION, AFCEA; Sheraton-Park Hotel, Washington, D. C., **June 4-6.**

INTERNATIONAL TELECOMMUNICATION UNION, PANEL OF EXPERTS MEETING, IEEE, et al; Geneva, Switzerland, **June 4-23.**

BIO-ENGINEERING SYMPOSIUM, ISA; Union Oil Co. Bldg., Los Angeles, **June 14-16.**

JOINT AUTOMATIC CONTROL CONFERENCE, IEEE, ISA, et al; University of Minnesota, Minneapolis, Minn., **June 19-21.**

X-RAY AND ELECTRON PROBE ANALYSIS SYMPOSIUM, American Society for Testing and Materials; Chalfonte-Haddon Hall, Atlantic City, N. J., **June 23-28.**

IMPACT OF MICROELECTRONICS CONFERENCE, Armour Research Foundation and ELECTRONICS Magazine; Illinois Institute of Technology, Chicago, Ill., **June 26-27.**

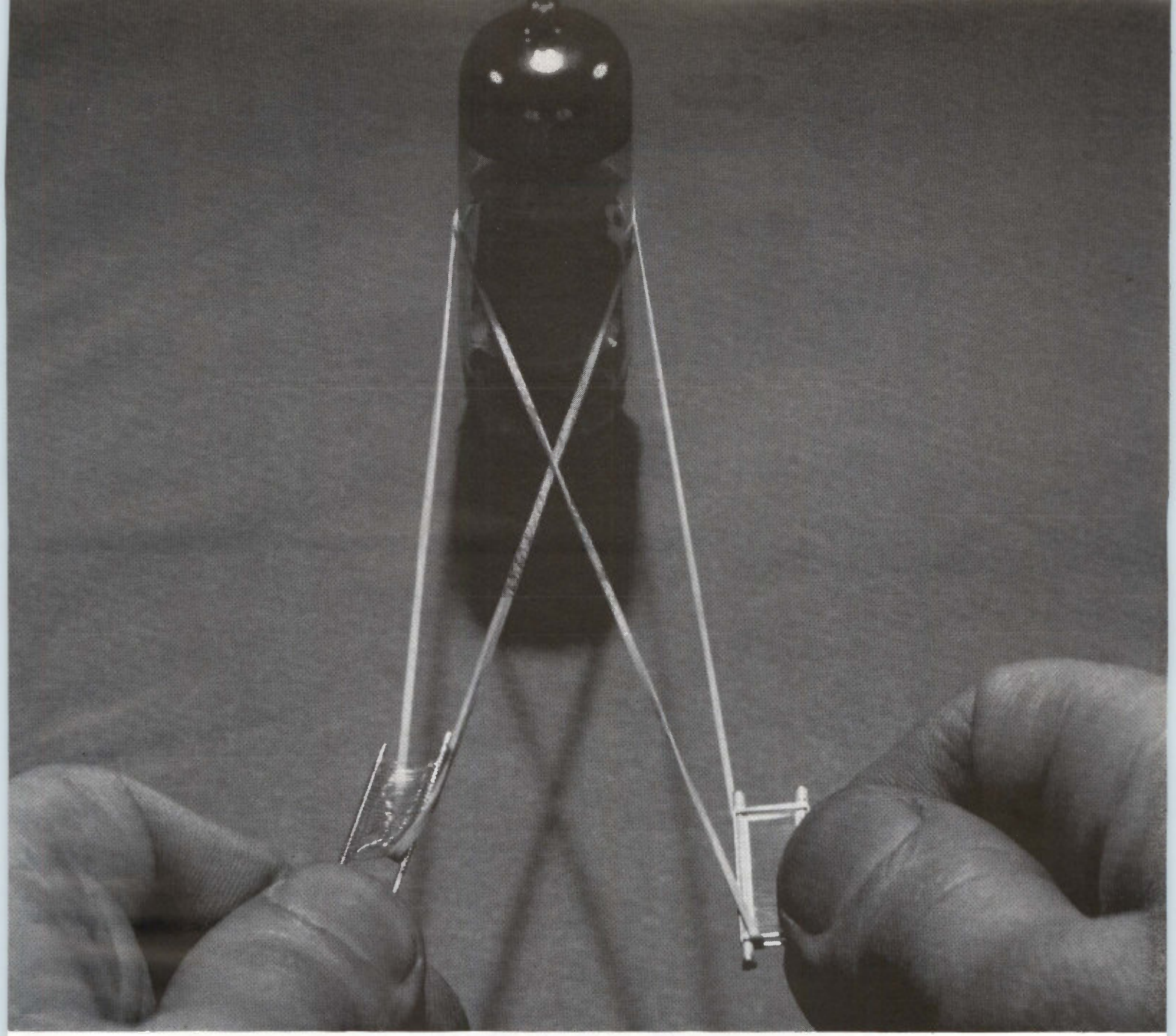
WESTERN ELECTRONIC SHOW AND CONFERENCE, WEMA, IEEE; Cow Palace, San Francisco, Calif., **Aug. 20-23.**

ADVANCE REPORT

NATIONAL VACUUM SYMPOSIUM, *American Vacuum Society; Statler Hilton Hotel, Boston, Mass., Oct. 16-18.* ***June 15*** *is the deadline for submitting 100-word abstracts in triplicate to: G. H. Bancroft, Program Committee Chairman, 398 Kilbourn Road, Rochester 18, New York. Subjects of interest include: structure and properties of thin films as related to their conditions of formation by evaporation and sputtering at low pressures; production and measurement of high and ultrahigh vacuum; surface phenomena at low pressures including friction, lubrication, sorption and permeation processes; vacuum techniques related to space simulation, freeze drying and other vacuum processes.*

RELIABILITY IN SPACE VEHICLES SEMINAR, IEEE-PTGR & PTGED; *Los Angeles, Calif., Dec. 6. July 1 is the deadline for submitting a 500-word summary to: W. H. Bleusl, Jr., Reliability Engineer, c/o Endevco Corp., 801 S. Arroyo Parkway, Pasadena, Calif. Topics of interest encompass areas of system and component reliability with regard to space vehicle operation.*

CIRCLE 43 ON READER SERVICE CARD→



How the strength of Sylvania's Strap Frame Grid improves tube performance

Tube grids in service never get the exact rack torture shown here, but it illustrates a point.

The conventional grid, on the left, depends on its winding for rigidity (which automatically imposes a minimum size limit on the wire). With any rough treatment of the sort encountered in missiles and planes, distances can easily change between the winding and the cathode it surrounds.

By putting metal braces across the backbones, the Strap Frame Grid is formed, which is rigid with or without the winding. With no physical support requirement, the wire can be smaller (allowing more turns per inch) and placed a short, precise distance from the cathode—permanently. This closeness greatly improves transconductance, Gm-to-Ib ratio, gain, bandwidth and noise figure. And physical stability translates into electrical stability, even with jarring or environmental changes.

Sylvania was several years ahead of other U. S. tube manufacturers putting Strap Frame Grids in subminiature tubes. And industrial and commercial versions in miniature size have been star performers for even longer.

Another example of how Sylvania advances electronics by introducing—ahead of the field—better-performing, more reliable components. Electronic Tube Division, Sylvania Electric Products Inc., Box 87, Buffalo, New York.

SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

NEW CAPABILITIES IN: ELECTRONIC TUBES • SEMICONDUCTORS • MICROWAVE DEVICES • SPECIAL COMPONENTS • DISPLAY DEVICES

TRW Electronics

PSI

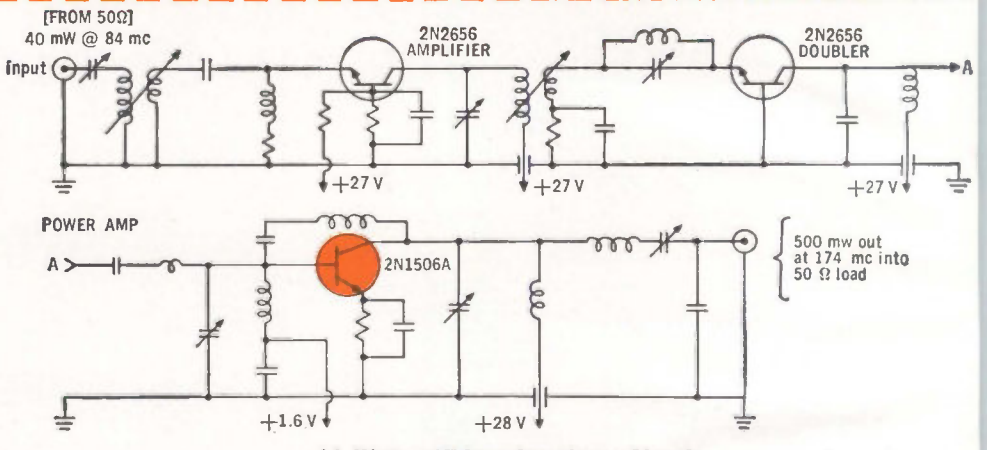
How to design transistorized communications equipment

MEDIUM POWER
VHF TRANSISTORS

2N1506A

• 1 watt • 70mc @ 28V • 10db gain

Ideal transistors for application in drivers and final amplifiers of telemetry transmitters to 2W, final amplifiers for mobile radio applications in the 140mc range, and as multipliers from 40 to 200mc.



½ Watt—174mc Sonobuoy Circuit

This circuit employs PSI 2N2656 and 2N1506A transistors to achieve high power for Sonobuoy applications. Outputs to 2 watts can be obtained by adding additional stages; the oscillator circuit is at the designer's discretion. This circuit is indicative of the increased design flexibility offered by PSI 2N2656 and 2N1506A silicon RF transistors.

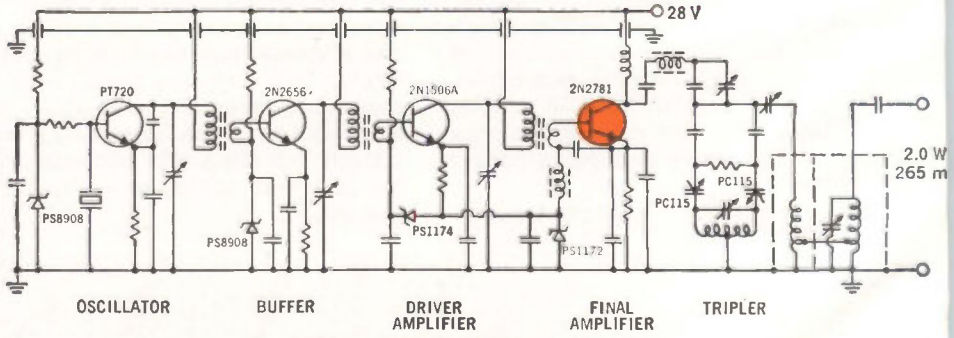
HIGH POWER
VHF TRANSISTORS

2N2781

• 5 watts • 30mc @ 28V • 12db gain

Use this series as final amplifiers in communications equipment, 2 to 5W telemetry equipment and mobile radio designs.

CIRCLE 44 ON READER SERVICE CARD



2 Watt—265mc Telemetry Circuit

Originally designed and engineered at PSI, this circuit applies a PSI PT720 as an oscillator, 2N2656 as a buffer, 2N1506A for the driver stage and a 2N2781 for the final, to deliver a conservative 2 watts at 265mc. This application is one of the first telemetry designs available using low cost, off-the-shelf units instead of state-of-the-art devices.

PSI SERVES THE COMPLETE COMMUNICATIONS SPECTRUM . . . From low-level, low-noise oscillators and amplifiers to advanced high-power, high-frequency devices, PSI has the communications transistor your designs require.

For the past five years, PSI has dedicated the major part of its transistor development and engineering efforts towards optimizing capabilities of silicon transistors in all communications equipment. Today PSI is a leading producer of RF transistors for high reliability space communications equipment in such projects as Mariner, OAO, Ranger, Relay, and Explorer. Realizing that component cost is a major factor in communications equipment design, PSI has had, as an early objective, the pricing of high performance RF devices at levels which will hasten the era of all-transistorized communications systems in many new fields.

Call PSI today to discuss your particular communications equipment design problems. Let PSI application engineering show you how you can design transistorized communications equipment on a vacuum tube budget through lower overall component costs due to lower voltage operation, lack of heater equipment, smaller power supplies, and greater efficiencies.

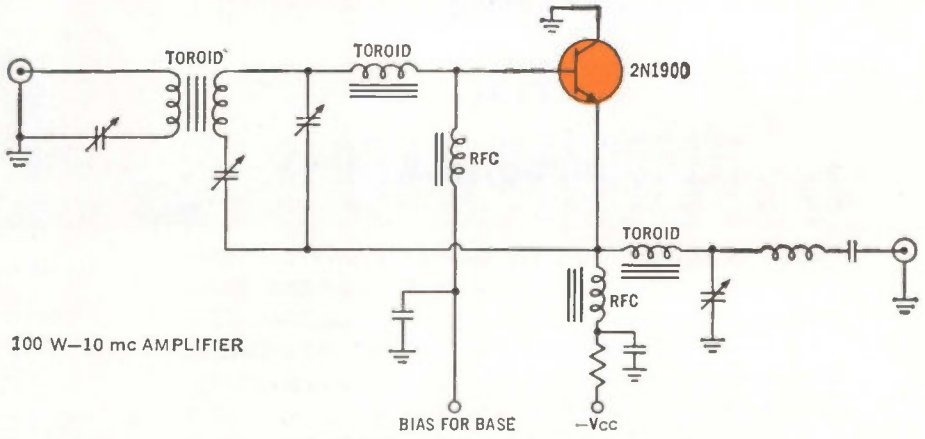
on a vacuum tube budget!

HIGH POWER
HF TRANSISTORS

2N1900

• 100 watts • 10mc @ 60V
• 10db gain

The PSI 2N1900 series is ideal for commercial, marine, and military PRC and VRC designs from 2 to 12mc, as 10 amp switchers in power conversion applications, and amplifiers in VLF transmitters up to 5KW.



100 Watt—10mc Amplifier for PRC, VRC and Marine Radio

This economical design employs optimum heat sinking to provide a substantial reduction in size over 100 watt tube amplifiers. This design employs a PSI 2N1900 in a reliable, cold-welded package to deliver 100 watts out at 10mc with greater than 10db gain.

LOW POWER/LOW NOISE
UHF TRANSISTORS

2N2656

• 50mW • 100mc @ 10V
• 10db gain

Apply these low noise figure units to your oscillator designs up to 50mW. These transistors also provide optimum performance in low to medium-level class A and B buffer amplifiers by delivering up to 200mW RF power with over 50% efficiency.

Pacific Semiconductors, Inc.
TRW Electronics
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14520 AVIATION BLVD., LAWNDALE, CALIF. • OS 9-4561, OR 8-0561
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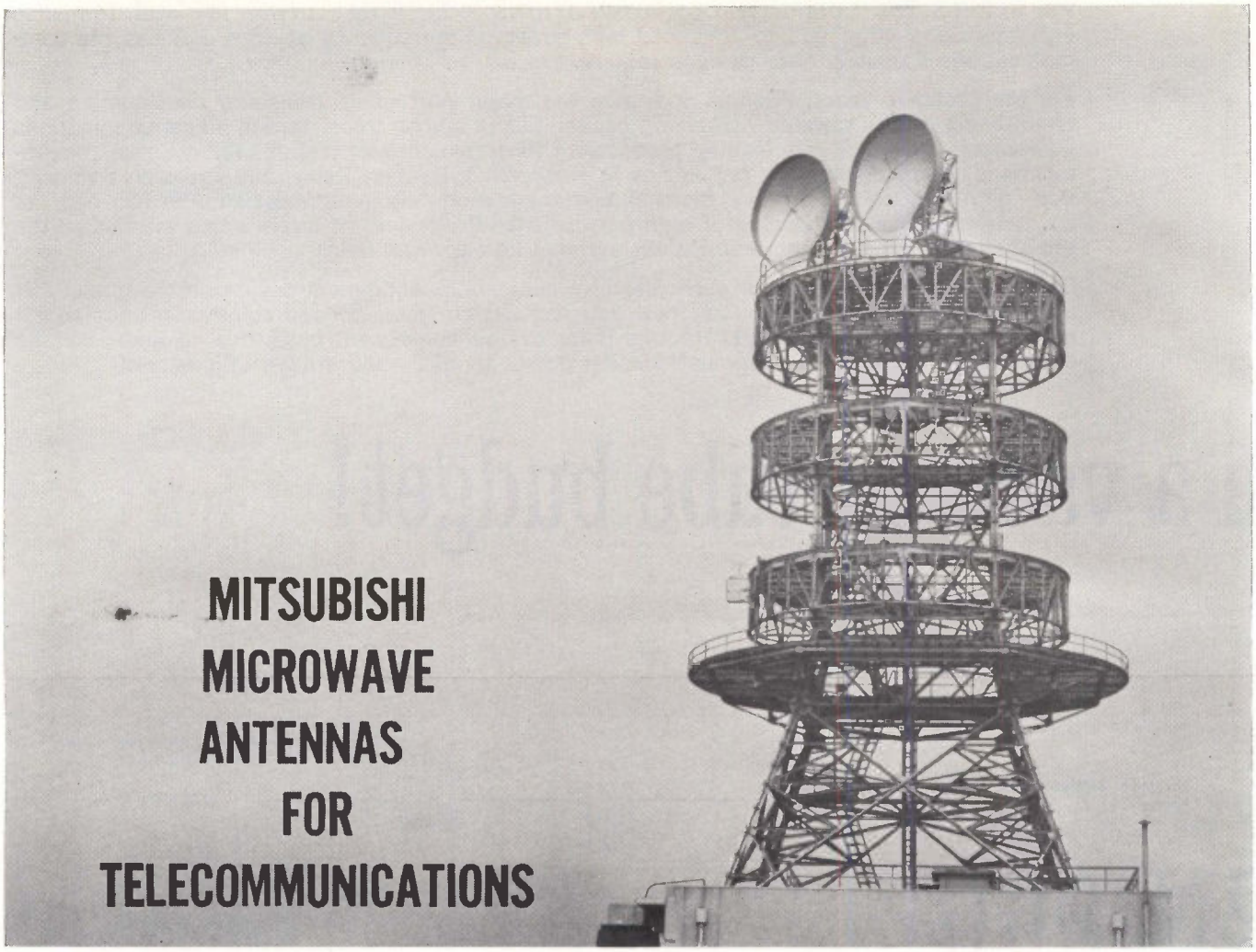
CIRCLE 47 ON READER SERVICE CARD



MITSUBISHI MICROWAVE ANTENNAS FOR TELECOMMUNICATIONS

Japan today has the second largest microwave network in the world. Mitsubishi Electric, with the longest microwave antenna experience in Japan, has supplied 90% of the antennas used in the trunk lines of this extensive network. Mitsubishi antenna systems include parabolic, scatter, horn reflector and radar types, as well as a complete line of waveguide components and accessories. Frequencies from 900 Mc. to 24 KMc. are covered. The IU-61, shown above and specified at the right, is typical of the outstanding performance of Mitsubishi microwave antennas. Full technical information on any of these types of antennas is available at your request.

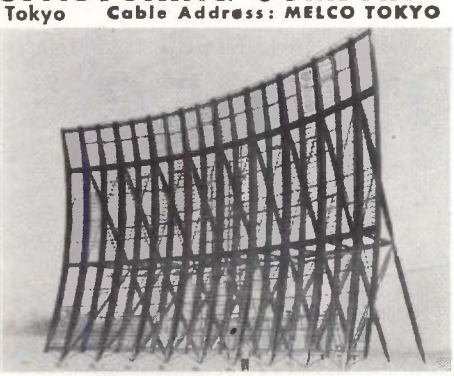
IU-61 6000 Mc. Band Parabolic Antenna

Diameter	: 4 meters
Frequency Range	: 5925~6175 Mc/s or 6175~6425 Mc/s
Feed System	: Dual circularly polarized wave
Gain	: 45 db
Beam Width	: 0.98 degrees (half power)
First Side Lobe	: −23 db
Wide Angle Radiation (over 60 degrees)	: −60 db
Front-to-Back Ratio	: 65~70 db
VSWR	: 1.02
Ellipticity Ratio	: 1.1 (power axial ratio)
Discrimination of anti-circularly polarized wave	: −30 db
Coupling of Both Arms	: −35 db
Guaranteed for Wind Velocity of	: 60 meters/second
Weight	: 800 kilograms

MITSUBISHI ELECTRIC MANUFACTURING COMPANY
Head Office: Mitsubishi Denki Bldg., Marounouchi, Tokyo Cable Address: MELCO TOKYO

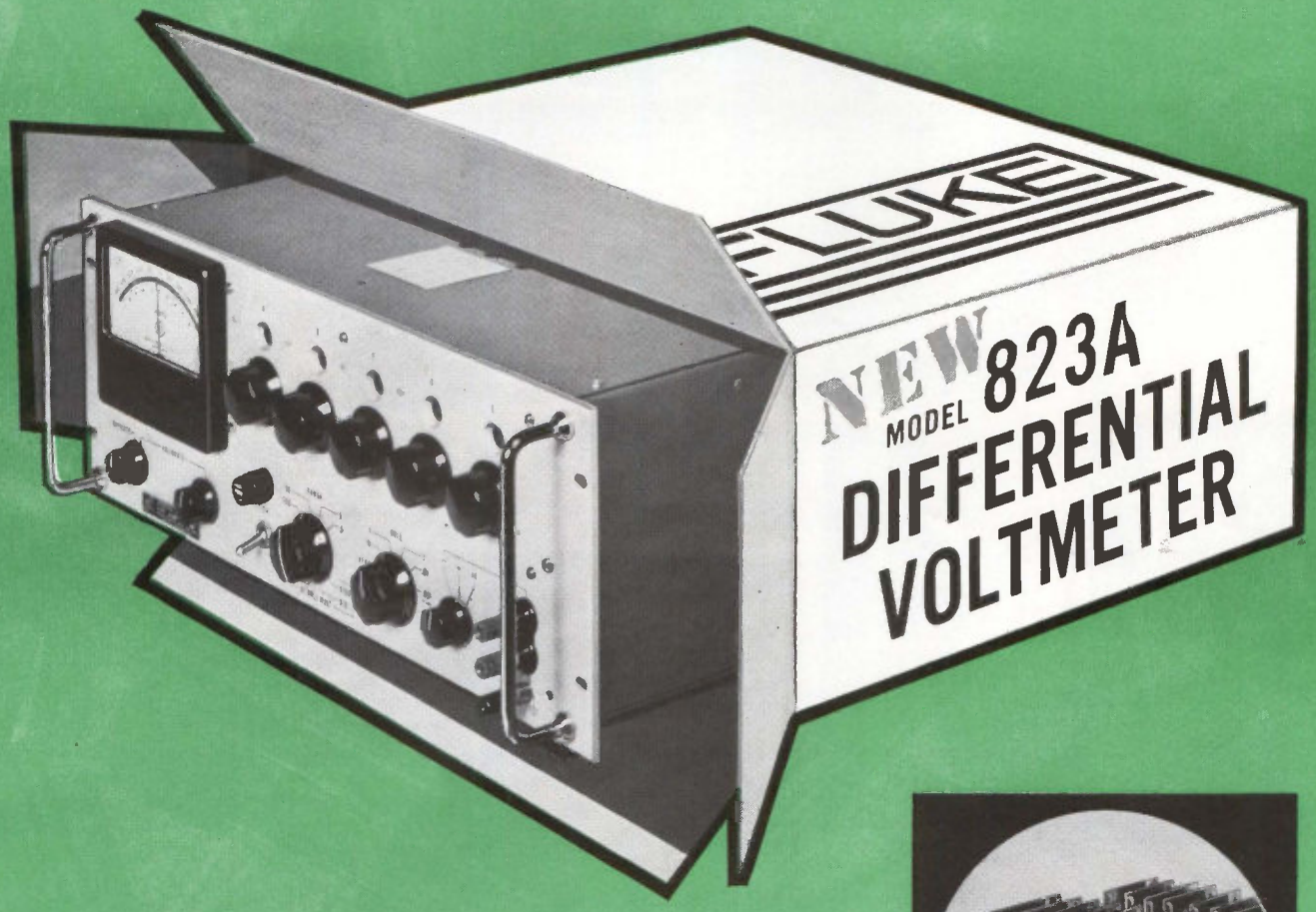
■ Horn reflector antenna

■ Air inflated parabolic antenna



■ 25×16 meter scatter antenna

Quite a package!



Fluke-manufactured, precision wirewound resistors, aged and matched both for resistance and temperature coefficient, guarantee the long term DC accuracy of the voltmeter to be better than 0.01%. Resistors used in critical portions of the Kelvin-Varley divider have temperature coefficients of less than one part per million per degree Centigrade.

Accuracy of 0.01% DC, 0.1% AC
a uniquely useful measuring instrument

The new Fluke Model 823A differential voltmeter provides the highest accuracy obtainable in a portable instrument. In addition, it provides infinite DC input resistance at null (0-500V), divider terminal linearity of 2-20 ppm, DC polarity switch, recorder output, and no zero controls.

Model 823A is designed to perform under severe environmental conditions. It is guaranteed to withstand the shock and vibration requirements of Mil-T-945A. It is guaranteed to perform within specifications from 0-80% humidity and from 55° to 95°F. It's quite a package.

Ask your Fluke representative for a demonstration, or request complete data from John Fluke Mfg. Company, Inc., P.O. Box 7428, Seattle 33, Wash. Tel. PR 6-1171; TWX 206-879-1864, TLX 852.

FLUKE

Brief Specifications:

MODEL 823A

DC ACCURACY
± 0.01% from 0.5V to 500V
± (0.01%+10 uv) below 0.5V

AC ACCURACY
± 0.1% from 30 cps to 5 KC
± 0.15% from 20 cps to 10 KC
overall frequency range 5 cps - 100 KC

CALIBRATION
500V internal reference supply calibrated to better than 20 ppm against built-in standard cell

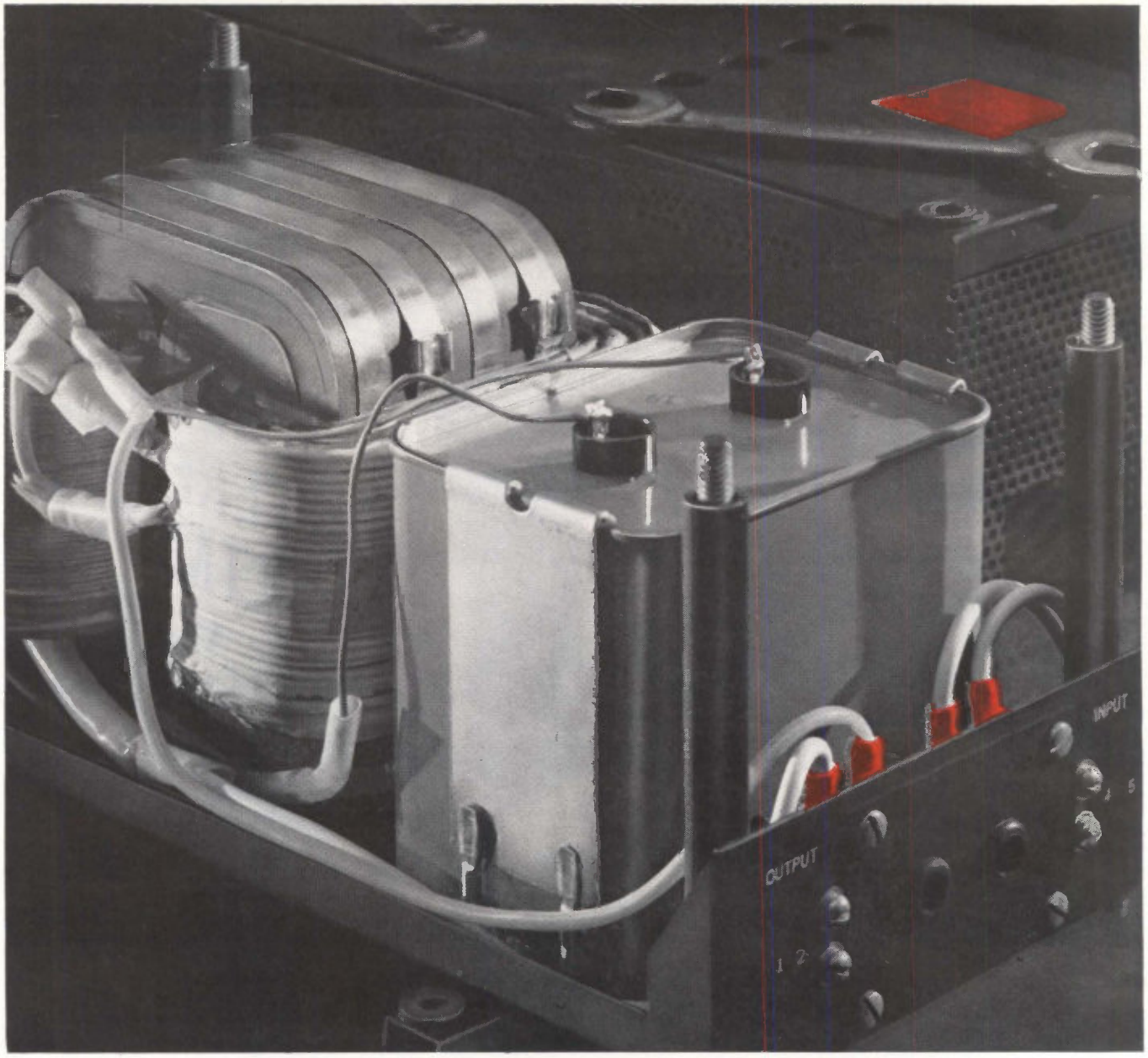
INPUT POWER
115/230V AC ± 10%, 50-400 cps, 80 watts

	CABINET	RACK
SIZE:	13" high x 9¾" wide x 16" deep	7" high x 19" wide x 15½" deep
WT.:	28 pounds	26 pounds
PRICE:	$1300.00	$1320.00

MODEL 803D

New Model 803D, available in either rack or cabinet configuration, offers many of the features of Model 823A. Accuracy—AC, 0.1%; DC, 0.02%. Price—cabinet, $1100.00; rack, $1120.00.

CIRCLE 49 ON READER SERVICE CARD



See the wrench?

The wrench is on the black box. It is an ordinary wrench.

The black box is an ordinary box. Commonplace. *Everybody* has one. That's why we used the wrench. We took the black box off.

Now you can see our new constant voltage transformer. See. It is small (13⅛" x 5⅞" x 6"). It is sturdy (Note construction). It is efficient (±1% line regulation). It is reliable (we never put the trademark CAPITRON on anything that isn't).

You can't buy a better constant voltage transformer anywhere. It's so good, you'll probably never have to take it out of the black box. That's why you won't get a wrench when you order but you *will* get:

- all solid state components (no moving parts)
- input voltage—95—135 VAC
- outpower —1450 VA
- Current limiting to 20 amps under short circuit conditions
- output current—12 amps
- line regulation—±1%/load regulation—±2%
- input frequency—60 CPS
- output voltage—120 VAC

We'll take the wraps off additional information, test data and other pertinent facts when you send for full details on the CAPITRON* Constant Voltage Transformer. Send today!

AMP INCORPORATED | *CAPITRON DIVISION*
155 PARK STREET, ELIZABETHTOWN, PA.

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ARTIST'S CONCEPTION *shows route taken in transmission of first color facsimile photograph by Relay satellite from Nutley, N. J. to England and return. RCA built the satellite*

ON OUR COVER:

First Color Facsimile Transmitted by Satellite

Successful color transmission opens new field for communication satellites in world-wide distribution of visual information

By JOEL STRASSER,
Assistant Editor

FIRST FULL-COLOR facsimile photograph to be successfully sent by satellite was transmitted by ELECTRONICS magazine on April 25 to the Goonhilly Downs station in England using NASA's Relay satellite (ELECTRONICS, Oct. 5, 1962, p 46). The color separations from which the plates for the front cover of this issue of the magazine were made constitute the first set successfully received. This experiment lays the groundwork for possible regular color photo transmission by satellite.

Transmission of the first set of color separations was accomplished on satellite pass 1035 between 4:40 and 5:09 p.m. EST, when the photos, showing an enhanced micromodule designed by the U. S. Army Electronic Research and Development Laboratory at Fort Monmouth, N. J., were sent from the facilities of RCA Communications, Inc. in New York to the Relay satellite, and received at the Fleet Building in London through the Goonhilly Downs station. Domestically, ground lines carried the signals from RCA Communications through American Cable and Radio's patch to the satellite communications station on the grounds of ITT Federal Laboratories at Nutley, N. J.

At the same time, black and white 10-sec photographs of the experiment in progress were taken and placed on the facsimile drum for transmission to Europe. Five days later, the pictures were retransmit-

ACTUAL COLOR SEPARATIONS *received from the Relay satellite transmission. Photo mislabeled "yellow" was really printed in red.*

ted by satellite from England and successfully received in the United States.

The experiment was devised to test the feasibility of using a communications satellite with limited usable time. As far as possible, the experiments were conducted with existing equipment using internationally acceptable specifications. Out of these experiments has developed a number of criteria for transmitting color separations by satellite.

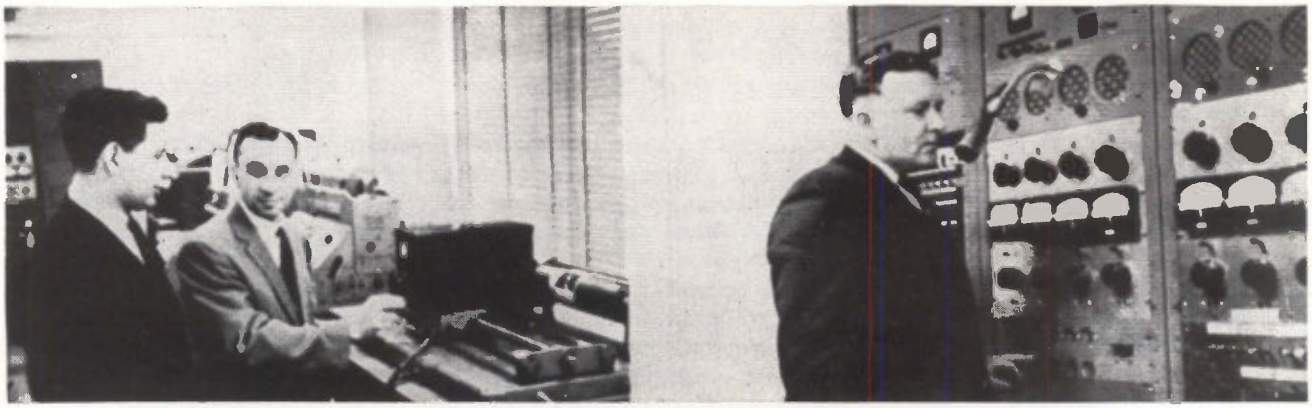
METHODS—Of the two major methods for transmitting a color photograph by satellite—color television or facsimile—the latter was selected because color television involves costly equipment that effectively limits the number of prospective users. To reproduce a tv image on the printed page, photographs have to be taken of the tv screen and color separations made. (Color television broadcast transmission by satellite has been accomplished previously.)

For facsimile transmission, color separations were made in the conventional manner from a color transparency of the subject. In general, this is accomplished by rephotographing the picture using complementary filters for the color separation desired. To obtain a black separation, a yellow filter is used; for blue, a red filter; for red, a green filter and for yellow, a blue filter. The results are prints emphasizing only the color for which the separations have been made. For example, the red separation shows as darkest those parts that are to be predominantly red in the finished photograph. (Our cover uses three separations: black, blue and red.)

If more than 24 minutes of satellite time had been available, we would have employed a "serial" transmission method, consisting of sending each of the three 8 × 10-inch separation prints through in sequence. The three separations could have been sent in "parallel," but this would have required three separate channels both on the ground and in space. As a compromise a "simultaneous" method of transmission was developed.

The photographs were reduced in size and reproduced vertically on one 8 × 10-inch glossy print. With this technique, maximum time conservation was achieved at some sacrifice of resolution. The 10-inch dimension was filled to capacity, while only 3 inches of the 8-inch width were utilized. The scanning rate was 100 lines per inch; thus, at 60 rpm the entire set of three separations was scanned simultaneously and transmitted in 5 minutes. Although during the 24 minutes allotted to the experiment on each satellite pass, four composite sets of separations could have been scanned, we actually scanned the one composite set twice and used the remainder of the pass to send the two black-and-white 10-sec photos of the experiment.

STANDARDS—The most popular and internationally acceptable standard for facsimile requires an index of cooperation of 352 and a speed of 60 rpm. The index is the product of the diameter of the cylinder (3.52 inches or 88 mm) and the scanning density in lines per inch (100), or the cylinder diameter divided by the line advance. These specifications have been pub-



EXPERIMENT IN PROGRESS. *In photo at left, author (left), and Ben DeMeo, RCA Communications technician, discuss the transmission as the first photos rotate on the facsimile transmitter. Facility Supervisor Joseph K. Unger, in photo at right, is in voice contact with London as the transmission begins. These 10-second photos were transmitted during the latter part of the satellite pass*

TABLE I—Transmission Requirements for 8 × 10-In. Photos
(Based on International Std: index 352, speed 60 rpm)

Transmission Method	2 Colors	3 Colors	4 Colors
SIMULTANEOUS Vertical mounting to 10-in. max.	See note a, 1 channel	See note a, 1 channel	See note a, 1 channel
SERIAL Scan 8-in. width	26.6 minutes plus 2 min. adjustment time,[b] 1 channel	39.9 minutes plus 4 min. adjustment time,[b] 1 channel	53.2 minutes plus 6 min. adjustment time.[b] 1 channel
PARALLEL Scan 8-in. width	13.3 minutes, 2 channels [c]	13.3 minutes, 3 channels [c]	13.3 minutes, 4 channels [c]

[a] Given width of pictures, W (inches);

$$t \text{ (transmission time, minutes)} = W \times \frac{100 \text{ lines}}{\text{in.}} \div 60 \text{ rpm}$$

[b] Allowing 2 minutes adjustment time between pictures for changing photos on drum and transmitting phasing pulse

[c] Requires additional facsimile machines and leased ground lines to transmitter

TABLE II—Typical Facsimile Specifications
(With time requirements for 8-inch scans)

Method	Index of Cooperation	Scanning Density (lines/in.)	Speed (rpm)	Time Per 8-Inch Scan (minutes)
CCITT International Standard	352	100	60	13.3
CCITT International Standard	352	100	120	6.7
Alternate CCITT International Standard	264	96	90	8.5
Associated Press	382	100	100	8
United Press International	440	150	120	10
CCITT—Weather Fax Standard	576	96	120	6.4

lished by the International Consultative Committee on Telegraphy and Telephony (CCITT). The transmission requirements for the various methods, including the times and numbers of channels, using this standard are summarized in Table I. Transmission speeds and other specifications for several facsimile methods are summarized in Table II. Using this table, transmission requirements, similar to those in Table I can be computed. Some time should be allowed to adjust the f-m limits at the beginning of the transmission, to change pictures on the drum and to transmit a phasing pulse for each separation. The last two operations require about two minutes between photographs.

The experiment was provided with backups to guard against failure. The photos were retransmitted by Atlantic cable to New York, and prints received in London were sent to ELECTRONICS by mail. At the same time, the signals were recorded on magnetic tape on a specially designed facsimile tape recorder acquired by the British for this occasion.

On pass 1073, on April 30 between 2:41 and 2:57 p.m. EDT, the tape recorded signals were successfully retransmitted from England by Relay satellite through Nutley, N. J. to RCA Communications in New York. The front cover photo however, was made from the separations returned by Atlantic cable to meet production schedules.

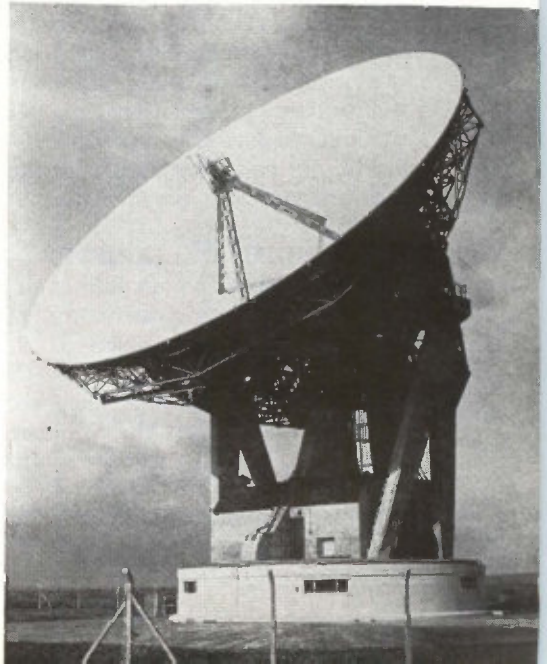
As a backup at the Nutley station, a modified Ampex FR-100B seven-track facsimile tape recorder was used. One channel carries a corrective frequency tone to monitor the speed. Three channels are used for f-m recording and the remaining three are used for direct recording from 20 cps to 50 Kc.

Output of the transmitter at the Nutley station is 10 Kw. A Cassegrainian antenna feed system is used with a 40-ft parabolic dish to pick up the signal. Transmitting frequency is 1,723.33 Mc. Dual-channel f-m receivers capable of receiving signals at 4,165 and 4,175 Mc are used at the station.

The facsimile transmitter at RCA Communications in New York is an RCA-built machine with an 88-mm diameter cylinder. A Westrex machine was on hand as a backup. The machines use a speed of 60 rpm and an index of cooperation of 352. The facsimile signals are originally a-m and are converted to f-m from 1,500 to 2,300 cps. White is transmitted at the 1,500-cps frequency; black at the higher frequency.

Transmitting frequency of the Goonhilly Downs station in Southwestern Cornwall, England is 1,726.67 Mc. The station has an 85-ft steerable parabolic antenna and a maser amplifier.

ELECTRONICS gratefully acknowledges the assistance and cooperation of NASA Headquarters, Washington, D. C., Goddard Space Flight Center, Greenbelt, Md., RCA Communications, Inc., Radio Corp. of America, International Telephone and Telegraph Corp. and American Cable and Radio Corp.



GOONHILLY DOWNS *station in England uses an 85-ft steerable parabolic antenna*

GETTING BOTH RELIABILITY AND ECONOMY IN

Power-Transistor Circuits

Well-designed germanium power transistors are highly reliable even in high-temperature circuits. Failures at elevated temperatures can be reduced when the basic and inherent properties of germanium are known and circuits designed to take advantage of this performance

By RALPH GREENBURG, Section Manager Power Supply Operations, Motorola Inc., Phoenix, Arizona

POWER transistors are being made of either germanium or silicon semiconductor material. Germanium devices have maximum temperature ratings around 125 C and silicon transistors can operate at temperatures as high as 200 C.

The difference in temperature ratings tempts reliability-conscious circuit designers to specify silicon transistors for equipment where, with proper design, germanium is more than adequate to meet the requirements. This causes unwarranted increases in equipment cost.

Well-designed germanium power transistors are highly reliable even in high-temperature applications. Device failures and improper circuit performance at elevated temperatures are normally due to circuit designs that neglect to consider the inherent properties of germanium. The following discussion provides reliability data, based on more than 21,000,000 device hours of life test information for germanium transistors, and describes circuit design areas that influence high-temperature performance.

GERMANIUM RELIABILITY — There are three factors influencing germanium power transistors reliability; surface condition of the germanium, temperature of the collector-base junction, and secondary breakdown of the collector.

Of these, only the last two items are under control of the circuit engineer, but a brief description of failures that can be caused by improper manufacturing controls and processes will help provide an insight for possible failure analysis.

Instability in germanium power transistors can be caused by contamination of the semiconductor surface during the manufacturing process. This may be due to exposure of the surface to oxidations in soldering and alloying furnaces. To reconstitute the surface, a cleaning process is normally employed just before encapsulation of the device. This usually consists of an etching, washing and drying cycle, followed immediately by encapsulation. When such a process is correctly carried out, neither storage nor operating temperatures have any pronounced effect on the transistor surface, and excellent stability is obtained.

Final assembly and encapsulation of power transistors is normally achieved by soldering the transistor junction assembly to a copper base having the lowest possible thermal resistance and enclosing this assembly in an air tight housing. In a single-ended package, as shown in Fig. 1, the base and emitter leads are inserted and solder-sealed through openings in the package and the structure is capped with a shell both to prevent mechanical damage to the semiconductor device and to guard against the entrance of contaminating gas or moisture.

Either hot-weld or cold-weld processes can be used for sealing the shell to the copper base. The assembly in Fig. 1A depicts hot-weld encapsulation while that of Fig. 1B illustrates the simpler cold-weld technique. Here, the copper cap is attached to the copper base under high pressure so that the cap and base fuse to become a single piece of metal. All measurements were made on cold-weld-sealed devices.

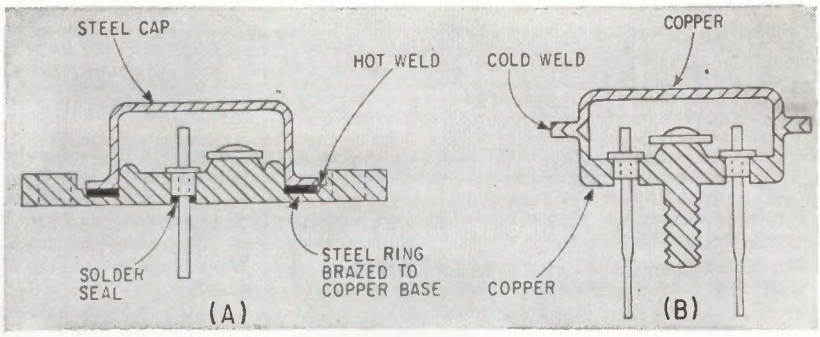
To neutralize any ambient gas or moisture trapped inside the sealed cap, absorbent materials known as desiccants, molecular sieves or getters are placed inside the device prior to encapsulation.[1] This keeps the internal moisture in equilibrium, thereby causing surface recombination of charges to be almost independent of temperature and age.

Faulty hermetic seals between cap and base can result in a relatively high transistor failure rate. Even a small leak can admit enough external gas to cause a device to breathe when exposed to alternately hot and cold temperatures in a humid environment. This results in the deposition of water vapor on the semiconductor surface which, if beyond the control capability of the desiccant, can cause variations in transistor characteristics.

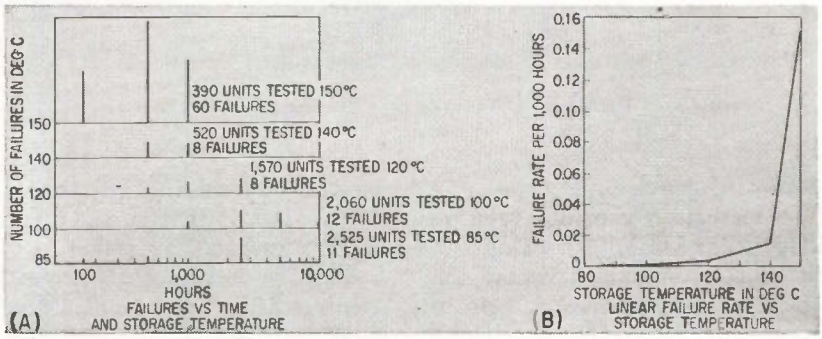
The reliability of properly constructed transistors, however, is virtually unaffected by temperature—at least, until the temperature reaches a point near the melting threshold of indium (about 150 C). Verification for this contention

GERMANIUM OR SILICON?

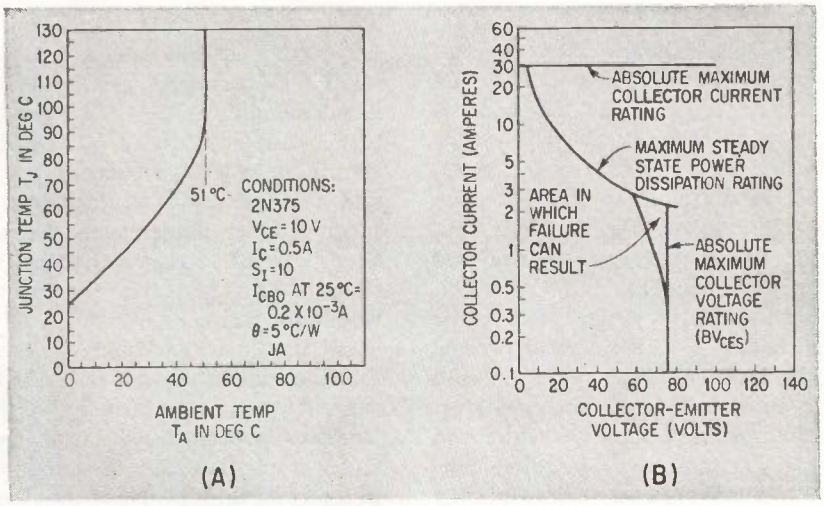
When given a choice, most electronics engineers will specify silicon transistors in a circuit involving high temperatures. The usual thinking is—well, silicon takes the temperature better. After an analysis based on 21,000,000 device hours, Motorola has arrived at some answers that may change a lot of present thinking about the silicon-germanium problem



ENCAPSULATION *of a power transistor can be in the hot-weld diamond package (A) or the cold-weld doorknob package (B)—Fig. 1*



FAILURES *plotted against time and storage temperatures (A) and linear failure rate plotted against storage temperature (B)—Fig. 2*



TYPICAL *conditions for thermal runaway (A) maximum limits for a 2N2158 transistor (B)—Fig. 3*

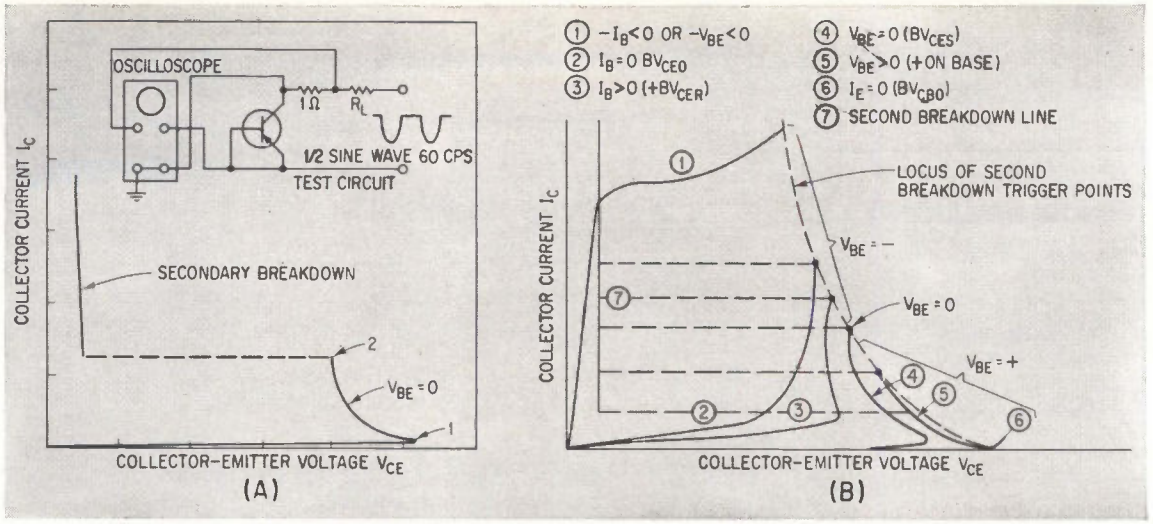
is shown in Fig. 2A and 2B where the results of a quality-control program are plotted. Both of these graphs show the low failure rate (although it does increase slightly) up to temperatures near the melting point of indium, after which failures increase drastically as the liquefied indium causes open and short circuits within the device.

The electrical characteristics of transistors vary with temperature. Reverse leakage current, for example, increases as temperature rises and current gain varies to some extent as temperature is varied. Reliable transistor circuit performance under widely varying temperature conditions, therefore, demands the utilization of worst-case-design procedures in which maximum and minimum characteristics are taken into consideration at the highest and lowest temperatures to be encountered. With such procedures, the design engineer can expect highly-reliable performance even at temperatures that were once considered to be destructive to germanium alloy devices.

DESIGN FOR CIRCUIT RELIABILITY — Though temperature alone is no deterrent to reliability, other factors may inadvertently raise the temperature of the semiconductor device beyond the maximum limit to cause device damage and improper circuit performance. In a study of device and circuit failures it was found that such failures were due principally to application of over-voltage to the transistor and to thermal runaway.

THERMAL RUNAWAY — The phenomenon of thermal runaway has been thoroughly covered in the literature.[2] It is the result of the temperature effects on collector leakage current I_{co}. Since I_{co} increases with temperature, any increase in junction temperature at a given value of collector current will cause a corresponding increase in collector power dissipation. This in turn causes a further increase in temperature and an additional increase in I_{co}. If the heat sink is not capable of dissipating the heat fast enough, that is, if no equilibrium between heat generation and heat radiation is reached, thermal runaway will occur. This can result not only in improper circuit performance, but in permanent transistor damage.

The precautions for preventing thermal runaway are generally known, but not always practiced and a typical condition for thermal



SECOND BREAKDOWN *and test circuit (A) with locus of second breakdown trigger points (B)—Fig. 4*

runaway is shown in Fig. 3A.

The methods commonly used to achieve bias stability, using an emitter resistor and keeping the base-return resistance low, help to prevent thermal runaway. However, current stability factor S_I is only one of four factors which multiply together to form a thermal stability criteria. Germanium transistors will not go into thermal runaway at or below 110 C if $\theta_{JA}\ S_I\ I_{CBO}\ V_{CE} < 16.5$C where θ_{JA} is junction-to-ambient thermal resistance expressed in degrees C/watt, S_I is circuit current stability factor ($S_I = \Delta I/\Delta I_{CBO}$), I_{CBO} is the collector cutoff current at the hot junction in amperes and V_{CE} is collector to emitter potential in volts.

Although V_{CE} is generally fixed by design conditions and I_{CBO} is an inherent property of the transistor, there are still two factors which the circuit designer can control to prevent thermal runaway. The stability criteria can be checked to a good approximation from $S_I = 1/[(R_E/R_B) + (1/h_{FE})]$ where R_E is external emitter resistance, R_B is external equivalent base resistance and h_{FE} is common-emitter d-c current gain.

One way of reducing the chances of thermal runaway is to minimize this expression by making R_E/R_B as large as possible. This can cause a sacrifice in efficiency and performance of many circuits.

The second method involves a reduction of thermal resistance by increasing the heat sink area, causing air flow, etc., but the benefits of this procedure are limited by the internal thermal resistance of the device; that is, the junction-to-case thermal resistance.

Usually, S_I values of 5 to 10 are easily achieved and θ_{JA} of 4 degrees C/W is readily obtainable with almost any power transistor and a finned heat sink. Thus, a product ($S_I \times \theta_{JA}$) of 20 to 40 is common practice. This means that the $I_{CBO}\ V_{CE}$ product cannot exceed about 0.4 watt without causing thermal runaway. For example, an $S_I \times \theta_{JA}$ product of 40, coupled with an I_{CBO} value of 20 ma at 100 C (a common value) and a V_{CE} of 20 v would bring the total product dangerously close to the thermal runaway point, although at 12 volts, the system would be stable.

If the mathematical threshold for thermal runaway is exceeded, several solutions to reduce the problem are practical. A larger heat sink or air flow can be considered to lower θ_{JA} and the use of the thermistors or larger emitter resistors to lower S_I may be practical. In certain cases, both methods may prove necessary, and in extreme instances, paralleling of systems may be required.

SAFE AREA OPERATION — Probably the major reason for damaged germanium power transistors or unreliable circuit performance results from a misinterpretation of data-sheet specifications by the engineer, and in some cases, insufficient data-sheet information from the transistor manufacturer. Paradoxically, unless the maximum ratings given on the conventional data sheet are tempered with a familiarity of device characteristics, one design can cause unreliable performance while in another results in overdesign and decreased circuit efficiency.

As an example, the maximum limits of a 2N2158 power transistor are plotted in Fig. 3B. The maximum-power-dissipation curve has been so drawn that the maximum rated power dissipation of 170 watts is never exceeded for any voltage-current product. This represents a steady-state power dissipation limit which, if the transistor case can be held to a temperature of 25 C (infinite heat sink), will result in reliable circuit performance.

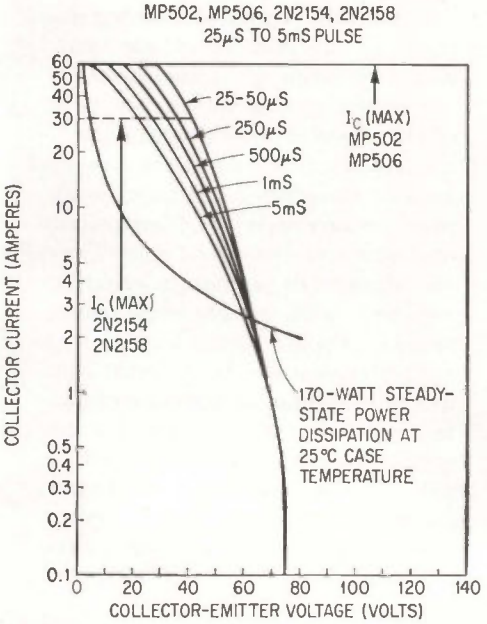
On the same graph, specified limits for maximum collector-emitter voltage (V_{CE}) and collector current (I_C) are indicated. The implication is that if either the maximum-power curve or the maximum voltage or current limits are exceeded, damage to the transistor will result.

What most data sheets fail to make clear is that the maximum voltage specification applies primarily to low collector-current applications on the assumption that high collector current and high voltage do not exist simultaneously. While this assumption is normally true for resistive loads, it does not apply to complex and reactive loads. As a result, the design of circuits using the specified high-voltage limit can lead to improper circuit performance and in some instances to device damage.

The reason for this is second breakdown, which is illustrated in Fig. 4A. Here, the collector current of a typical power transistor is plotted as a function of collector-emitter voltage, with the base externally shorted to the emitter. Under this condition, an increase in applied voltage causes only a slight increase in I_C until the V_{CE} reaches point 1 where the collector junction begins to break down giving rise to an avalanche condition. Any increase in applied voltage beyond point 1 actually reduces V_{CE} and the difference between the applied voltage and V_{CE} will appear across the external load resistor.

At point 2 of the graph, at a specific value of collector current, a second breakdown occurs causing V_{CE} to switch back to a very-low value. This phenomenon is accompanied by an instantaneous rise in current, sufficient to melt the transistor base and causing permanent damage to the transistor.

Normally, the maximum voltage rating of a transistor is specified at an amount of collector current that restricts the operation to the area between points 1 and 2 of the curve. Thus, at higher collector currents, circuit malfunctioning and device damage can result. More important is the effect of base current on the first and second breakdown points.



WORST-CASE *failure loci for pulse operation of a series of typical power transistors—Fig. 5*

The curve of Fig. 4A applies for only the shorted-base condition. Under more normal conditions where forward bias is applied to the base-emitter junction and collector current increased, the primary and secondary breakdown points both shift to the left as shown in Fig. 4B. Thus, the maximum collector voltage that may be safely applied to a transistor is a function of circuit conditions and collector current. Second breakdown can be triggered in many transistors at a current value substantially below that value which gives rise to the calculated maximum power dissipation rating of the device at the maximum rated V_{CE}. To avoid second breakdown, it may be necessary to restrict V_{CE} to a lower-than-specified value at higher currents.

Determination of the characteristics that avoid the second breakdown point under any condition for a particular series of transistors can be accomplished only through extensive testing of a large number of devices. It is the responsibility of the semiconductor manufacturer to provide safe-area data that eliminates the inadvertent design errors that can lead to device failures. In the absence of such data, analysis of a circuit that appears to damage transistors for no apparent reason may reveal operation too close to the second breakdown region.

OPTIMIZING EFFICIENCY — While reliance on the maximum power dissipation curve can cause power transistor failures under certain conditions, it can lead to inefficient circuit operation under other circumstances. In pulse circuits it is permissible to exceed the maximum power curve, often by a considerable margin, provided that the excursions into the excess power region have relatively short duration.

Although it could be assumed intuitively that the maximum power dissipation curve could be exceeded for pulse applications, since this curve represents a steady-state condition, such intuition would lead to the conclusion that both pulse width and duty cycle would influence the maximum excursion. This, according to extensive tests, is not necessarily true. While tests did confirm the dependence of maximum excursion on pulse width, no correlation was found as to duty cycle for pulse widths less than 5 milliseconds. In fact, the destructive testing of large quantities of power transistors revealed that for a given pulse width (100 μs) there was no apparent change in the failure zone for duty-cycle variations ranging from 50-1 to 10-1. For pulse widths larger than 5 milliseconds, duty cycle will affect junction temperature through thermal time constant effects. This leads to the conclusion that the safe operating areas for pulse applications cannot be calculated from a maximum power dissipation curve, but must be obtained through actual destructive tests on a large enough sampling of devices to yield usable results. The results of a representative test of this nature are shown in Fig. 5, coupled with the worst-case failure loci for pulse widths from 25 μs to 5 ms for 2N2158 transistors.

Tests such as these have been made on Motorola's entire line of germanium power transistors and the results are being incorporated in data sheets (with an added safety factor) to characterize safe-area operation for both steady-state and pulse circuit applications.

CONCLUSION — Of the power transistor failures that have been brought to the attention of the applications engineering department, the majority by far were caused by over-voltage applications because safe operating areas were either ignored or not clearly defined. The second most frequently encountered cause was improperly designed bias circuits, resulting in thermal runaway. Thus, the final achievement of high-reliability circuits involving well-built germanium power transistors lies in improved circuit design based on more completely specified device characteristics provided by transistor manufacturers. The publication of safe-area curves for both steady-state and pulse conditions on data sheets is a major step in this direction.

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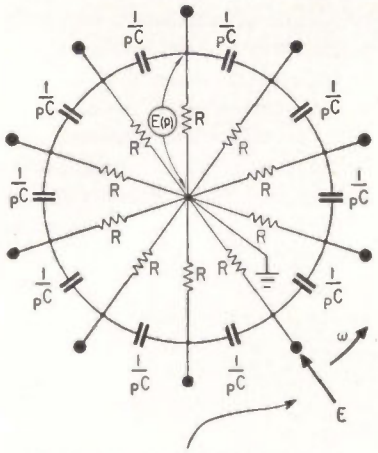
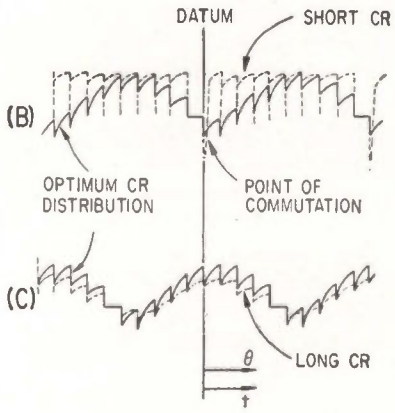
(1) Gnaedinger, Flaschen, Hall and Richey, Selection of Germanium Transistor Parameters by Control of Moisture, Journ Electrochemical Soc, 109, 7, July 1962.

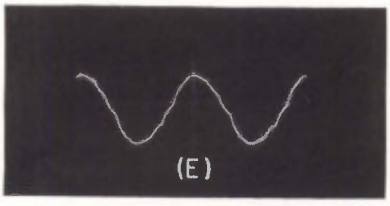
(2) Motorola Power Transistor Handbook.



ROTATING CONTACT CONNECTS SUCCESSIVE R-C STAGES TO THE SUPPLY IN MECHANICAL ANALOG OF RING COUNTER

(A)





MECHANICAL *switching systems represent ring counter laid out in circular form (A), waveforms across diametrically opposite contacts (B) and (C) show effect of different time constant on harmonic content of waveform. Oscillogram (D) shows waveform appearing at one contact of ten-stage ring; approximately sinusoidal waveform is derived from two diametrically opposite contacts on ring (E)—Fig. 1*

Basic principles of the static alternator differ fundamentally from the more familiar static inverter. Advantages of the new technique include sinusoidal output without filtering and a simple technique for generating polyphase power

By ROBERT H. MURPHY
Chief Engineer, Transitron Electronic Limited, Uxbridge, England

Developing True

THE CONVENTIONAL METHOD of converting d-c into sinusoidal 3-phase a-c involves three separate parallel inverter circuits accurately triggered to give the correct 120 degree phase shift. Apart from the problem of introducing correct relative time delays to the trigger pulses, the parallel inverters have to be followed by complex high-level filters to minimize the harmonic content of the output waveforms. In addition to insertion losses, the filters modify the load presented to the inverters and can introduce severe operating problems, particularly when wide variations of load are encountered.

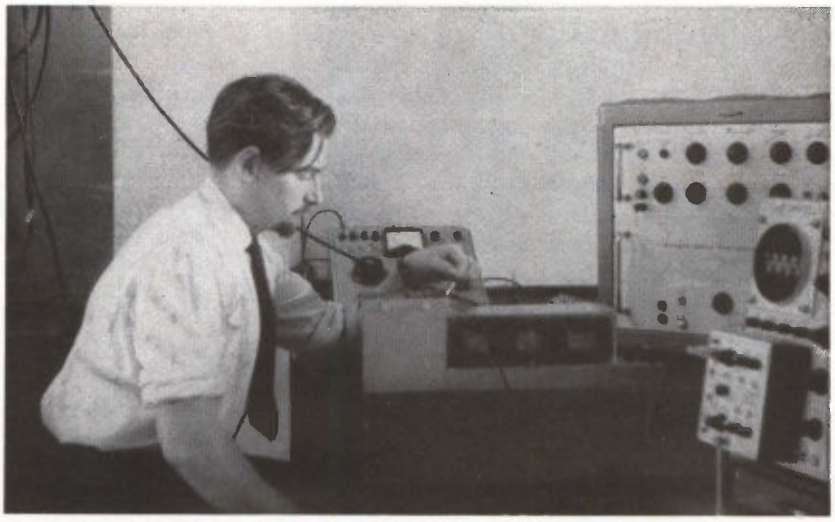
A new technique of using scrs in ring-counting circuits for polyphase sinewave synthesis overcomes many of these problems. The system is based on an electronic analog of the conventional rotary alternator in which the current-inducing magnetic field is sequentially switched rather than mechanically rotated. Any rotary sequential switch, electronic or mechanical, can produce, across diametrically opposite contacts, polyphase repetitive waveforms that closely approximate the sinusoidal.

THEORY OF OPERATION—The circuit associated with the switch requires the special network geometry illustrated in Fig. 1A. This can be viewed as a ring of RC differentiating networks on which the point of step function excitation is moved progressively around at a constant switching speed. The effect of varying the component values R or C in Fig. 1A is illustrated by Figs. 1B and 1C, which show that there is an optimum time constant (CR) which causes the waveform on one contact to just reach the supply voltage E by the time its diametrically opposite number has come to the end of its excitation period or point of commutation.

Conversely, for any given value of CR there is an optimum triggering frequency f_T which causes the kind of waveforms described to appear on any pair of diametrically opposite contacts in the ring. These waveforms are periodic (period T_0) and are most conveniently represented in polar form, Fig. 2, with datum chosen at the point-of-commutation of one of the pair of contacts under consideration and the time axis expressed in terms of the polar coordinate angle θ. Hence, these polar diagrams correspond to one revolution of the count at the optimum frequency (f_0) given by

$$f_0 = 1/T_0 = f_T/N \qquad (1)$$

where N = number of contacts in ring, or $T_0 = Nt_T$ (2)



AUTHOR *observes static alternator output on oscilloscope while making circuit adjustments*

Solid-State Static Alternators

where t_T is the optimum trigger period.

It may be shown that the boundaries of these optimum distributions closely approximate $E\cos^2\theta/2$ and $E(\cos^2\theta/2 + K)$ for Fig. 1B, and $E\sin^2\theta/2$ and $E(\sin^2\theta/2 + K)$ for Fig. 1C. The constant K represents the abrupt voltage transition (expressed as a fraction of E) when the count moves from one stage to the next.

All steps are equal because of the continuous coupling between stages, and in fact K depends only on the number of stages in the ring.

From the following identities

$$E\cos^2\theta/2 - E\sin^2\theta/2 = E\cos\theta \quad (3)$$

$$E(\cos^2\theta/2+K) - E(\sin^2\theta/2+K) = E\cos\theta \quad (4)$$

the algebraic sum of the voltages across diametrically opposite contacts conveniently cancels the abrupt transitions, yielding a quasi-sinusoidal waveform of half-cycle peak magnitude E and frequency f_0.

However the polar diagrams of Fig. 2 not only represent the time variation of voltage during one cycle on a pair of opposite contacts, but also sets of voltage-variations-with-time during one triggering period, on sets of diametrically opposite contacts. Hence the argument also describes the production of $N/2$ sinusoidal waveforms having relative phase relationships determined solely by the geometrical relationship of the pairs of opposed stages, that is, the sinusoids are distributed at phase angles of $360 \div N/2$ to each other and represent a set of $N/2$ phases. Here the analogy with the mechanical alternator is apparent since the phase relationship in the switched mechanism depends on a network geometry analagous to the spacial geometry in the rotating machine.

Although the abrupt transitions in the individual contact waveforms are cancelled by taking the output from diametrically opposed stages, the relative magnitude, K, of these steps is extremely important, both in the analysis to determine the optimum circuit parameters, and because of its relationship to distortion in the output sine-waves. Figure 3 shows the effect of number of stages on output waveforms.

SCR RING COUNTERS—The network geometry is ideally suited to scr's as the switching elements since unidirectional current is involved and the capacitors can be used for commutation. In fact the circuit was developed from an scr ring counter switching numerical indicator unit: it was realized that circuits of this kind could switch currents of 20 amp. or more

THIS ALTERNATOR DOESN'T MOVE

Conventional single-phase static inverters are rugged and efficient even if they do get into trouble when delivering sinusoidal output and operating over a wide load range. Three phase static inverters can become a major headache—their design often becomes complex enough to make it debatable whether they offer any improvement over rotary converters or motor generators. Need variable frequency plus reasonable power and the solid state project grinds to a halt. However the static alternator technique offers a solution—its near-sinusoidal output needs no elaborate filtering, and polyphase output comes without elaborately phased triggers for controlling individual phases

at frequencies in the kilocycle region and thus cover the power and frequency range desirable for static inverters.

If the transformer primaries in Fig. 4A are replaced by purely resistive loads the result is a 6-stage scr ring counter. The principle of operation, applicable to any number of stages, is as follows. Assume that one stage is conducting. In the absence of a trigger pulse the reverse voltage across the succeeding diode will be equal to the forward conducting voltage of the scr (about 1-2v). Further, since all other stages are off, the remaining diodes will be reverse biased to a much greater extent (of order E_v volts). A positive trigger pulse, as shown in Fig. 4A, will thus bias only this one diode into conduction and will trigger the succeeding scr through the coupling capacitor. The commutating capacitor will then switch the originally conducting stage off.

An interesting and useful feature of the circuit is that assuming identical scr's in all stages, the upper frequency limit increases with the number of stages since each commutating capacitor may then take longer to recharge after performing its commutating function before its operation is required again. This is responsible for the vastly increased frequency range of a multistage counter over that of a simple scr bistable circuit. For example, a 50-Kc count-rate for a decade counter as opposed to 10-Kc for the bistable assuming identical low current switches. There is, of course, no lower frequency limit because the almost perfect switching quality of the scr allows it to remain in either of its two stable states indefinitely.

ALTERNATOR PROTOTYPE — The design of the prototype static alternator was based on an scr ring counter with output produced across any two diametrically opposite resistive loads. During development it was convenient to consider only balanced resistive loads reflected through an ideal polyphase output transformer or group of ideal single phase transformers with center tapped primaries, Fig. 4B.

An analysis for the optimum value of C and R in the resistive load ring counter yields

$$1/CR = 4f_0 \qquad (5)$$

Replacing the resistive loads with loads reflected by the output transformer makes it necessary to evaluate the equivalent value of CR for given secondary load resistors (R_L) and commutating capacitors (C_c). The values of both components are modified by transformer action. In addition, graphical analysis to obtain the half-cycle peak value of the synthesized primary waveform showed that this was not of the expected magnitude ($2E$) that would be obtained by the doubling action of a center tapped primary. In fact, the relationships for all three parameters were found to be

$$C = 4C_c \qquad (6)$$

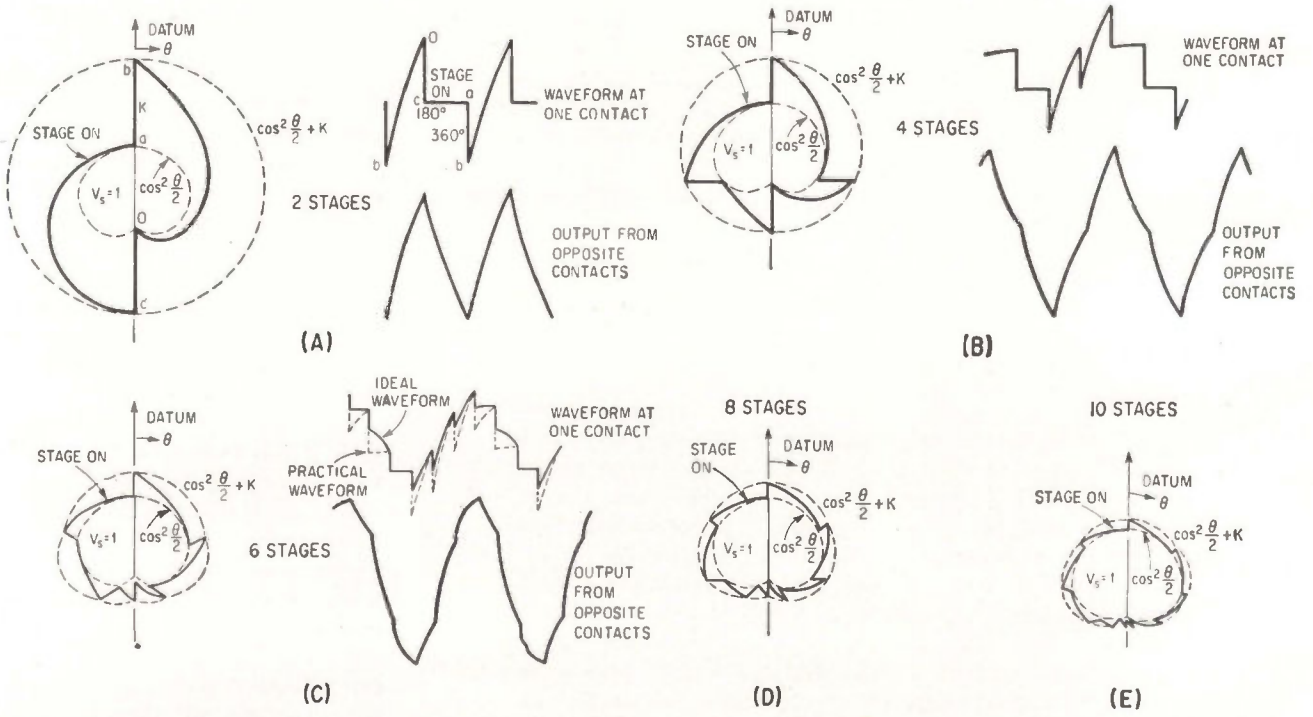
$$R = R_L/n^2 \qquad (7)$$

(transformer ratio 1 + 1 : n)
The rms primary voltage becomes

$$1.5E/1.41 \approx E \qquad (8)$$

Equation 8 conveniently allows the use of standard $E : E_{ph}$ transformers (E_{ph} being the desired output voltage per phase.) In the prototype the approximation expressed in Eq. 8 was almost completely eliminated by losses incurred by the inherent foward voltage drop of the scrs when conducting.

The prototype illustrated in Fig. 4, together with its oscillogram, was designed for inversion from 30 v d-c to 240 v, 60 w, per phase at 400 cycles a-c, corresponding to a triggering frequency of 2.4 Kc. It employed three standard 240-v, 50-cycle, 75-va transformers with center tapped 30 v primary windings. A production model using a specifically designed 400-cycle, 3-



POLAR DIAGRAMS *of potentials shows how the harmonic content diminishes as the number of stages in the ring increases from two (A) to ten (E)—Fig. 2*

phase transformer would result in a very significant space and weight reduction.

RESULTS — In general performance at constant frequency the prototype was found to be extremely rugged and reliable and in fact more versatile than the simple single phase scr inverter. When using this ring-counter inverter, an increase in the value of the balanced load power (decrease in R_L) merely increases the harmonic content of the output waveform because of the increased value of f_0 relative to the operating frequency (Eq. 5). A characteristic of the circuit is that it appears to be less critical of abrupt frequency switching (a factor of 10 can be readily introduced within the operating frequency range) and abrupt open-circuiting of one or two phases. Wide frequency range is not possible in the conventional inverter, but follows naturally in this circuit from the ring-counter's ability to operate over a wide counting-speed range.

Although not yet as rugged as a rotary inverter in its ability to accept wide variations and unbalance of loads, the static alternator can be operated into open circuit loads in all phases by employing overswing diodes whereby reactive energy can be returned to the supply.

A significant advantage over most contemporary 3-phase scr inverter designs is the need for only one set of trigger pulses by virtue of the simple ring-counter gating system employed. Also the transient operating conditions applied to the scrs do not deviate excessively from the average conditions as they do for inverters which use resonant circuits to generate the sinewaves. This is especially true for reverse voltage conditions to which scrs are particularly susceptible. Here the ratio of peak reverse voltage to supply voltage is 0.5 as compared with 2-3 for the simple parallel inverter with resonant turn-off. Thus the utilization factor is considerably improved.

USES—One of the most important applications of semiconductor devices in the power supply field is the design of electronic inverters to replace the rotary systems which have long been used to transform low voltage d-c into single and three phase sinusoidal a-c supplies. Typical applications lie in mobile equipment such as aircraft, motor vehicles, boats, and so on.

With regard to potentialities in motor control, here the static alternator principle would appear particularly compatible with center-tapped windings on a three phase induction motor, which would then replace the output transformer of Fig. 4 circuit. However, certain problems, such as the need to increase the output voltage with frequency and motor speed, and an ability to cope with starting and stalled conditions have yet to be solved.

NO. OF STAGES	IDEAL K	PRACTICAL K
2	1	1
4	0.5	0.5
6	0.25	0.5
8	0.15	0.35
10	0.1	0.31
12	0.06	0.25
24	0.02	0.13

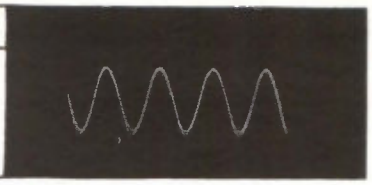
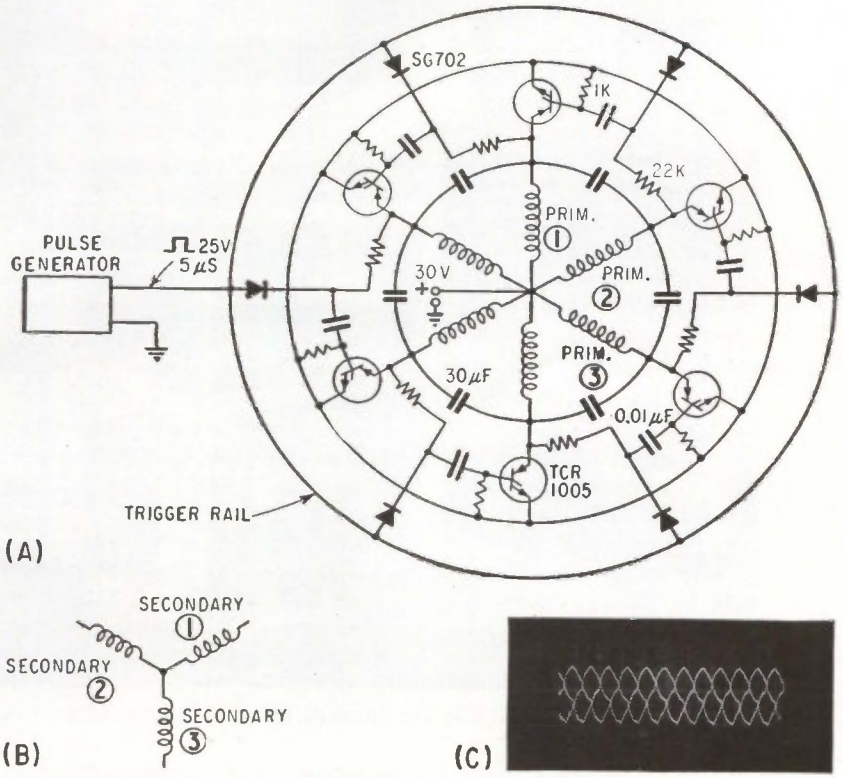


TABLE *shows voltage transition, K, falling to relatively insignificant values as the number of stages rises; oscillogram compares the output from a 24-stage ring with the sinusoidal output from a commercial audio generator—Fig. 3*



PROTOTYPE *solid state static alternator uses scr's as current switching elements (A); connecting transformer secondaries in star yields three-phase output (B), actual output waveform is reasonably sinusoidal considering that no filtering is used (C)—Fig. 4*

The author acknowledges the guidance of K. P. P. Nambiar (until recently chief engineer of Transitron Electronic Ltd.) during the investigation of the problem.

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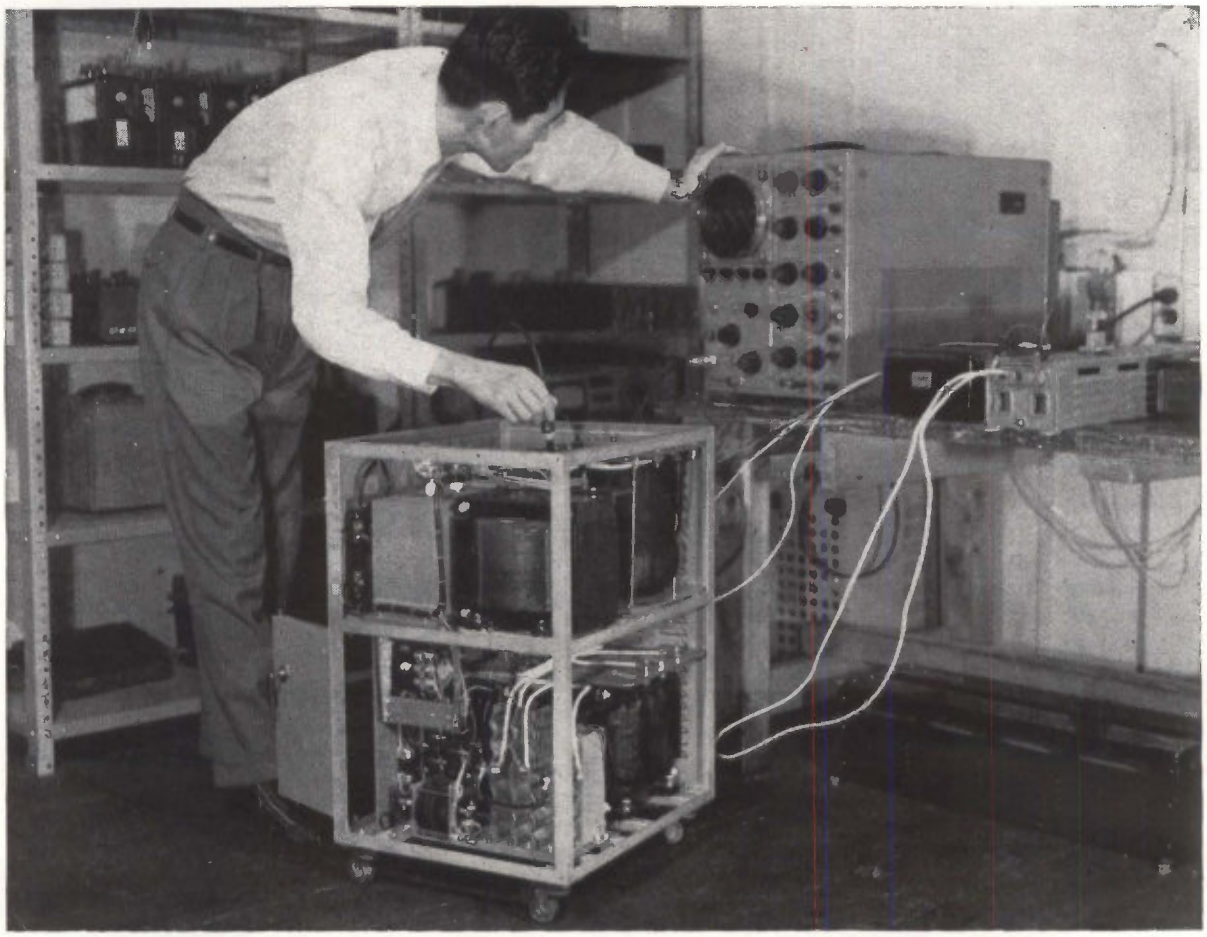


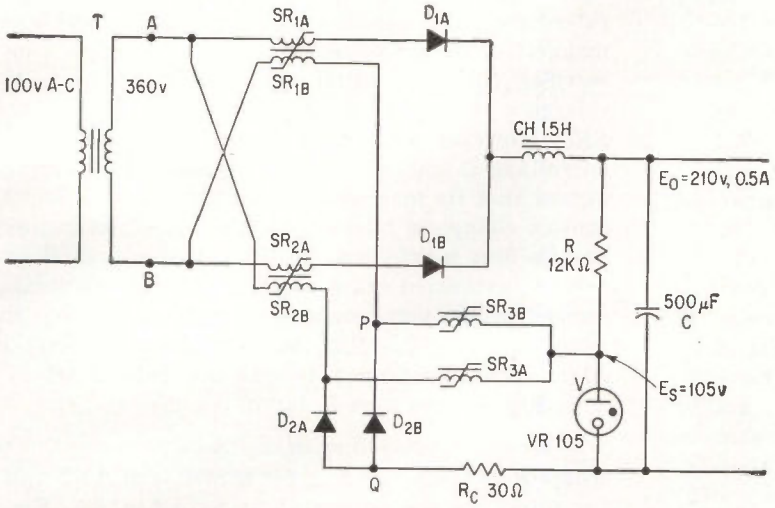
CONSTANT VOLTAGE *rectifier has a single-phase rating of 1.2 kva. Output is 58 volts d-c with regulation of 0.2 percent from 5 to 20 amperes load*

New Way to Use Saturable Reactors:

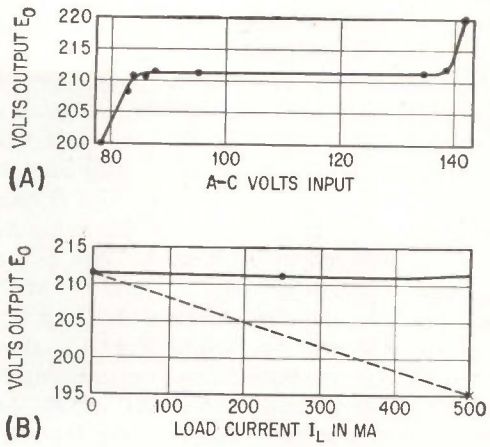
VOLTAGE STABILIZED power sources using series regulator tubes, saturable reactors or silicon-controlled rectifiers are usually inefficient and not suitable for high power. A new constant voltage rectifier, taking advantage of properties of a saturable reactor with rectangular-loop core material, is a reset-type transductor regulator. The method of resetting or demagnetizing the transductors requires no transistors, vacuum tubes or magnetic amplifiers. Instead, demagnetization of the transductor is accomplished by using part of the line voltage to increase the degree of the demagnetization automatically with changes of line voltage.

Output voltage is maintained constant against variations in load current, frequency and wave shape of the input line voltage, or the effectiveness of the smoothing circuit. For example, output voltage is constant even when load current becomes too small for normal operation of a choke-input smoothing circuit.

Impedance of a transductor varies according to the magnetic state of the core, e.g. in a case of a transductor have a sendelta core (50 percent Ni permalloy), the ratio of magnetization current to allowable load current for its winding is a few thousandths. Thus, a transductor of this type can be used for switching. Power consumption for controlling or



BASIC CIRCUIT *of a single-phase constant voltage rectifier using saturable reactors with a rectangular loop characteristic—Fig. 1*



OUTPUT VOLTAGE *variation with input line voltage changes (A) and with load current (B)—Fig. 2*

Transductors with a rectangular hysteresis loop characteristic are key components in new power supply design that resists step changes in line voltage

By TOSHIO KURIMURA and KAZUOMI YAMAMURA
Kokusai Denshin Denwa Co. Ltd.,
Research Laboratory, Tokyo, Japan

SMOOTHING THE RUFFLED CURRENT

When load current swings from zero to 20 amps, keeping the voltage constant within 1 percent is a neat trick. And if line voltage varies, the problem becomes worse. Now, the Japanese have come up with a scheme to solve this problem in which they take advantage of the unique magnetic characteristics of the transductor. First major application of the device will be to power a large computer

Stabilizing High-Power Rectifiers

magnetizing a transductor is small compared with the regulator. Efficiency of the regulator can be 80 percent or more. The circuit is simple, the device is easy to construct, and ability to handle overload and temperature variations is good.

Rectifiers of several watts to several thousands watts or more may be built around this system. There is no limit in designing to a wide range of line voltage variation and load current.

CIRCUIT—In the single-phase full-wave rectifier, Fig. 1, transductors SR_1 and SR_2 each have a pair of windings A and B in series with rectifiers to form a bridge full-wave rectifier. SR_1 and SR_2 are called the main transductors. Auxiliary transductors SR_{3A} and SR_{3B}, connected in series with a reference voltage E_s, or a constant voltage device, are in parallel with rectifiers D_{1B} and D_{2A}. Output voltage E_o is kept nearly twice that of E_s. Current capacity of the reference voltage source is roughly several thousandths of the maximum output current of the regulator, and the demagnetization current of SR_1 and SR_2 tends to charge the source.

In Fig. 2A, output voltage E_o is substantially constant while the line voltage changes nearly 50 percent. The lower break of the curve is caused by too low

line voltage, and the upper break is due to loss of control of the transductors. In Fig. 2B, the dotted line shows the characteristic of load current I_L vs. E_o without using compensating resistor R_c. The improved characteristics by using R_c, is indicated by the solid line.

A three-phase, high-power full wave rectifier, Fig. 3. has six main transductors with windings, SR_{1A}, SR_{1B} and SR_{1C} and SR_{2A}, SR_{2B} and SR_{2C}, in series with rectifiers D_{1A}, D_{1B} and D_{1C} and D_{2A}, D_{2B} and D_{2C} respectively. Auxiliary transductors SR_{3A}, SR_{3B} and SR_{3C} are connected as in Fig. 1. The difference is that auxiliary rectifiers D_{3A}, D_{3B} and D_{3C} are used to reset SR_{1A}, SR_{1B} and SR_{1C} instead of using transductors.

An improved version of Fig. 3 is shown in Fig. 4. Auxiliary windings with the same number of turns as the main transductors SR_{2A}, SR_{2B} and SR_{2C}, and auxiliary rectifiers D_{4A}, D_{4B} and D_{4C} are added. Current in the auxiliary circuits is only several thousandths of the main circuit current.

Characteristics of these two units are shown in Fig. 5. Dotted lines in Fig. 5A and Fig. 5C indicate E_o vs line voltage and E_o vs I_L respectively for the basic circuitry. Solid lines are the improved characteristics of the modified circuit. Figure 5B shows transient response of E_o vs a step change in line voltage for the modified circuit. The ratio of the variation rate of E_o to that of line voltage is lowered to nearly a tenth.

OPERATION—Voltage and current waveforms, Fig. 6A, B and C, are those of the single-phase full-wave rectifier of Fig. 1. It is assumed that the transformer, the transductors and the choke coil have no ohmic resistance and the individual rectifiers have ideal characteristics, besides the reservoir condenser is very large and the ripple in output voltage is negligible, moreover the resistor R_c is zero.

In Fig. 6A, the dotted lines e_{ab} and e_{ba} indicate output voltage of transformer T of Fig. 1, measured from point B to A and vice versa. Line e_{ch} is the voltage waveform of the choke coil using the potential at point Q as reference. In an ordinary rectifier, the voltage e_{ch} does not take a negative value, but here, e_{ch} becomes negative for the period t_2 to t_3, t_5 to t_6, etc., because the rectified current or the choke-coil current i_{ch}, Fig. 6C, cannot shift immediately from D_{1A} circuit to D_{2B} circuit at t_2 nor from D_{2B} to D_{1A} at t_5 because of choking action of main transductors. The main transductors reach saturation at t_3 or t_6 and lose the choking action. Then the current i_{ch} shifts abruptly.

The area s_1 is the magnitude of the choking action of SR_{1A} and SR_{1B} for t_2 to t_3, (of course the same action is performed by SR_{2A} and SR_{2B} for t_5 to t_6).

Since a choke-input type smoothing circuit averages the input voltage e_{ch}, the output voltage E_o is given as the mean value of e_{ch}. The following equation is valid from the period t_2 to t_5:

$$E_0 = (K - 2S_1)/(T/2) \qquad (1)$$

where K is an area of e_{ba} for t_2 to t_6, a part of which, for t_2 to t_3, is the same area of S_1, T is a period of e_{ch}.

Figure 6B shows how main transductors SR_{1A} and SR_{1B} are demagnetized and shows operation of the auxiliary transductor SR_{3B}. The heavy line indicates the voltage waveform at point P taking point Q as a reference. SR_{3B} is in a saturated state at t_1, and is demagnetized by the volt-secs area G for t_1 to t_6. Since rectifier D_{1B} is in cutoff condition for t_6 to t_8, the voltage e_{ab} is applied to the series circuit of SR_{1B} and SR_{3B}. However, while SR_{3B} is in an unsaturated state, no voltage is induced on SR_{1B} because SR_{3B} is so designed that its magnetizing current is insufficient to cause a change in magnetic flux of SR_{1B}. Accordingly SR_{3B} is first magnetized by the volt-secs area H and reaches saturated state at t_7. Then SR_{1B} is demagnetized by the volt-secs area S_2 up to t_8. Having the same core as SR_{1B}, SR_{1A} is simultaneously reset in effect. The time from t_1 to t_7 is one-cycle of SR_{3B}.

In Fig. 6B the area S_2 is:

$$S_2 = K - (H + J + S_1) \qquad (2)$$

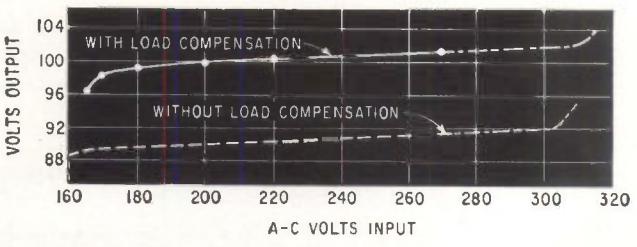
where K is the area of e_{ab} for t_5 to t_9, a part of which for t_5 to t_6, is the same area as S_1 in Fig. 6A. Since the area G and H, and S_1 and S_2 are equal, Eq. 2 becomes:

$$K - 2S_1 = H + J = E_s T \qquad (3)$$

From Eq. 1 and 3, $E_o = 2E_s$.
Therefore, constant output voltage is maintained without amplifiers regardless of line variation:

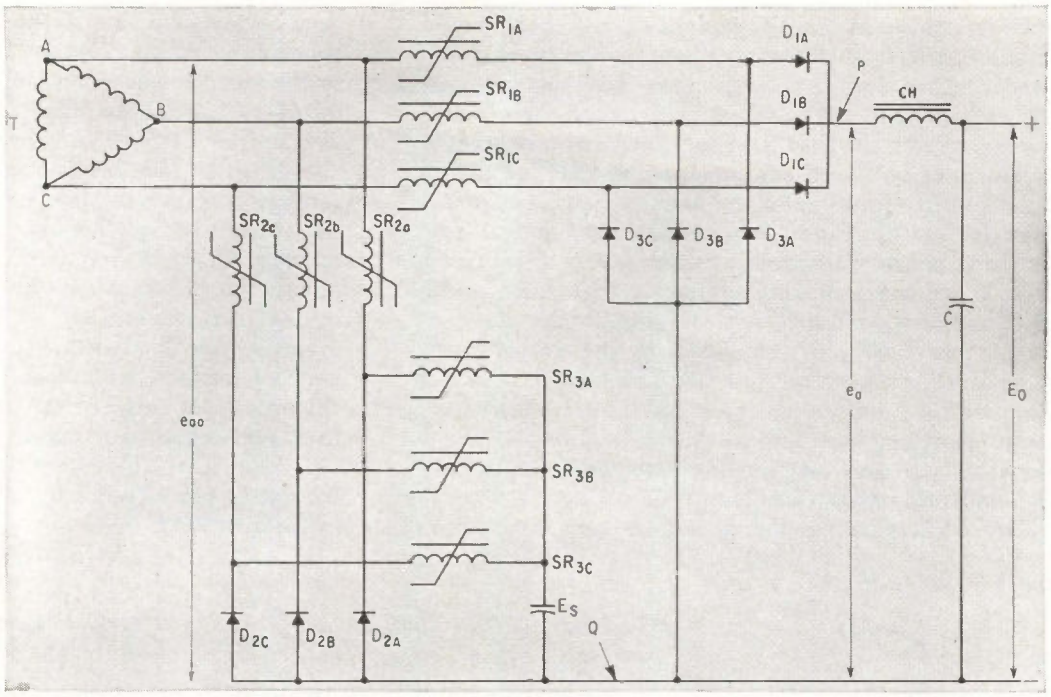
RESISTANCE—Resistance components cause E_0 to decrease in accordance with the increment of I_L. This is shown by the dotted line in Fig. 2B. Output resistance is about 30 ohms. However the output resistance can be reduced to almost zero by using R_c which has a value of 30 ohms, and the resultant characteristic is shown by solid line in Fig. 2B. The reason is that the voltage drop across R_c, i.e. $\Delta I_L \cdot R_c$, is added to reference voltage E_s, then a voltage $2E_s + 2\Delta I_L \cdot R_c$ or $E_o + 2 \cdot \Delta I_L \cdot R_c$ is induced inside the device, and increment $2 \cdot \Delta I_L \cdot R_c$ is canceled by voltage drops across R_c and the output resistance.

The output resistance is a sum of the choke-coil resistance and part of the resistance of the main transductors. However, the resistance component of the transformer does not have any influence because E_o is not affected by a change in input a-c voltage. Moreover the effect of the main transductor resistance to the output resistance can be diminished to nearly zero by introducing an auxiliary winding for controlling the transductor. Thus, modified transduc-

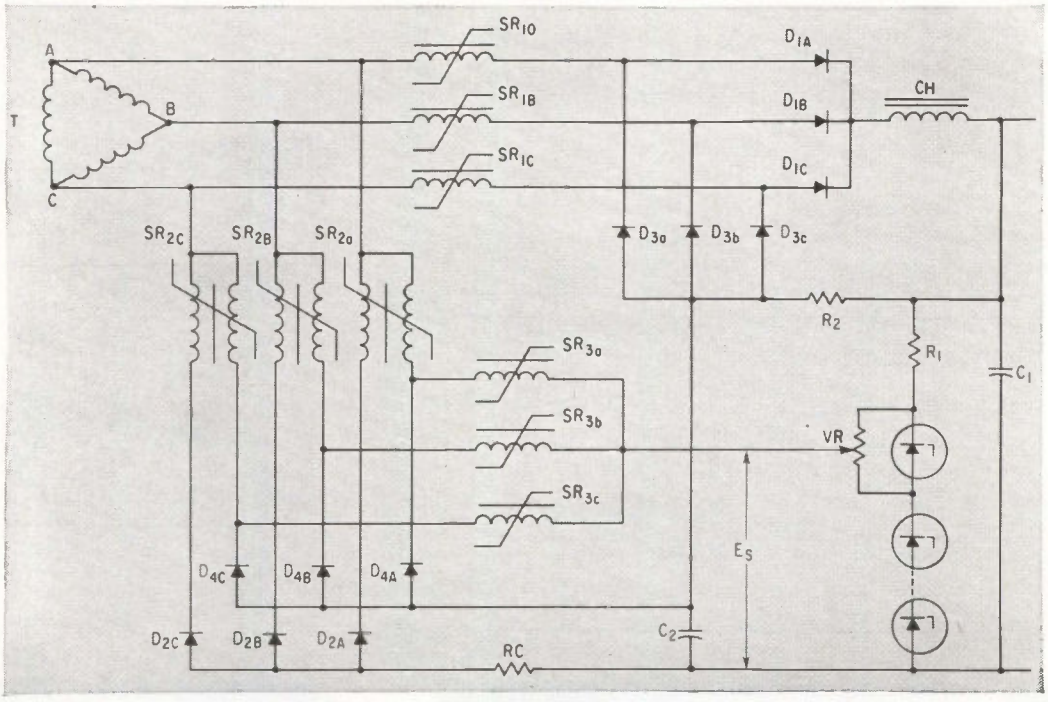


(A)

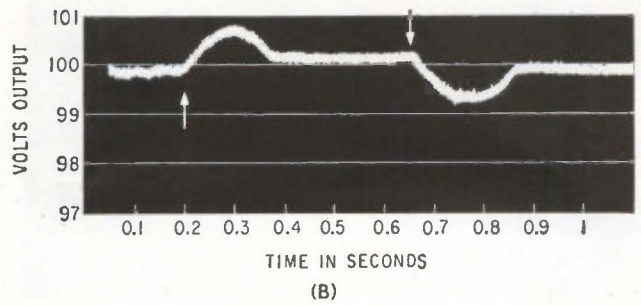
OUTPUT CHARACTERISTICS *with and without load current on output with and without compensation (C)*

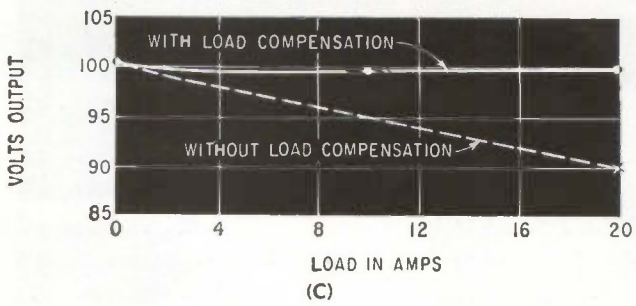


THREE-PHASE *full wave rectifier basic circuit—Fig. 3*



LOAD CURRENT *compensation added to the basic three-phase, full wave rectifier circuit of Fig. 3 for improved regulation —Fig. 4*





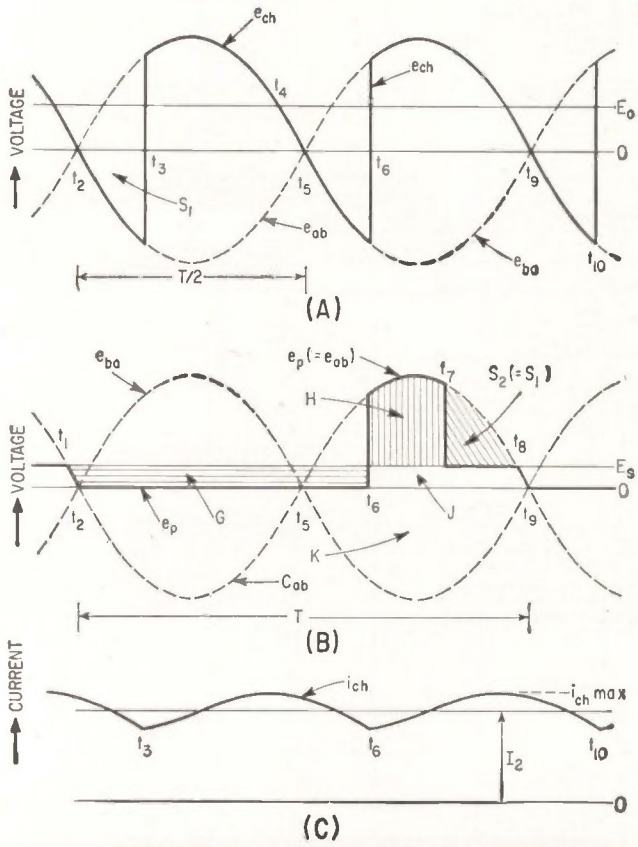
compensation (A), transient response to step changes of 10 volts from a line voltage of 200 volts (B) and effect of load —Fig. 5

tors are shown in Fig. 4, and the power consumption in R_c (0.1×20^2 watts) is reduced to only 2 percent of the output power.

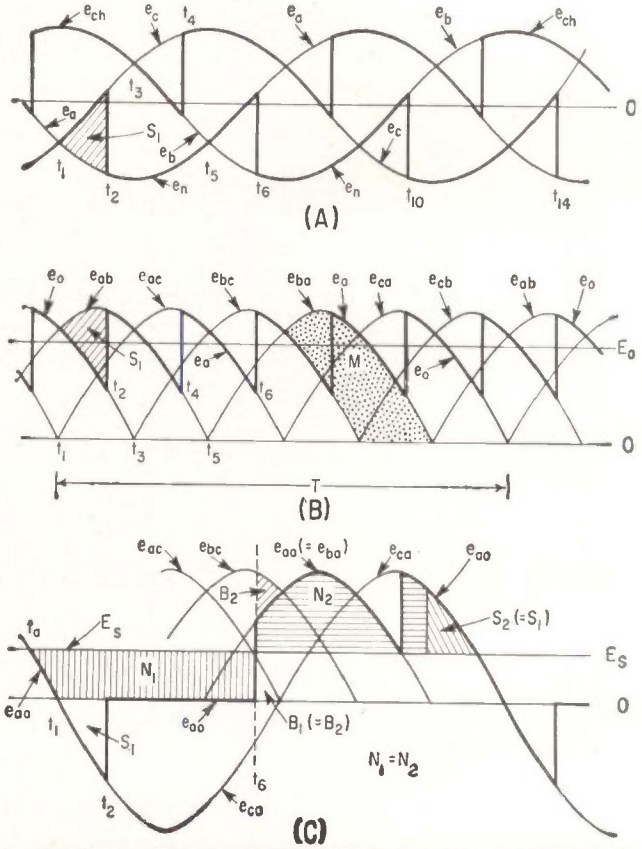
Figures 7A, B and C shows the voltage waveform for the circuit of Fig. 3. Light lines indicate the waveform of e_a, e_b and e_c at the points A, B and C in Fig. 3. Heavy lines show e_{ch} and e_n, the voltage at points P and Q respectively, taking the neutral of the three phase voltage as a reference or zero line. Area S_1 indicates choking action of SR_{2A}, SR_{2B} and SR_{2C}, and this volt-secs area is simultaneously applied to one of SR_{1A}, SR_{1B} and SR_{1C} by the way of D_{3A}, D_{3B} and D_{3C} respectively to demagnetize the SR_{1A}, SR_{1B} and SR_{1C}. This operation is different from single phase operation where the demagnetization of SR_{1A} and SR_{2B} is performed by using a common core with SR_{1B} and SR_{2A} respectively.

Figure 7B is similar to Fig. 7A taking e_n as reference. The heavy line shows the voltage difference e_o between e_{ch} and e_n. Output voltage E_o must be equal to the mean value of e_o, then E_o can be expressed as $6(M - s_1)/T$, where M is the area shown in Fig. 7B, T is a cycle of the line voltage.

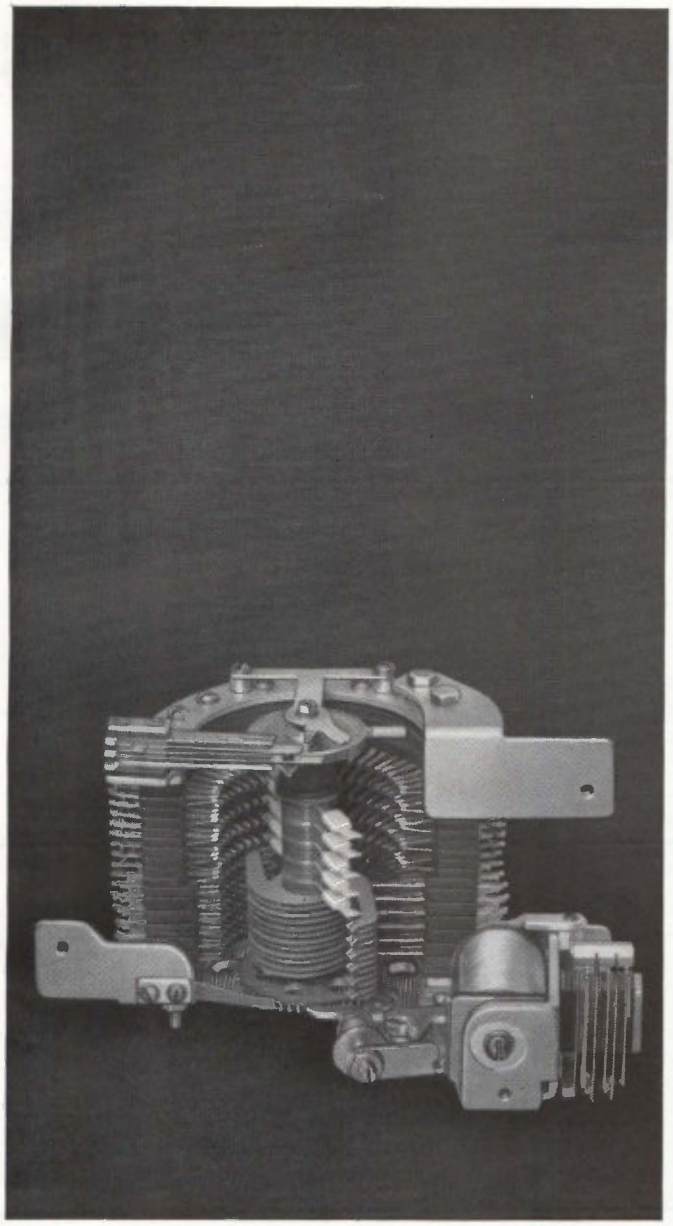
In Fig. 7C, the heavy line shows the voltage difference e_{ao} and e_n to show how auxiliary transductors SR_{3A}, SR_{3B} and SR_{3C} operate and how the main transductors SR_{2A}, SR_{2B} and SR_{2C} are reset. From this figure, the volt-secs area S_2 by which the main transductor is reset, is $(3M - 2S_1) - T \cdot E_s$. Note that areas B_1 and B_2 are equal because the difference between e_{bc} and e_{ba} is nothing but e_{ac} itself, and that the area N_2 is equal to the area N_1. Since S_2 is equal to S_1 for single phase operation, then: $3(M - S_1) = TE_s$, and $E_o = 2E_s$. Output voltage E_o depends upon E_s and is not affected by a-c line voltage as single-phase operation.

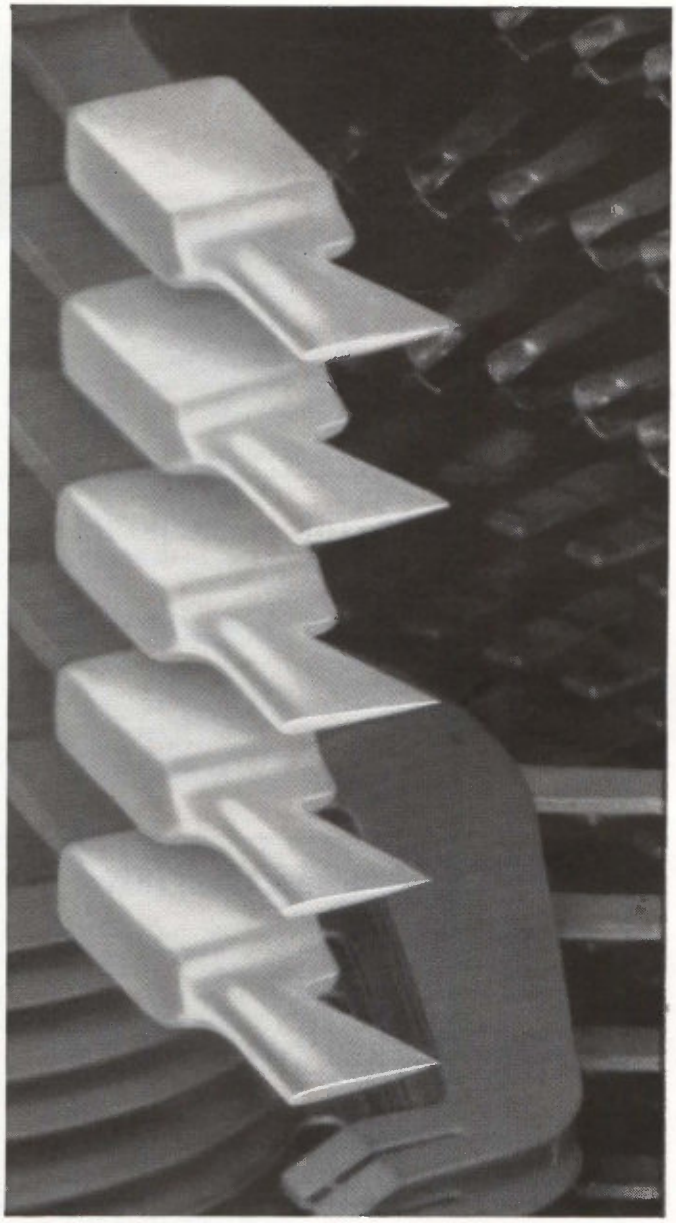


SINGLE-PHASE *rectifier waveforms for circuit analysis (A), (B) and (C), and actual oscillogram (D)—Fig. 6*



THREE-PHASE *waveforms illustrate operation (A), (B), (C) along with actual oscillogram (D)—Fig. 7*





so, what's new?

This is AE's new Type 45NC Rotary Stepping Switch. Each bank is made up of two standard levels tensioned together so that each set of bank contacts forms a closed circuit. The wiper assembly, tipped with a molded Delrin insulator, opens the contacts one at a time as it rotates. Normally open and normally closed banks may be specified on the same switch. ■ Contacts are gold-plated phosphor bronze, providing contact resistances of only 10 to 20 milliohms measured at 6 volts, 100 milliamperes. ■ The 45NC is ideal for self-interrupted hunting or testing circuits. In either case, no auxiliary relays are needed to initiate operation. For full information, ask for our "Product News: 45NC." Write Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois.

normally closed contacts, that's what

AUTOMATIC ELECTRIC

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

The Proven Line of Servo Components

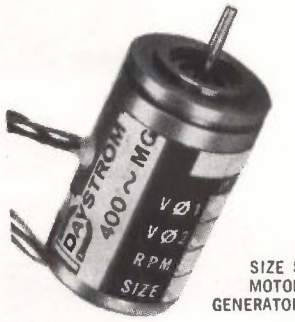
MOTORS — Daystrom Transicoil offers a wide line of servo motors, in sizes 5, 8, 9, 11, 15, and 18. These are available in many configurations, with gear trains supplied in standard ratios as part of the unit where desired. Special ratios are supplied on request. In addition to standard and short-housing type motors, Daystrom Transicoil produces high-torque units, acceleration-damped units, and velocity-damped units. ■ Some of the special features of these motors include stainless steel ball bearings, completely encapsulated motor windings, corrosion resistant alloy laminations, stainless steel housings, precision machined stainless shafts, 12" Teflon insulated leads, and precision pinions (Class II per AGMA 236.04 or better).

SIZE 5 MOTOR

SIZE 8 SHORT MOTOR

MOTOR GENERATORS & TACHOMETERS —Among the precision rotating components from Daystrom Transicoil is a full complement of motor damping generators and rate generators and integrating tachometer generators. These are available in standard configuration or in short-housing; as temperature-compensated units and as high-performance units. All units are offered with both standard and high torque ratings. ■ Transicoil standard motor tachometers feature low inertia with outputs up to 3.5 v/ 1000 rpm Temperature-compensated motor tachometers will maintain an output voltage per 1000 rpm within ±0.5% over an extended range from −55°C to 125°C. Phase shift is held to within ±0.5°. ■ Special features of the motor tachometers and generators are similar to those listed under motors above.


SIZE 5 MOTOR GENERATOR



SIZE 8 MOTOR GENERATOR

SYNCHROS, RESOLVERS, INDUCTION POTENTIOMETERS — Daystrom Transicoil produces control transformers, differentials, resolvers, transmitters, and inductive potentiometers in a variety of standard sizes from Size 5 through Size 11. These units are designed for high accuracy and reliability; most types offer maximum error from electrical zero of ±7 minutes. Corrosion-resistant materials are utilized throughout, and all units are designed to meet the rigid requirements commonly encountered in airborne and aerospace applications. ■ Transicoil pancake synchros have been designed into many aerospace systems where precision performance and high density packaging are critical. Our engineering group has extensive experience in pancake applications, and can design units to meet the most stringent specifications.


(GIMBAL MOUNTED) SIZE 25 PANCAKE SYNCHRO

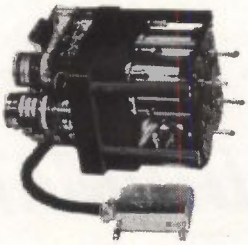

(BEARING MOUNTED) SIZE 25 ENCASED PANCAKE SYNCHRO

AMPLIFIERS & SPECIAL UNITS — Transistorized servo amplifiers from Daystrom Transicoil are designed to provide high linearity signal amplification for driving motors up to Size 18. They are virtually insensitive to temperature variations. Both silicon and germanium types are offered. ■ Other servo units produced by Transicoil include integrated servo follow-ups, in-line servo assemblies, mechanical filters, etc. Information on these is available on request.

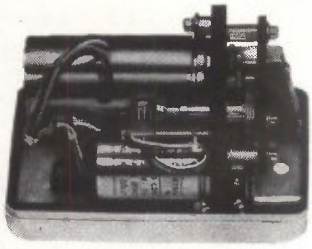

MINIATURIZED TRANSISTOR AMPLIFIER


GEAR TRAINS SIZE 5, 8, 11, 15, 18

COMPLETE PACKAGES — Complete servo assemblies and sub-assemblies have been designed by Daystrom Transicoil for numerous applications. Among these are azimuth indicators, height indicators, synch drives, gain changers, TACAN couplers and sub-assemblies, base-line indicators, and many other systems. As a contributor to various aircraft and missile programs, the company has proven its ability to design highly reliable servo packages to the most demanding requirements.


LORAN "C" INDICATOR

SYNCHRONOUS DRIVE ASSEMBLY



and Assemblies from Daystrom Transicoil

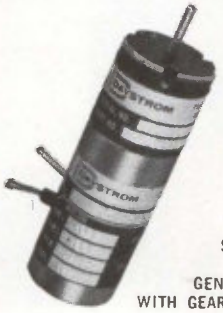

SIZE 9
MOTOR


SIZE 11
MOTOR


SIZE 15
MOTOR


SIZE 18
MOTOR


SIZE 9
MOTOR
GENERATOR


SIZE 11
MOTOR
GENERATOR
WITH GEAR TRAIN


SIZE 15
MOTOR
GENERATOR


SIZE 18
MOTOR
GENERATOR
WITH GEAR TRAIN


SIZE 25
20 SEC ACCURACY
ENCASED RESOLVER


SIZE 8
TEMPERATURE
STABLE
CONTROL
TRANSFORMER

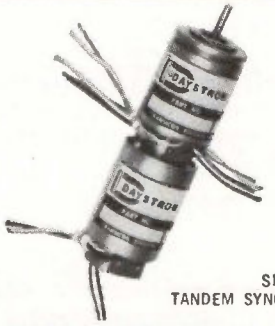

SIZE 8
CONTROL
TRANSFORMER
WITH SOLDER
TERMINALS


SIZE 11
CONTROL
TRANSFORMER

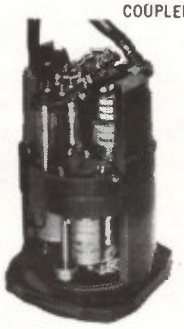

INTEGRATED
SERVO ASSEMBLY:
THREE SIZE 5
COMPONENTS
IN 1" HOUSING


MECHANICAL
FILTERS


SIZE 8
STEPPER MOTOR


SIZE 8
TANDEM SYNCHRO

ANTENNA
COUPLER



In its newly enlarged modern plant, Daystrom Transicoil possesses the facilities and capability to manufacture its servo systems and components from wire, bar stock, and other raw materials to finished precision units. Virtually all machining and other operations are performed on the premises, under the supervision of the production engineering group. Clean rooms, white rooms, and other facilities permit a high level of quality control, and result in an unusually low reject rate.

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CIRCLE 69 ON READER SERVICE CARD 69

Special Computer Integrates Rainfall

U.S. Weather Bureau experiments with new electronic integrator

By RONALD T. H. COLLIS
Stanford Research Institute, Menlo, Park, Calif.

COMPLETE SYSTEM *including a subsidiary display at upper left. Photo code wheel is in control unit; author Collis is standing—Fig. 1*

THE INTEGRATOR is a simple special-purpose relay computer, which automatically samples the output of a standard WSR-57 weather radar. The data are processed in digital form and displayed on a series of electromechanical counters arranged in a grid set on a map showing the area covered (Fig. 1). The counters show in inches the rainfall accrued at each point since time of reset.

The main display of the prototype has 141 counters uniformly distributed over a circle 200 nautical miles in diameter to a scale of 1:250,000. A subsidiary display (to a scale of 1:125,000) shows a special trial watershed for the Norman installation and employs 17 counters.

The display can be located near the main radar display, or may be remoted to any distance. The remote facility is possible because the system employs a 5-channel punched-tape link to the displays. This link can readily be extended by standard teletypewriter.

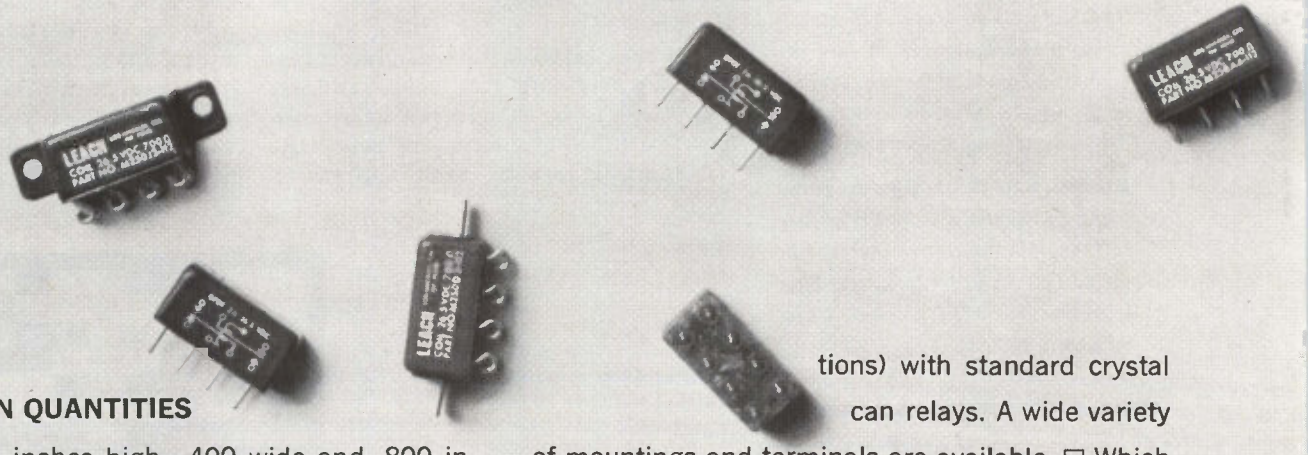
AUTOMATIC OPERATION—Five incremental readings are obtained per hour, leaving the radar free for other use in the meantime. Every 12 minutes, after a warning, the integrator takes over the radar and ensures that the radar is operating in the correct manner. (An operator at the console still has full control over the linear receiver and the displays, but unless he overrides the integrator control, the antenna scans in PPI fashion at a predetermined rate and elevation.)

DATA ACQUISITION — Range-corrected video from the logarithmic receiver, together with trigger and antenna position data, is processed as follows: The location of each of the address points of the grid at which rainfall is to be integrated is so arranged that only one point lies on any one radial from the radar site (for block diagram see Fig. 2). It has been found that quite regular rectilinear grids can be set up on this basis, and provided that the range of each address can be established, the address can then be identified solely by reference to the azimuth of the antenna. In this way it is possible to scan in sequence, identifying each address by counting consecutively from a reference heading. The azimuth of each address is identified by a photo electric trigger system operating on a code drum, driven in synchronism with the antenna. The drum, produced photographically on a standard film base (see Fig. 3), has transparent slots at positions corresponding to the addresses in azimuth. An identical trigger system is derived from a single slot corresponding to the reference heading. Coinciding with each address position, the drum also carries a 7-bit binary-code word which reports the range of each address. This information is read by a photodiode array and used to control the opening of the address gate in range, by reference

HOW MUCH RAIN FELL AND WHERE?

Although weather radar provides valuable information on the intensity of rain falling over a large area, it gives no direct data on the accrued rainfall. A special-purpose computer described here was developed for this purpose by the Stanford Research Institute under sponsorship of the U.S. Weather Bureau, and is now undergoing evaluation and trials at the Weather Bureau's Weather Radar Laboratory at Norman, Oklahoma

NEW LEACH HALF-SIZE CRYSTAL CAN RELAY



NOW IN PRODUCTION QUANTITIES

It's only .400 inches high, .400 wide and .800 in length. This smallest of the Leach relay family is also the lightest – only .25 ounces. □ Most important is its performance. It gives full-size results in low level to 2 amp. switching and is completely interchangeable (including internal terminal connections) with standard crystal can relays. A wide variety of mountings and terminals are available. □ Which reminds us, Leach has a complete line of standard size subminiature crystal can relays, too. Yes, when it comes to relays, any way you look at it, you should

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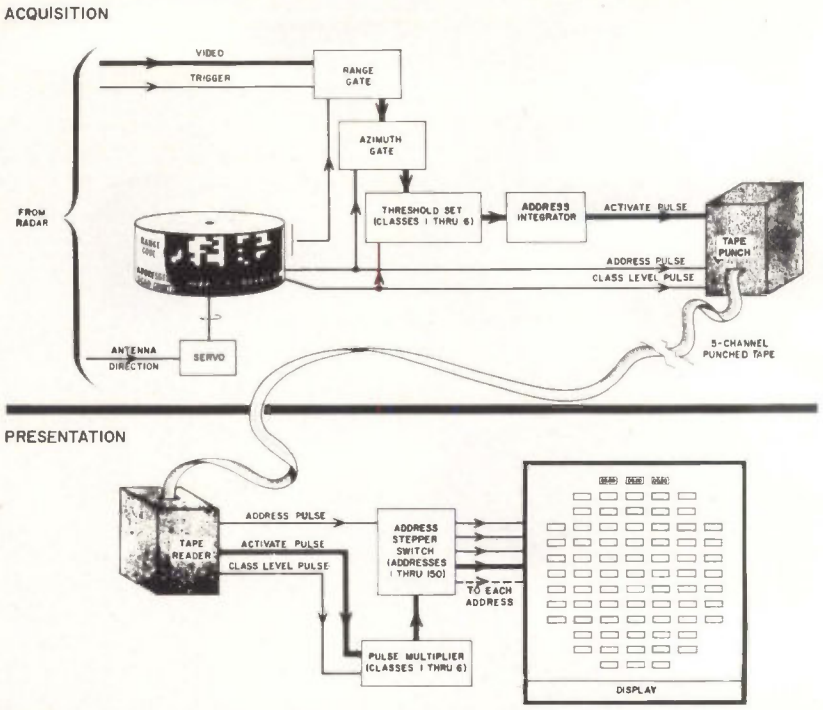
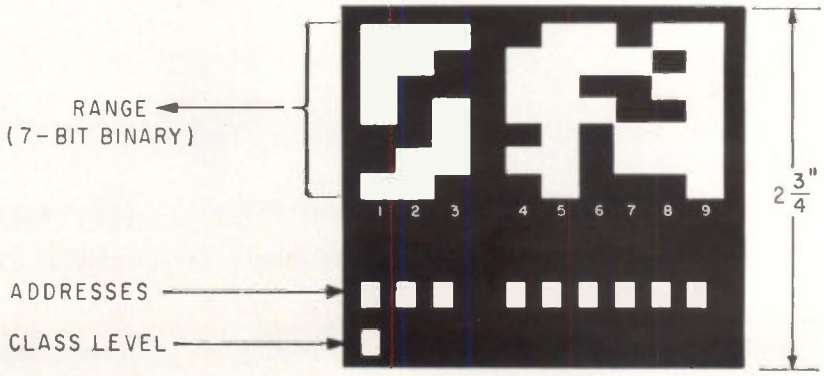


BLOCK DIAGRAM *of complete radar precipitation integrator, showing the acquisition system at top, presentation system at bottom—Fig. 2*

to the radar trigger. The length and width of the range gate can be varied by adjustment, but in the initial arrangement they are, respectively, equivalent to 4 nautical miles and 1 degree.

The rotation of the code drum in synchronism with the antenna thus yields the following: One reference heading pulse for each complete scan, a series of address pulses, counting off each address in turn from the reference heading, and a gate which, when applied to the radar video, enables echoes relating to a discrete area, corresponding to each address point, to be considered as a unit. The echo intensity, and hence the rainfall rate at each address is evaluated by making six scans with the antenna. At each scan, a threshold in the gated video circuit is set up at successively higher values. The video signal is processed in an address integrator unit on a satistical basis to determine whether a significant precipitation echo is present in the gate. If such an echo is present and has a value in excess of the threshold value for that scan, a "yes" pulse is generated. Thus the intensity of an echo at any address is reported as a series of up to six pulses, representing six classes of rainfall intensity. These activate pulses are passed on to the storage and display units of the integrator in synchronism with



CODE DRUM *section illustrates how one address is stored in each vertical column—Fig. 3*

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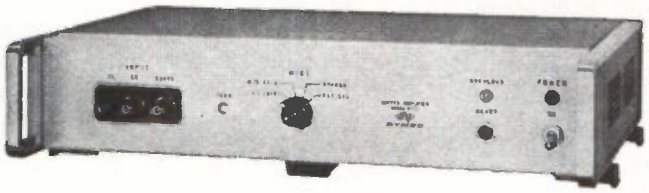

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DY-2411A Guarded Data Amplifier adds the ±10 mv full scale 5-digit range to the DY-2401A Voltmeter, with overranging to 30 millivolts and constant 10,000 megohm input resistance. It preserves the guarded measurement features of the 2401A, providing 134 db effective CMR. Gain settings of +1, +10 and bypass are programmed by simple ground closures, with no effect on common mode rejection.

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DY-2411A, $1150
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the address and reference heading pulses. The latter, used to identify (and generate) the threshold changes, are known as class level pulses.

A complete incremental observation is thus reported in the form of a series of pulses in three channels. The series consists of six cycles of observations, each made with a different threshold level. The start of each cycle is marked by a class-level pulse. Each cycle consists of a series of address pulses, marking each address in turn. At each address at which there is a positive report of rainfall, an activate pulse coincides with the address pulse in question.

To enable the data to be processed more slowly than it is acquired, a punch-tape buffer stage is used. This makes it possible for the relatively slow display and storage techniques to keep up with the acquisition stage by taking advantage of the 10-minute intervals between each observation cycle.

PRESENTATION STAGE — A punched-tape reader converts the observation report back to pulsed form at a speed determined by the operation of the display unit. The series of address pulses actuates a stepper switch. This brings each electromechanical counter of the display unit into circuit in sequence. If an activate pulse is present at the address, it is fed to the corresponding counter by way of the pulse-multiplier unit. The function of this unit is to convert the single activate pulse into a train of pulses, which represents the increment to be added to the counter for the class level in question. In this way, class levels may have a nonlinear relationship, since any reasonable weighting factors can be applied by the pulse-multiplier unit. These factors are selected, in turn, by the successive class-level pulses marking the intensity classes in which the data were evaluated in the acquisition stage.

The counters, operating in unit increments, show directly the depth of accrued rainfall.

A buzzer may be set to sound if an echo is reported in the most intense class. This could provide timely warning of rainfall likely to cause floods.

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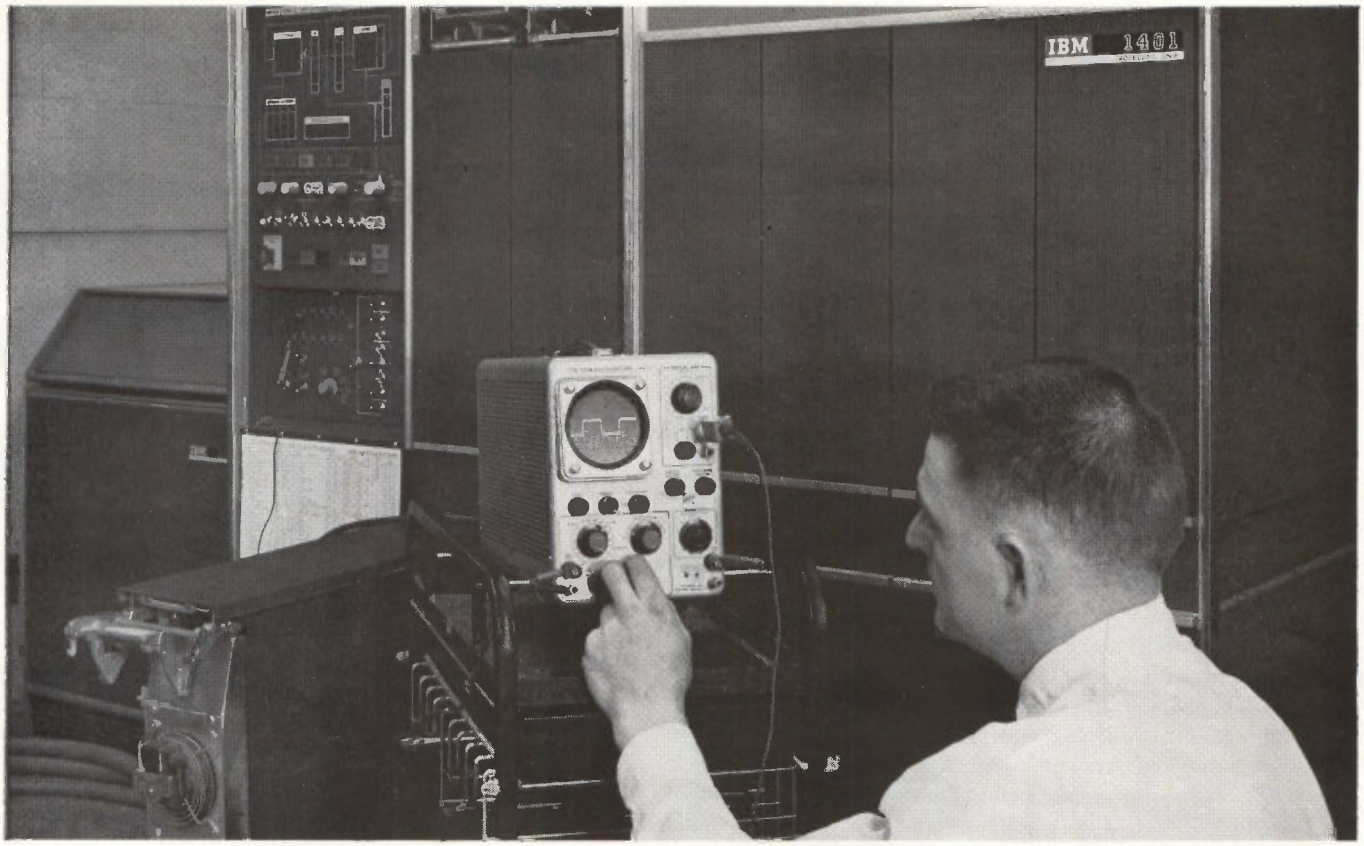

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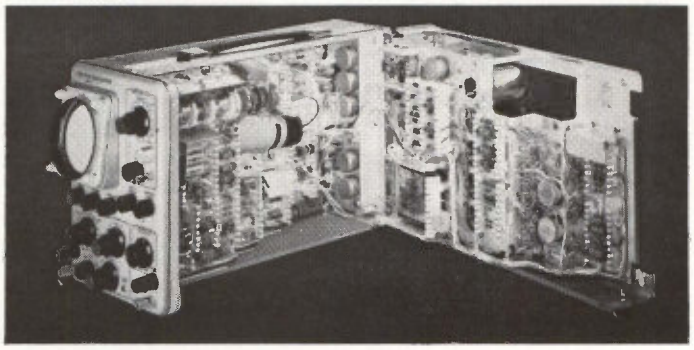

Hinged chassis affords easy accessibility to all tubes and components. Size is 10³/₈" high by 7" wide by 17⁵/₈" deep. Weight is 23 pounds.

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Here a computer technician uses a Tektronix Type 310A Oscilloscope for preventive maintenance on a data processing unit.

Periodic checks—such as this one on the noise level of pulses in the main timing circuit—aid the technician in keeping the unit operating to its fullest capability.

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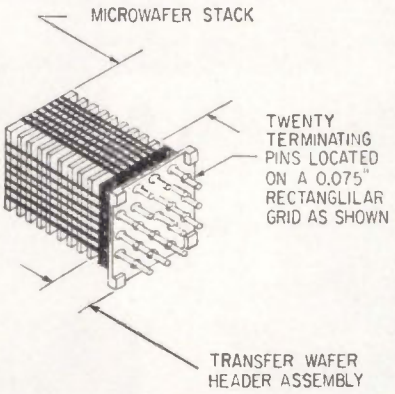
Modules Incorporate Integrated Circuits

Army program exploits thin-film and integrated block technology

By R. A. GERHOLD,
D. S. ELDERS,
U. S. Army Electronic Research and Development Laboratory
Fort Monmouth, New Jersey



INTERCONNECTIONS *for thin-film and semiconductor integrated circuits in micromodules are provided by ribbon conductors welded on each side of notchless wafers (left). Photo, right, shows close-up of these connections in developmental model—Fig. 1*

A NEW generation of micromodules will provide a reliable approach for incorporating advanced circuit technology into military equipment.

The enhanced micromodule will include thin-film and integrated semiconductor circuit technology in its stacked-wafer structure. Application of new interconnection techniques will allow significant gains in performance and reliability.

The new micromodule structure, Fig. 1, provides uniform and economical interconnections within a single hermetic can and header assembly.

CONDUCTORS—A stack of microcircuit wafers, containing thin-film and integrated circuit elements, is connected by welding copper-ribbon conductors to metallized terminal areas around the edges of notchless wafers.

Resistance values for these microconnections are in the order of 0.01 milliohm and are more stable than thermocompression bonds. Newly-developed modifications of resistance welding also may prove to be adequately reliable for these microminiature joints.

Interconnections on a 25-mil grid yields a potential termination density of 1,600 terminations per square inch. On a volume basis, 64,000 microconnections could be contained in one cubic inch. This is one-tenth of the volume occupied by the same number of soldered riser wire connections of the micromodule.

Up to 9 ribbon conductors may be used on each side of the notchless microelement wafers of the standard 0.310-in. size. This provides for 36 interconnecting ribbon conductors in place of the 12 riser wires of the conventional micromodule.

The bottom transfer wafer connects twenty of these ribbon conductors to the pins of a hermetic header. The twenty header pins are located on a 75-mil grid to permit use of relatively noncritical multilayer printed wiring for interconnections between modules.

The can is hermetically sealed to the enhanced micromodule by electron-beam welding, and no flange is necessary. Leakage rates of less than 10^{-9} cc/sec have been demonstrated for such sealed modules. The package is suitable for extreme thermal environments.

Originally, the micromodule was planned with full awareness of the anticipated strides in the thin-film and semiconductor integrated circuit areas.

Back in 1961, a program was explored with Servomechanisms, Inc. to apply multilayer thin-film integrated circuits to the micromodule. Integrated circuit microelements in hermetic flat-packs were assembled into micromodules by Texas Instruments.

A 0.225-in. sq flat-pack is now under development with Westing-

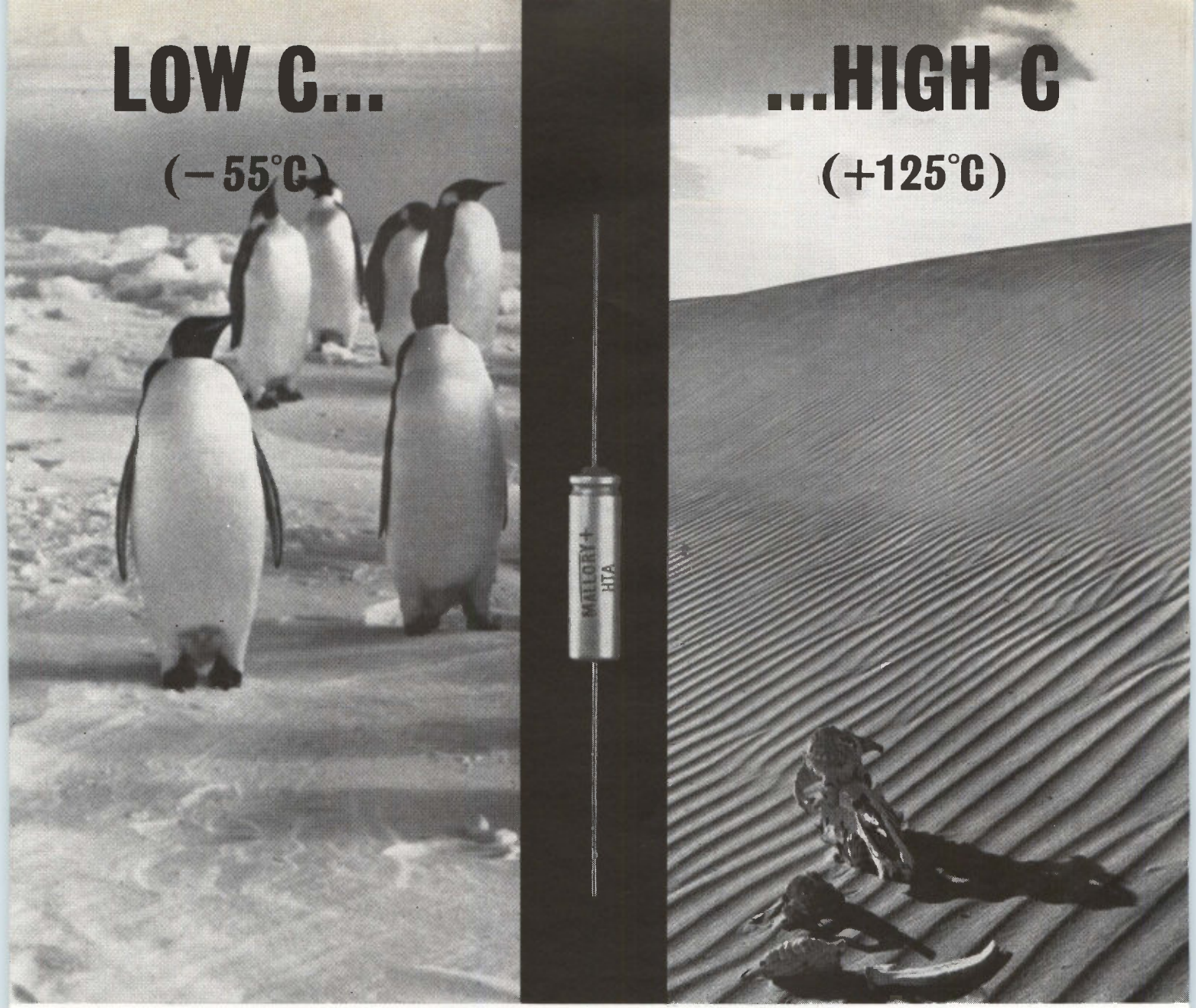
MICROMODULES BY THE MILLION

Since the micromodule program started five years ago, an estimated $18 million has been spent on this method of miniaturizing military circuits.

More than 50 companies have been involved in various phases of manufacture. Over 675 different circuits, both digital and linear, have been reduced to micromodule design. Reliability of the modules has been confirmed by over 57 million element-hours of life tests, the authors say.

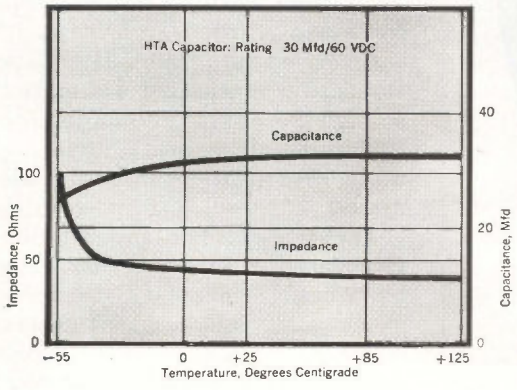
This program keeps pace with new circuit technology, presently scheduling premium applications which can most readily support initial cost differentials between modern techniques and conventional circuits.

Army now has over a score of equipments under consideration. These would require over a million micromodules



thermal breakthrough in aluminum electrolytics

TYPICAL PERFORMANCE DATA—TYPE HTA



Typical stability of capacitance at low and high temperatures.

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The Mallory HTA is a new kind of aluminum electrolytic capacitor. For the first time, designers of industrial and commercial electronic circuits can apply the economy of aluminum capacitors to applications in high and low temperature ranges—and still have performance characteristics approaching those of tantalum units.

Take a close look at the HTA's temperature performance: you may find a lot of spots where you figure nothing but tantalum would do. HTA's are supplied in ratings of 8 to 300 mfd, 60 to 3 volts. Standard diameter is $\frac{3}{8}$-inch. Case length is $1\frac{3}{16}$ to $1\frac{5}{8}$ inches. Tubular aluminum case, with axial leads. Supplied with Mylar* sleeve if desired.

Call or write today for technical data. Mallory Capacitor Company, Indianapolis 6, Indiana—a division of P. R. Mallory & Co. Inc.

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P. R. MALLORY & CO. Inc.
MALLORY

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house. This will provide useful circuit area equivalent to that of the much larger TO-5 can.

SINGLE CAN—Since no polymeric materials are incorporated within the enhanced micromodule assembly, the package is suitable for temperature extremes. An aggregate of uncased semiconductor devices and integrated circuits can be sealed within a single enclosure.

Interconnections of the semiconductor devices are accomplished in a contamination-free environment. Design eliminates the need for much of the printed wiring now used between individual integrated circuit packages.

With two uncased integrated circuit flip-flops on each of the ten microcircuit wafer, an entire flip-flop shift register could be contained in a single 0.8-in.-high enhanced micromodule. The single overall hermetic seal replaces 20 relatively expensive flat-packs.

From a point of view of efficiency of microminiaturization, 21 parts per flip-flop would result in a total of 420 parts. This results in a packing density of some 9 million parts per cubic foot at the module level. The micromodule program has shown that possibly one-third of this figure could then be realized in extensive logic arrays in practical equipment.

The limiting factors as to reliability are the circuits on the wafers. Full reliability of the integrated circuits are realized by the microwelded connections to the ribbon conductors. Lead lengths between circuits may be greatly shortened and capacitance of the many metal parts of the individual cases minimized.

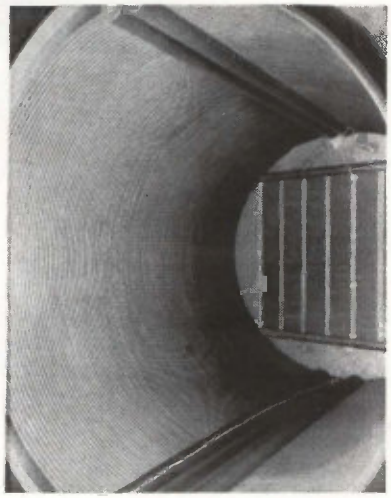
Retention of the 0.310-in. sq standard microelement will make it possible for the equipment designer to incorporate a broad catalog of established high-performance elements.

The micromodule program has established a broad vendor capability commensurate with the range of available microelement characteristics. Vendors will supply microelements to any equipment manufacturer desiring to assemble micromodules.

Mechanized module assembly facilities have been established at P. R. Mallory, Paktron, and RCA

Semiconductor Division to ensure initial production capability adequate for broad military commitments.

Thermal Shroud Cycles Orbital Temperatures



AUTOMATIC *programming capabilities of thermal chamber, developed by Bethlehem Corp., permits cycling to orbital thermal environments without any surplus equipment to add to vacuum pumping load. Chamber simulates temperatures from —320 F to 500 F, is in use at RCA's Space Center, Princeton, N. J.*

Switching Cores Developed For Molecular Circuits

SIGNIFICANT reduction of drive-current requirements for magnetic thin - film memory elements is claimed by Univac Div. of Sperry Rand Corp.

New magnetic elements have been deposited that operate at drive currents of between 20 to 30 milliamperes. This has been accomplished by altering the chemical composition of the magnetic material and reducing the size of the drive wire to 5 mils. The film thickness was reduced to 200 Angstroms to decrease demagnetization effects.

NEW LOW—Tests of the new film indicated an anisotropy field of about one oersted. This is said to be 3 or 4 times less than films now in use.

The new magnetic memory has a

flux of about 0.2 millimaxwells and generates an output voltage of a few tenths of a millivolt when switched in 10 nanoseconds.

The film has been used in operational memory circuits in which signal-to-noise ratios of 10 to 1 have been demonstrated. Outputs of 40 millivolts have been achieved with amplifier gains of 40 decibels.

The magnetic film is a ternary alloy of nickel, iron and phosphorus.

Most existing magnetic thin-film structures require several hundred milliamperes for current drive. Bringing down power requirements to 20 or 30 milliamps make magnetic memory switching elements compatable with molecular integrated circuits.

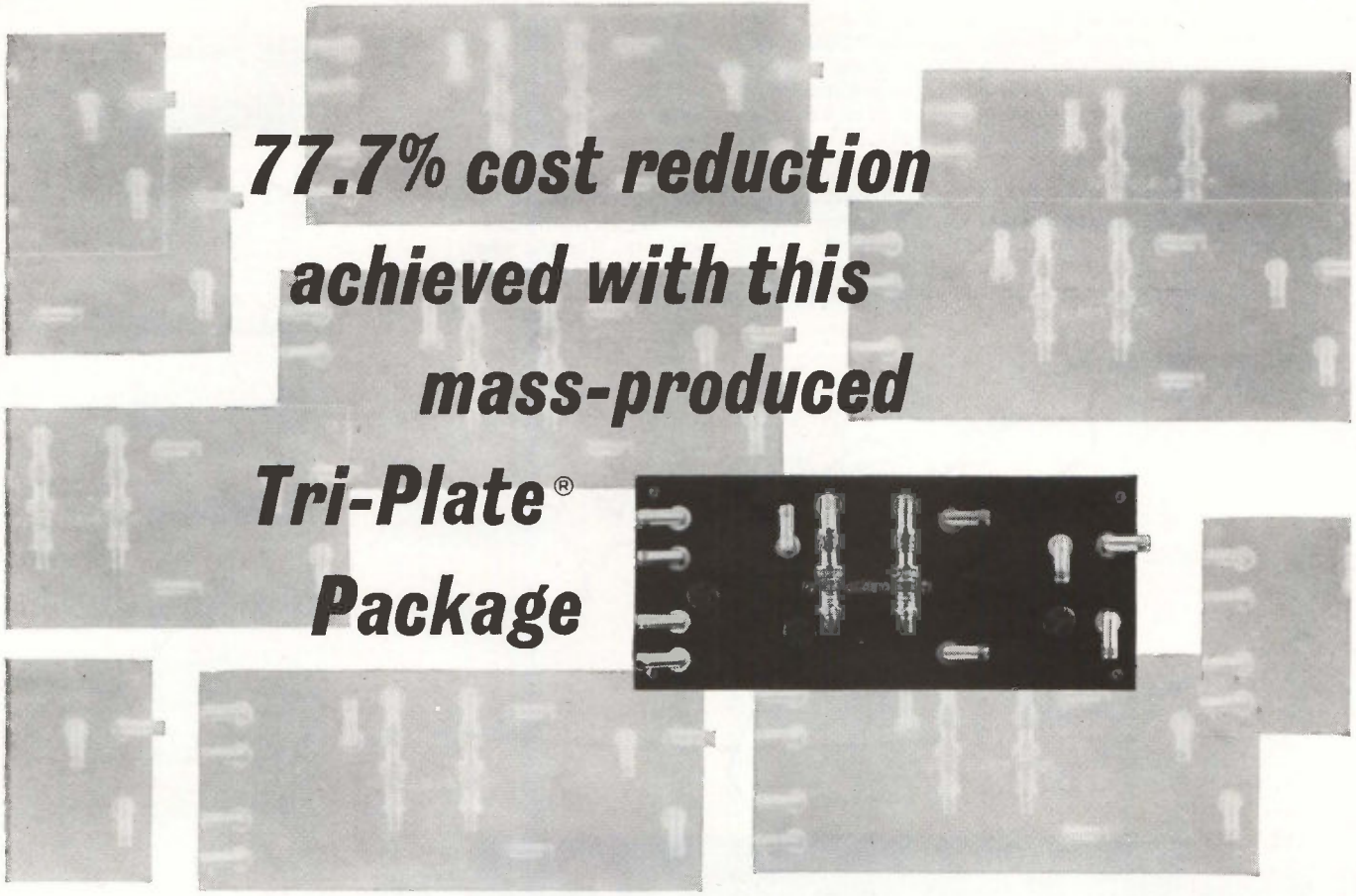
Univac spokemen say that this thin-film breakthrough makes possible the future development of 256-word memories, complete with selection circuits, drivers and amplifiers, in a volume of about one-half cubic inch. This development assumes use of evaporated circuit components and conductors with miniaturized diodes and transistors. Full use of evaporated circuits that include active elements would permit even smaller volumes.

Laser, Electron Beam Machining Compared

WESTINGHOUSE ELECTRIC scientists estimate the cost of electron beam devices for machining applications at $50,000 to $75,000 and for lasers at $25,000. The laser systems they consider, however, do not have the average power capabilities of electron beam devices, but can deliver the same power densities.

C. H. Church, W. J. Smith and G. R. Feaster say that repair costs to laser systems would be relatively high in large capacitor machines because of the need for capacitor replacement. Lasers, though, would not require the vacuum systems necessary in electron beam work. For welding, they considered power densities from 10 to 15 Mw per square inch and working areas of 0.01 to 0.03 inch in diameter, with average power of 1 to 10 Kw. For drilling and cutting, they considered power densities over 100 times larger covering smaller areas, such as 0.001 inch in diameter.

In breadboarding, packaging and quantity production, what the concept of strip transmission line promised, TRI-PLATE techniques deliver — they've made the concept a practical reality! □ The multi-component airborne package shown below is produced in volume and is a good example of how TRI-PLATE techniques cut size, weight, and costs. This circuit produced in conventional coaxial line measured 160 cu. in., weighed 6.25 lbs. and cost $1369.63. By comparison, the same assembly produced as an integrated TRI-PLATE line package measures only 108 cu. in., weighs less than 2.5 lbs., and costs just $306.05. □ In addition, TRI-PLATE Line minimized the interface problem by at least 60%. This was accomplished by combining six components — two 3 db couplers, one 6 db coupler, two 10 db couplers, two crystal detectors, two crystals, and a termination — into an integrated assembly. By eliminating multiple connectors, VSWR was also improved. And this Integrated TRI-PLATE Package, the design of which was proved feasible through the use of TRI-PLATE Modules before quantity production was initiated, exceeds environmental Mil Specs for airborne equipment. □ Microwave, semiconductor and fast switching circuits with high density packaging, that heretofore have been thought impractical or impossible to build because of their bulk or complexity, are successfully produced in TRI-PLATE Strip Transmission Line. □ To help speed the time from design to breadboard to prototype to production, there are more than 600 TRI-PLATE Modules — plus over 150 TRI-PLATE Mounts for standard and advanced semiconductor devices — available from Sanders. They let you test new circuit ideas — no matter how different or daring — with speed, ease and economy. You can go from paper schematics to functioning circuits in just minutes to evaluate new design concepts. □ And a system designed with TRI-PLATE Modules can be produced in quantity as an Integrated TRI-PLATE Package, with performance equal to or better than that of the modular prototype, and with great savings in size and weight. □ For more information about Strip Transmission Line and how TRI-PLATE Products have made it a practical reality, for the latest literature — including specifications and prices — or for consultation regarding your specific requirements, write to Sanders Associates, Inc., Microwave Products Dept., Nashua, New Hampshire.



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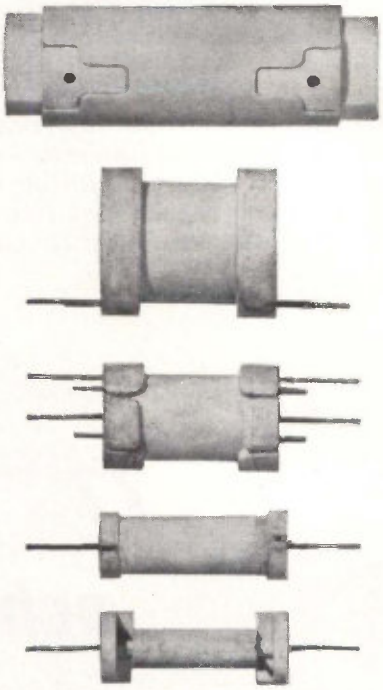

These amplifiers will be spaced at 20-mile intervals along a single cable on the ocean floor to help the Bell System handle the growing number of intercontinental telephone calls—well over 4,000,000 last year alone.

In designing these new amplifiers the Bell System engineers aimed at developing a device that would stand up for at least 20 years under the extreme pressure. For failure of any of the complex components could interrupt vital transoceanic circuits.

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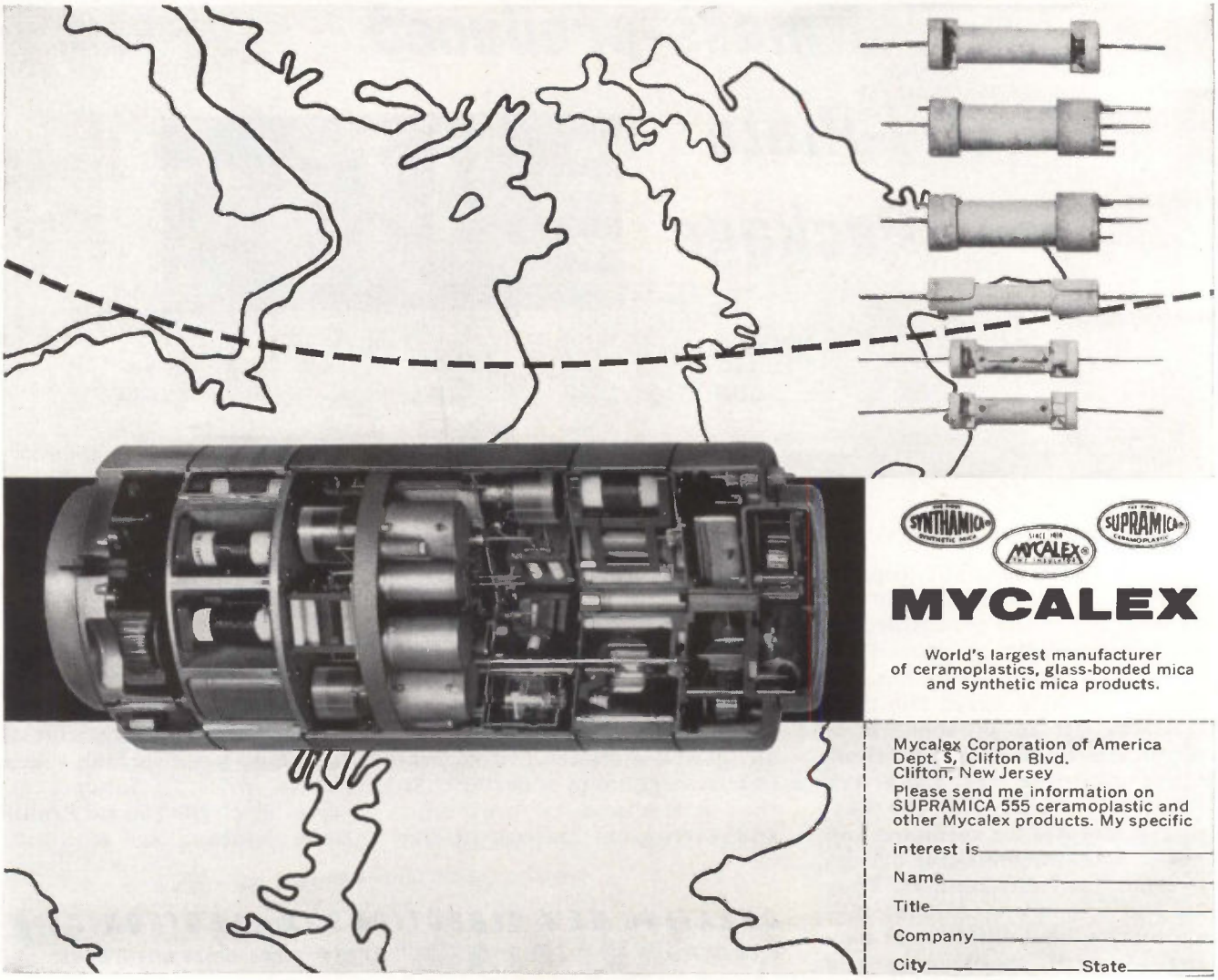

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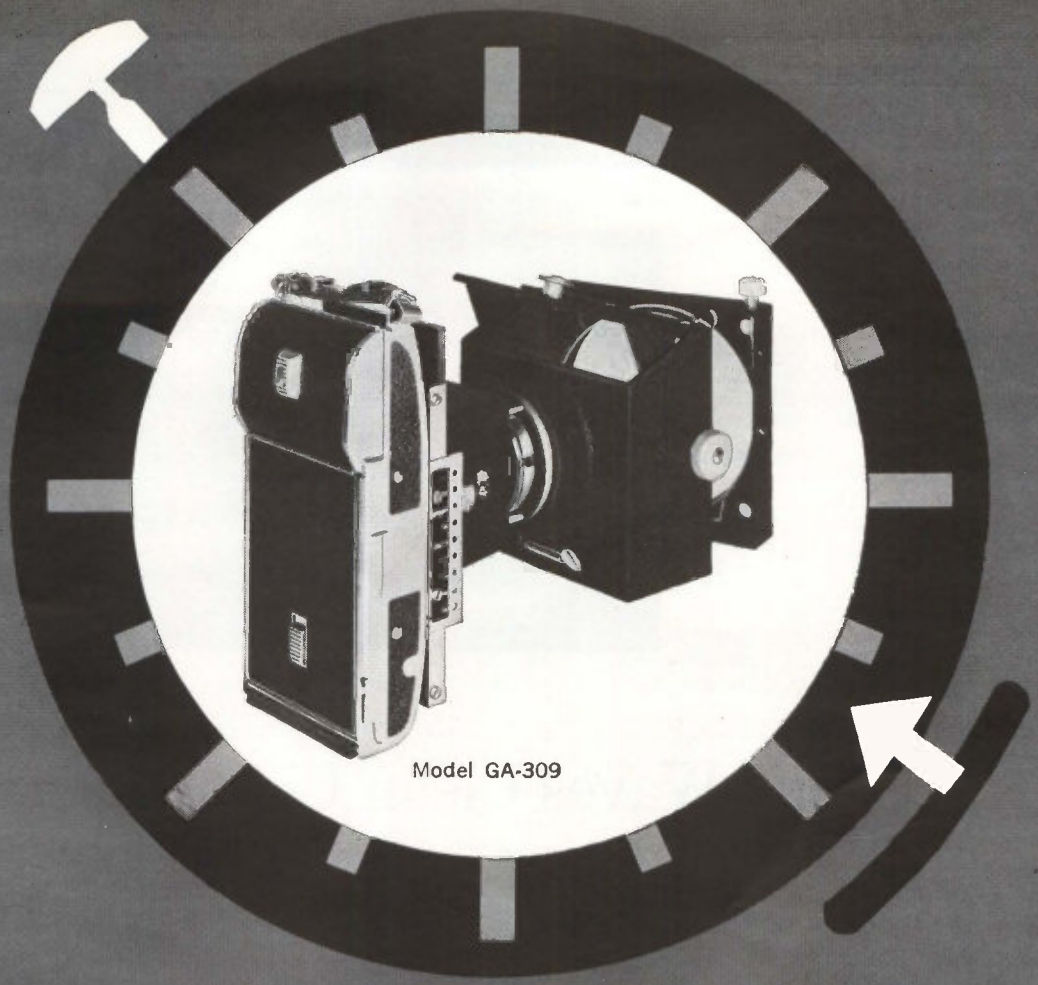

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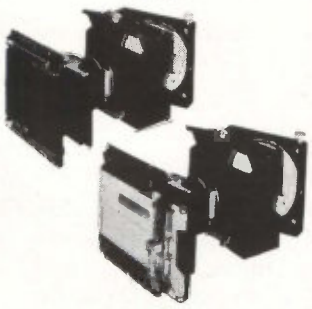

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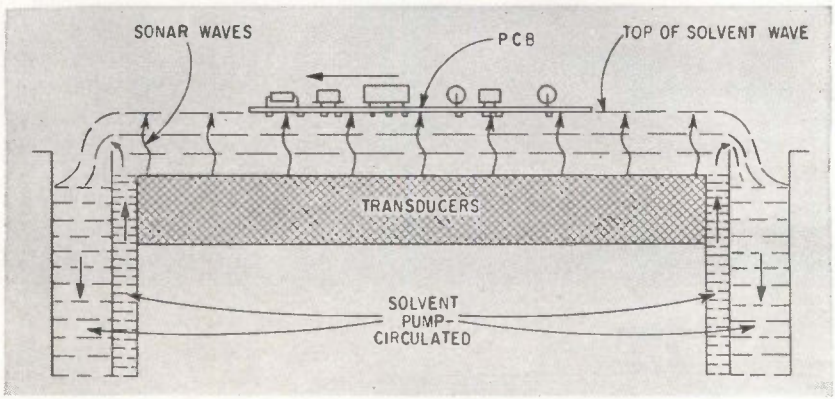
New technique keeps boards moving in-line on soldering conveyor

By PAUL J. BUD
Electrovert, Inc.
New York, N. Y.

Ultrasonic Waves Clean Circuit Boards

CLEANING of circuit-board assemblies is an extremely critical factor in pre- and post-soldering phases of in-line production. To get away from present dipping in ultrasonic cleaning tanks that disrupt in-line character of wave soldering, Electrovert has developed the near-surface ultrasonic-transducer configuration shown in an accompanying illustration. Called the Ultrasonic Wave Applicator, the patent-applied-for device is believed to be the first equipment allowing straight-line (or in-line) ultrasonic cleaning.



CARRIER *holding printed circuit is positioned on solder-process conveyor belt just ahead of ultrasonic-wave cleaner (top). Cleaner uses a near-to-surface ultrasonic-transducer configuration (bottom)*

PRINCIPLE — Heretofore, ultrasonic cleaning tanks were provided with transducers placed either at the bottom or on side walls of tank. Both configurations required stop-and-go operations and deep dipping of part to be cleaned. A great deal of ultrasonic energy is wasted due to large volume of cleaning solvent between transducer and part.

L. V. Tardoskegyi, chief industrial engineer at Electrovert, took a new tack by designing the Ultrasonic Wave Applicator so as to avoid both dipping (out-of-line) and energy-dissipation problems: transducer is positioned only 1 to 1½ inches below solvent surface, which itself has a wave configuration that enhances cleaning through washing-action on board bottom. Solvent is circulated at the high rate of 1,000 gals per hour.

EQUIPMENT — The Ultrasonic Wave Applicator includes a stainless steel double-walled tank which is filled with the proper cleaning solvent (to be discussed). A certain solvent level is maintained in tank by an automatic gravity-flow feeding system. In addition, solvent inside double walls is pump-circulated over the large flat metallic mirror surface of transducers located just below normal level of cleaning solution. Thus, a flat continuously flowing, smooth laminar wave 12 by 12 inches in area is produced in, or on, which ride circuit boards propelled by solder-process conveyor belt. Height of wave is controllable, averaging about ½ inch.

With topside of transducers no more than 1½ inches below wave surface maximum effect is realized from ultrasonically-induced cavitation effect in cleaning exposed printed-circuit board surface. Energy supplied by transducers is 5 watts per sq. inch.

PRECLEANING — Because of the combined wave and cavitation effect, printed circuit assemblies can be made absolutely clean in pre-cleaning operations including re-

SA-84WA
10-63,680 mc

This instrument was the microwave "hit" last August at WESCON. They were standing three deep to see it in October, at N.E.C. At NEREM, in November, we were demonstrating it **continuously.** At IEEE, eight months after its introduction, it was a **standout** attraction!

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- **ACCURATE IF ATTENUATION** . . . ±0.05 db/db accuracy in the SA-84WA!
- **WIDE FREQUENCY RANGE** . . . 10-63,680 mc in the SA-84WA!
- **HIGH MAXIMUM SENSITIVITY** . . . to —115 dbm in the SA-84WA! (defined in the only **meaningful** way: S + N = 2 × N)
- **CALIBRATED WIDE-RANGE DISPERSION** . . . over 80 mc in the SA-84WA!
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- **WIDE-RANGE VARIABLE-FREQUENCY MARKERS** . . . ±40 mc in the SA-84WA!

We can only touch the high spots here — but our brand-new 40-page Spectrum Analyzer Bulletin A63 gives the complete specifications. Use this card—we'll send your copy by return mail!

Incidentally, we make seven classes of spectrum analyzers, in 35 standard versions, hundreds of standard variations. Turn the page for a brief summary.

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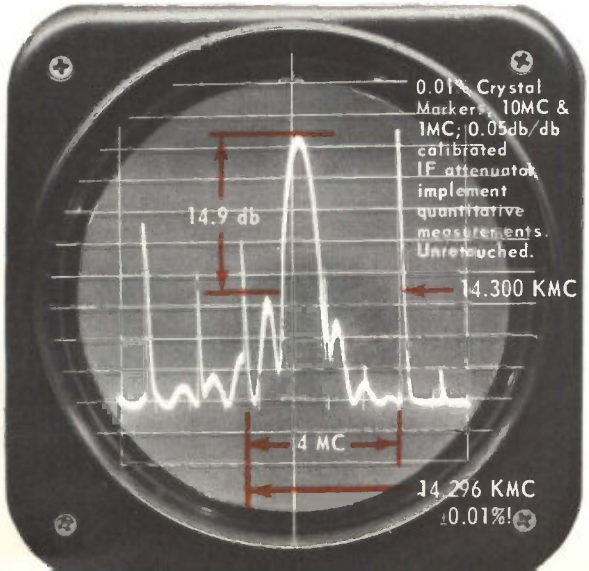

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TSA	$3,990.*	Multiple PLUG-IN HEADS	10 mc to 40 gc	1 kc to 80 kc	100 kc to 25 mc	LIN-LOG	Video Filter	−115 dbm to −50 dbm	Lowest cost analyzer for specific frequency application.	Buy only the head you need — expand range later!
TSA-W	$4,335.*	Multiple PLUG-IN HEADS	10 mc to 44 gc	1 kc to 80 kc	25 kc to 80 mc (25 mc on STU-1 band)	LIN-LOG	Sweep and Video Outputs. Video Filter	−115 dbm to −50 dbm	Lowest cost analyzer for specific frequency application requiring wide dispersion.	
TSA-S	$4,635.*	Multiple PLUG-IN HEADS	10 mc to 44 gc	Spect. Anal. 5 kc, 50 kc; Syn-chro. 500 kc, 5 mc	400 kc to 25 mc	LIN	Sweep and Video Outputs. Trigger Output	−105 dbm to −50 dbm	Combined spectrum analyzer & synchroscope for frequency & time domain displays.	
SA-84	$5,000.	Universal MULTI-BAND	10 mc to 40.88 gc	25 kc	500 kc to 25 mc	LIN	Military Standard UPM-84	−90 dbm to −40 dbm	Lowest cost analyzer for wide frequency coverage	Single unit covers all bands
SA-84T	$5,650.	Universal MULTI-BAND	10 mc to 40.88 gc	20 kc	500 kc to 25 mc	LIN	41 DB Calibrated IF Attenuator	−105 dbm to −55 dbm	Transistorized, portable, battery or line operated, wide frequency coverage.	
SA-84W	$6,290.	Universal MULTI-BAND	10 mc to 40.88 gc	1 kc to 80 kc	25 kc to 80 mc (25 kc to 100 mc on special order $100 add'l)	LIN-LOG	20 DB Calibrated IF Attenuators IF & RF Crystal Markers, Video Filter	−105 dbm to −55 dbm	Wide frequency coverage with wide dispersion.	
SA-84WA	$6,490.	Universal MULTI-BAND	10 mc to 63.68 gc	1 kc to 80 kc	25 kc to 80 mc (25 kc to 100 mc on special order — $100. add'l)	LIN-LOG	20 DB Calibrated IF Attenuator IF & RF Crystal Markers, Video Filter	−115 dbm to −45 dbm	Widest frequency coverage with wide dispersion.	

* With One Head

STANDARD OPTIONS

OPTIONS	UNIT
1. 100 mc Dispersion	1. TSA-W, SA-84W, SA-84WA
2. Phase Lock Capability	2. All Units
3. AM Marker Modulation Input	3. All Units
4. XY Recorder Output & Slow Scan Rate	4. TSA, TSA-W, SA-84W, SA-84WA
5. 50 DB on Screen Log Display	5. TSA, TSA-W, SA-84W, SA-84WA
6. 63 DB Calibrated IF Attenuator	6. SA-84T
7. Choice of CRT Phosphor	7. All Units

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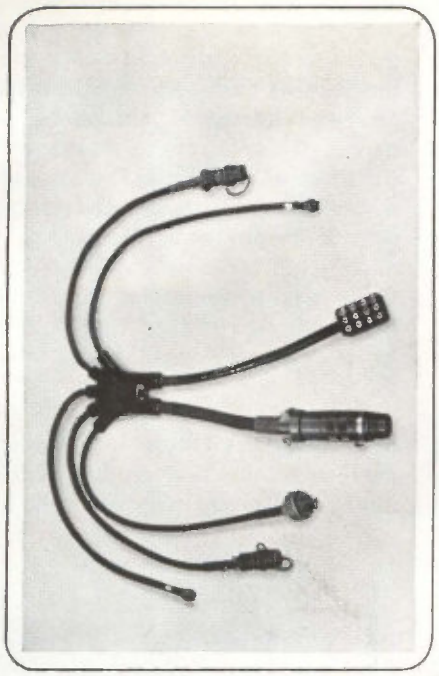
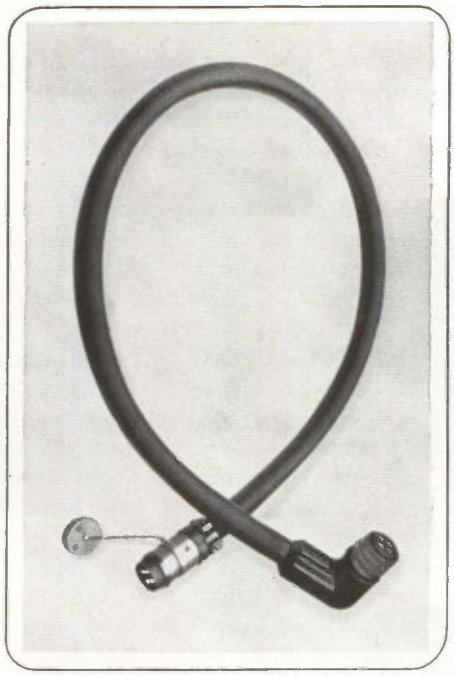
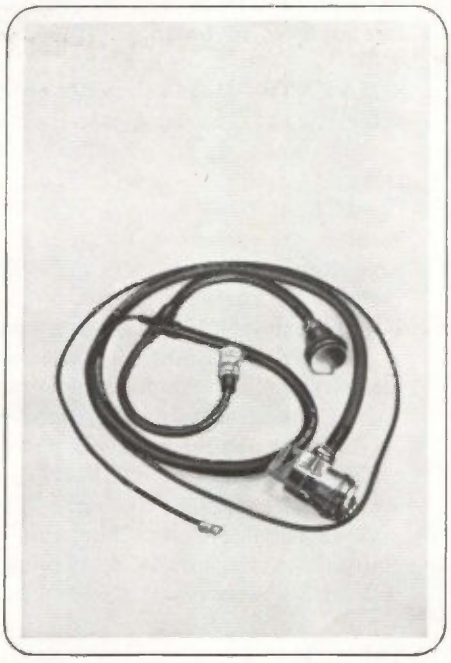
This 40-page engineering bulletin contains an excellent "State of the Art" summary and a review of many new and unusual applications, as well as complete specifications on the industry's largest line. Use the card—get your copy by return mail!







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moval of perspiration, fumes, grease and oil. Frequently, removing of some of these hard-to-remove substances has required mechanical cleaning (solid-particle sprays, brushes) or thorough submersion in conventional ultrasonic cleaning tanks. Actually, cavitation may be considered a mechanical process.

POSTCLEANING — Postcleaning operations largely resemble precleaning operations. However, in many cases circuit boards do not have to be submerged in wave during precleaning but only have to contact energized surface of wave. Postcleaning, on the other hand, in most cases requires a slight submersion of boards below wave surface in order to remove flux and flux residues from both bottom and top surfaces of board.

SOLVENTS—Depending on characteristics of flux used, two choices can be made as to cleaning solutions:

- If flux is rosin-based, excellent results are possible by using a proper chemical solvent (e.g. "Chlorothene Nu" or equivalent).
- If water-soluble fluxes are used, a properly conditioned aqueous solution produces excellent cleaning.

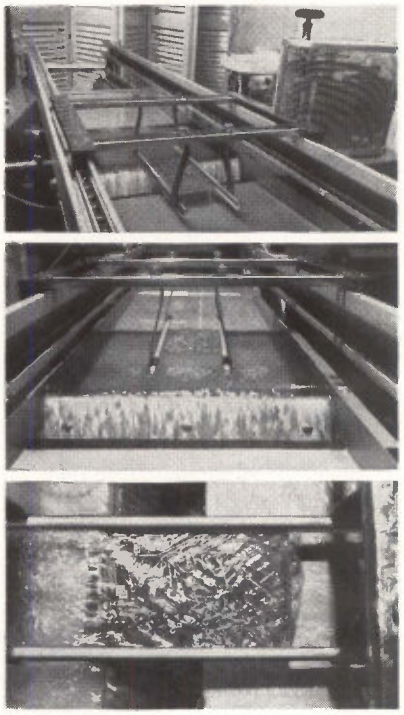
If a chemical solvent is used in cleaning, it should be easily recoverable by distillation. This will increase operational efficiency and give excellent results. The unit is equipped with outlets for connection with a recovery still.

OIL — The use of oil — by either mixing it in solder or by applying it by spray or wave to the board after passing the solder wave—is a quite controversial procedure. Oil provides a protective layer that keeps air from solder, preventing oxidation. Oil also changes surface and interfacial tension conditions prevailing during soldering operation, thus influencing soldering results.

With properly designed assemblies and prepared board and lead surfaces, excellent soldering results can be achieved without oil, if proper attention is given to presolder cleanliness.

While oil's use may thus be justified only in special cases, its use might make preconditioning and precleaning less critical. However, oil residues should always be removed. This, of course, makes postcleaning a complicated job: some materials used in printed circuit boards are porous or might pick up oil by capillary action. We feel that there is no better means for removing these oil residues (as required by government regulations) than the ultrasonic-wave method.

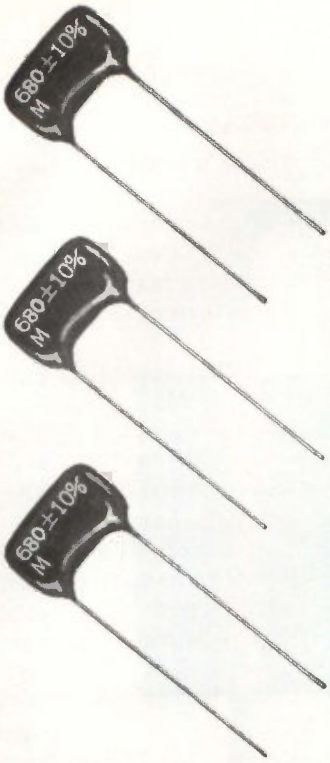
SEMICONDUCTORS — Semiconductors on printed circuit boards might be directly exposed to the effect of supersonic waves if immersed vertically into ultrasonic tanks having transducers on sidewalls of tank; or they might be exposed to waves reflected from sidewalls of tanks equipped with bottom transducers. Such exposure can develop a damaging resonance effect.

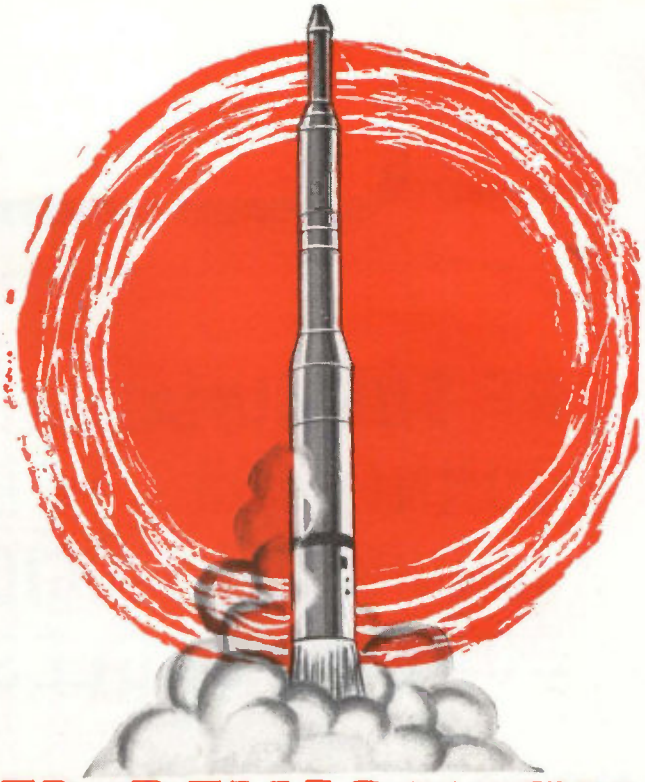


PRINTED *circuit board moves into ultrasonic wave and is exposed to wave's mechanical cleaning action which is a combination of ultrasonic cavitation and wave-washing effects. Top view shows board moving away from camera into wave; middle view shows it approaching transducer area of wave (towards camera); bottom view shows close-up of board's topside as it enters wave (on left)*

With the surface exposure, or the

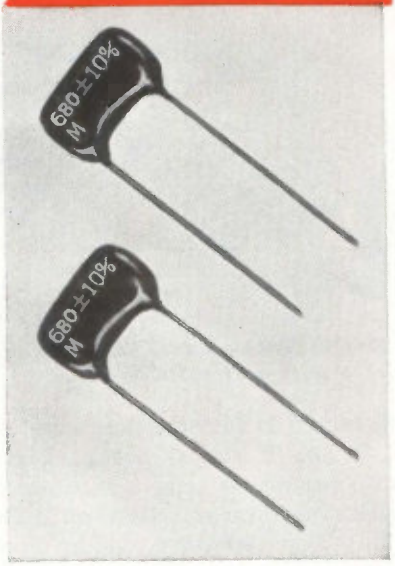
SELECTED BY RCA FOR A HIGH RELIABILITY PROJECT





Here is MEASURED RELIABILITY!

DUR-MICA CAPACITORS TYPE M2DM



Ten thousand EL-MENCO high reliability dipped mica capacitors were put on life test at 85°C with 225% of the rated DC voltage applied—After 26,500,000 actual test unit-hours no failures of any type occurred.

The accumulated 26.5×10^6 test unit-hours without any failures can be used to calculate many different failure rates depending upon the confidence level desired. However, we shall explore the meaning of the results at a 90% confidence level.

Assuming no acceleration factor for either temperature or voltage, we have verified a failure rate of less than 0.01% per 1000 hours. (Actually, there is a temperature effect and it has been found that, with the DC voltage stress remaining constant, the life decreases approximately 50% for every 10°C rise in temperature. There is also a voltage effect such that, with the temperature stress remaining constant, the life is inversely proportional to the 8th power of the applied DC voltage.)

Assuming no temperature acceleration factor and assuming the voltage acceleration exponent is such as to yield an acceleration factor as low as 100, we have nevertheless verified a failure rate of less than 0.0001% per 1000 hours.

Assuming no temperature acceleration factor and assuming the voltage acceleration factor is on the order of 250 (test results are available to confirm this) we have accumulated sufficient unit-hours to verify a failure rate of less than 0.00004% per 1000 hours!

Note that all the above failure rates are calculated at a 90% confidence level!

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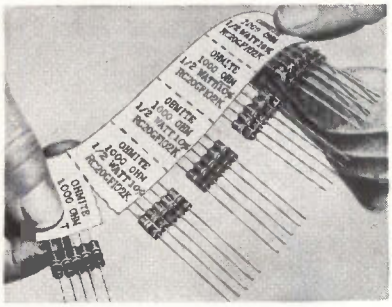
slightly-submerged exposure, experienced in the ultrasonic wave process, semiconductor components are shielded from most such resonant effects.

FLUXES—Besides its present use in cleaning, the ultrasonic wave technique might be applied to fluxing. In this way, a cleaning phase can be imparted to fluxing operations. Thus, preliminary cleaning can be eliminated in obtaining cleaned and fluxed boards with flux solution providing the medium for ultrasonic-cavitation effect.

OTHER APPLICATIONS — The new wave applicator can be used for other applications that can take advantage of the ultrasonic vibration and liquid wave combination. There are many industrial processes, particularly those involving extremely careful cleaning, coating and general surface applications and processing, that will benefit from this new device.

Tally Packaging Prevents Spilling

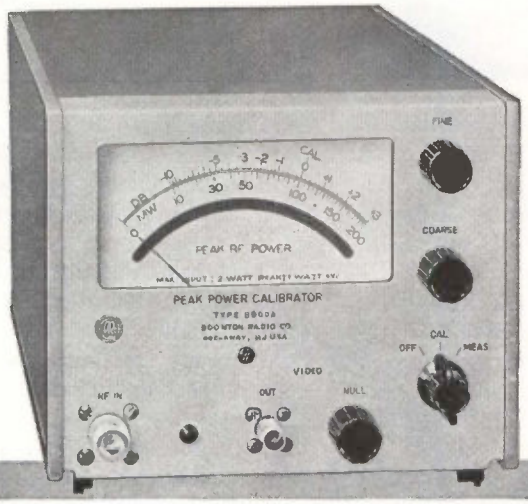


RESISTORS *are torn off in groups of 5 with perforated tape*

RESISTORS in four wattage sizes (¼, ½, 1 and 2 watts) are packaged with perforated tape, 5 resistors to each perforated segment. The Tally Tape technique used by Ohmite permits a rapid count of resistors because of the 5-in-a-group arrangement with a standard number of groups being used in each perforated tape. Tape prevents resistors from spilling and tangling, and printing on tape spells out resistance value, size, tolerance, and MIL type designation.

MEASURE PEAK POWER INDEPENDENT OF DUTY CYCLE

150-1500 MC



- ±0.6 db ABSOLUTE ACCURACY
- 0.1 db PRECISION
- READILY STANDARDIZED WITH EXTERNAL BOLOMETER

The Type 8900-A Peak Power Calibrator provides a convenient means for measuring the peak RF power of pulses in the range from 150 to 1500 MC. The power level is read out directly on the panel meter and is completely independent of repetition rate and pulse width (>0.25 μsec). The instrument consists of a precision terminated input circuit, diode detector, DC reference supply, meter and a chopped video output system.

In operation, the RF signal is applied to the input circuit, which, through a power splitter, feeds the diode detector. The demodulated diode output and the output of the DC reference supply are simultaneously fed to the video output through a mechanical chopper.

In making a measurement, a suitable external oscilloscope is connected to the video output and the DC reference voltage is adjusted so that it is exactly equal to the peak value of the demodulated pulse. The level of the required DC reference voltage is then indicated on the panel meter, calibrated to read peak RF power. The diode is operated in a biased condition for maximum stability of calibration. Provision is made, however, for readily standardizing the instrument against an external bolometer or calorimeter by simply connecting to the input circuit in place of a standard termination.

The Peak Power Calibrator is completely self-contained and housed in a modular cabinet which may be readily rack mounted.

SPECIFICATIONS

RADIO FREQUENCY MEASUREMENT CHARACTERISTICS:

RF RANGE: 150 to 1500 MC

RF POWER RANGE: 200mw* peak f.s.
*May be readily increased through use of external attenuators or directional couplers.

RF POWER ACCURACY: ± 1.5 db*
*± 0.6 db with custom calibration curve.

RF POWER PRECISION: 0.1 db

RF PULSE WIDTH: >0.25 μsec

RF REPETITION RATE: 1.5 MC max.

RF IMPEDANCE: 50 ohms

RF VSWR: <1.25

PHYSICAL CHARACTERISTICS:

MOUNTING: Cabinet for bench use; readily adaptable for 19" rack mounting.

FINISH: Gray engraved panel; green cabinet (Other finishes available on special order).

DIMENSIONS: Height: 6⅛", Width: 7¾", Depth: 11"

WEIGHT: Net: 10 lbs.

POWER REQUIREMENTS:

8900-A: 105-125/210-250 volts, 50-60 cps

PRICE:

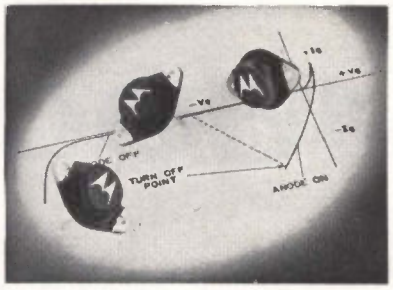
8900-A: $485.00—F.O.B. Rockaway, N. J.
Custom Calibration Curve: $75.00

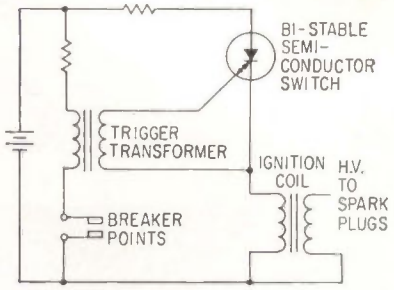
BOONTON RADIO COMPANY
A Division of Hewlett-Packard Company

GREEN POND ROAD, ROCKAWAY, NEW JERSEY
Tel. 627-6400 (Area Code 201) TWX: 201-627-3912 Cable Address: Boonraco

Bistable Semiconductor Easily Turned Off

New unit combines merits of transistor and scr, simplifies switching problems





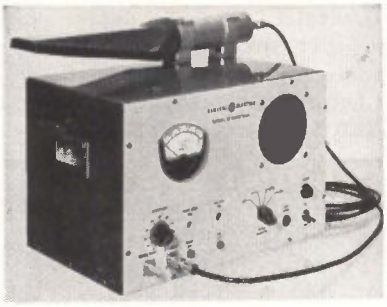
THE SILICON gate-controlled-switch, a descendant of the scr, is among the newest of semiconductors to hit the market. This new unit offers considerable advantage over the scr since it can be turned on and off by low power trigger pulses. The scr is easy to turn on, but it usually has to be disconnected from the supply or fed from a-c before it goes off. The gate-controlled-switch works equally satisfactorily from either a-c or d-c supplies. Unlike the transistor, the gate-controlled-switch needs no continuous input to hold it in one or the other of its bistable conditions.

The switch, photo, from Motorola Semiconductor Division, East McDowell Road, Phoenix 8, Arizona, is packaged in the TO-41 and TO-3 configurations, and is rated 25 through 400 volts, spanning models MGCS 821-1—MGCS 821-6. Current capacity is up to 5 amperes; minimum turn-on current-gain for the series is 50 at 25 Centigrade, minimum turn-off current-gain is 10 for the 25 to 200 volt units and 5 for the higher-voltage models.

In the automobile ignition system (see illustration) the breaker points carry only the current necessary to fire, and turn-off, the switch. Since this current is at least five times smaller than the ignition-coil current, considerable saving in contact erosion is achieved.

CIRCLE 301, READER SERVICE CARD

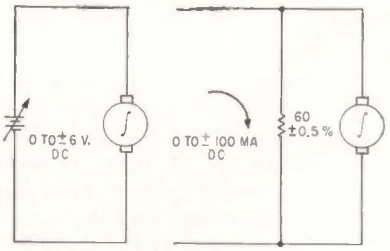
Meter Monitors 4 Types of Radiation



SEMI-PORTABLE radiation survey unit type NF02 is transistorized throughout except that the high voltage supply for the radiation detector uses a corona regulator. Besides giving a visual indication of count rate, the unit is equipped with a 1,000 cps oscillator, whose output is gated to a loudspeaker by detected radiation pulses, thereby giving an audible indication of count rate.

Different probes for measuring alpha, beta, gamma and neutron radiation are available as optional extras. The transistors are mounted on printed circuit cards, and are designed for easy interchange during maintenance. The unit, manufactured by General Electric's Nuclear Electronic Products Section, 175 Curtner Avenue, San Jose, Calif., occupies 14 × 9 × 9 inches volume, gives 10 percent overall accuracy, and a zero-to-1,000 count-per-minute rate, in three ranges. Input is 115 volts a-c, 50 or 60 cps, power rating is 40. **(302)**

Analog Integrator Based On Sensitive Motor



MANY of the disadvantages of electronic integrating systems may be overcome by using this sensitive integrating motor, capable of responding to 600 microamperes input current, to integrate the variable under consideration. Added flexibility is provided, since the motor revolutions, which are proportional to time-integral of input, can be read out from a digital or analog rotation counter. The unit also retains its reading when the supply is interrupted.

Secret of the integrator's efficiency, which lies in reducing frictional and electrical losses in motor, is the use of jeweled armature bearings, a p-m field system, plus a noble-alloy commutator used in conjunction with wire brushes. At full speed, when operating from a six-volt supply, the motor absorbs less than 4 milliwatts driving power. The units, which come in several

models, are available from Acromag, Inc., 15360 Telegraph Road, Detroit 39, Michigan.

In the illustrations, the voltage integrator (left) shows how simple the technique is, since no auxiliary equipment is needed. Current integration is achieved (right) by addition of a parallel resistor to provide a "stiff" voltage source.

CIRCLE 303, READER SERVICE CARD

Thermocouple References Stable From —40 to 212 F

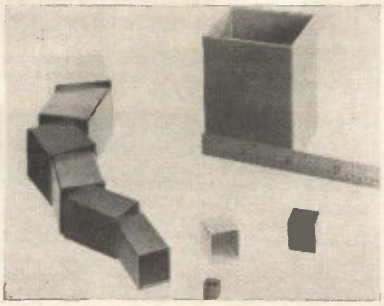
DESPITE their environmental temperature changing at 10 degrees F per minute, these thermocouple reference elements don't deviate from their calibration by more than ¼ degree F. The units, designated JR130, enable a low level d-c measuring system to be converted to an accurate temperature indicator that retains its calibration under severe operating conditions.

An advantage of the new unit is the ease with which it can replace such elaborate thermocouple references as ice baths, liquid hydrogen, or liquid nitrogen baths, and at the same time eliminate auxiliary equipment that keeps these references in working order. The manufacturer, Consolidated Ohmic Devices, Inc., 900 Third Avenue, New Hyde Park, N. Y., states that their reference elements will meet MIL-E-5272 and that the life of the units under continuous use is at least 10,000 hours. The references weigh 25 grams, they are epoxy encapsulated and size to 4¼-in long by 1-in diameter; their output impedance is 200 ohms. **(304)**

D-C Amplifier for Wideband Use

SOLID-STATE wideband potentiometric d-c amplifier, model 260, has been introduced. Bandwidth: down 3 db at 200 Kc minimum; settling time, full-scale step input, 10 μsec to within 0.01 percent of final value; gain accuracy, ±0.002 per-

cent at d-c; input impedance, 1000 megohms minimum at d-c. Redcor Corp., 7760 Deering Ave., Canoga Park, Calif. (305)



Encapsulating Shells Come in Many Sizes

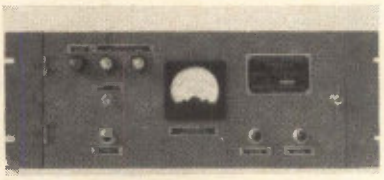
EXPANDED line of square encapsulating shells come in sizes every sixteenth of an inch, from $\frac{3}{16}$ in. to $2\frac{5}{8}$ in. square, and in heights up to $2\frac{1}{2}$ in. from $\frac{1}{16}$ in. square. Featuring a recessed shoulder in order to accept a firm mating header, the unit can be filled with an encapsulant. When the encapsulant cures, the component is ready for use. High volume resistivity is achieved in both alkyd or diallyl phthalate, both affording continuous high operating temperatures. The Milton Ross Co., Box 274, Southampton, Pa. (306)

H-V Power Supply In 7 to 75 Kv Range

HIGH VOLTAGE regulated supply, model MR.75R, has been designed for use in laboratories and for a wide range of industrial applications such as crt supplies, component testing, particle acceleration, image intensification and numerous other electrostatic processes. Operation is by power tube oscillators, working at approximately 8 Kc,

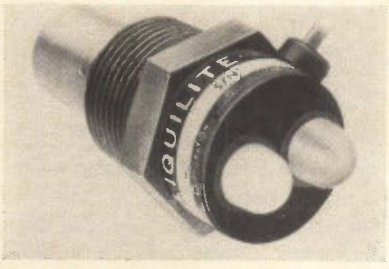
used with an encapsulated ferrite cored transformer to provide the output which is fed to a selenium type rectifier system, arranged as a voltage multiplier. The d-c output is monitored with a 100 μa movement and a high stability series resistor, which also provides the feedback to the stabilizer. Output voltage range is from 7 Kv to 75 Kv with an output current range of from 0 to 0.5 ma. Brandenburg, Ltd., 139 Sanderstead Rd., South Croydon, Surrey, England.

CIRCLE 307, READER SERVICE CARD



Monitor Measures Frequency Difference

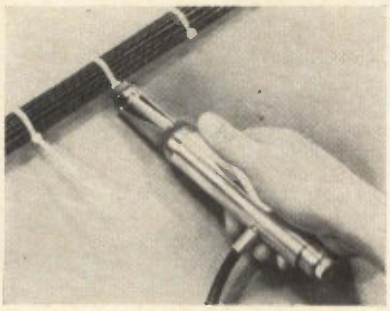
PURPOSE of the frequency difference monitor is to visually indicate the resulting beam frequency of 8 Kc, plus or minus an allowable 5 Kc deviation that could be obtained when two h-f signals in the range of 108 to 112 Mc are applied to the unit. Operation is such that it is independent of the nature of the incoming signal within and exceeding that of predetermined conditions. One of the uses to which the equipment can be put is detecting variations in process heat, as in a chemical reaction, and controlling the heat to within a small tolerance. More than one point can be monitored for temperature with the same unit using separate sensors at the input. Marine View Electronics Inc., 88-06 Van Wyck Exprswy, Jamaica, N.Y. (308)



Liquid Level Sensor Is Tiny and Accurate

SERIES 200 Liquilite is a liquid level sensing, indication and control sys-

tem, complete in one unit. Its self-contained alarm lamp permits one to "see through" the tank wall, while providing remote indication and control many miles from the tank. All-transistor design results in the tiny and accurate (0.01 in.) device. Made of stainless steel, it mounts in a standard 1 in. pipe threaded hole. When liquid reaches the sensing level, the self-contained transistor circuit lights an integral alarm lamp. Simultaneously, a transistor output signal operates remote alarm lamp, relay, etc., up to miles from tank. Controlotron Corp., 7 Commercial St., Hicksville, N. Y. (309)



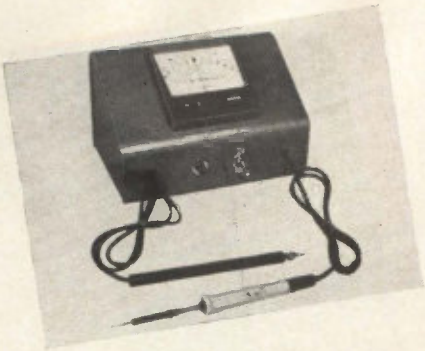
Installation Tool for Production Cabling

PNEUMATIC-POWERED Sta-Strap installation tool for production cabling applications is completely automatic. It sets correct strap tension and cuts strap flush with head. No twisting of strap or operator labor required. The tool, designated ATS-2, features in-line feed and is actuated by a single lever. No air regulator is required because strap tension is precisely controlled by means of an internal spring mechanism. Panduit Corp., 17301 Ridgeland Ave., Tinley Park, Ill. (310)

Semiconductor Tester Is Easily Programmed

GO/NO-GO multiparameter tester, series 250, is capable of conducting tests at the rate of 900 units per hour. It features 16 variable go/no-go tests per unit. Series 250 is easily programmed with decade cards or fixed resistor cards. Accuracy at 1 μa is $\pm$ 0.5 percent ($\pm$ 1 percent at 100 μa). A system for priority sorting is optional. Fairchild Semiconductor, a division

Fairchild Camera and Instrument Corp., 545 Whisman Road, Mountain View, Calif.
CIRCLE 311, READER SERVICE CARD



N-P Meter for Semiconductor Material

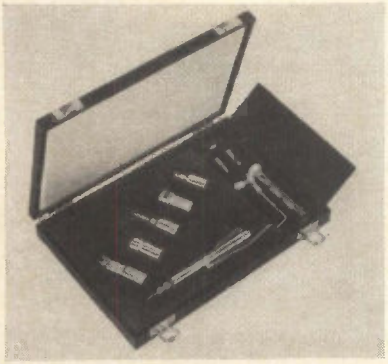
THIS INSTRUMENT determines whether a semiconductor material is *n* or *p* by measuring the magnitude and polarity of the Seebeck voltage generated by a hot probe. It can be used as a quality control or inspection instrument in thermoelectric module production or as a laboratory instrument. In the lab, it is useful in determining the exact location of an *n-p* junction in a material sample. Unit consists of a standard meter probe, a heated probe (approximate temperature of 330 C) and a 50-0-50 microammeter. Instrument is priced at $49.50. Scientific Columbus, Inc., 840 Kinnear Road, Columbus 12, Ohio. **(312)**

Thermal Shock Chamber Comes in Varied Sizes

COMPACT environmental test chamber designed for automatically performing the thermal shock portions of MIL-202B, Methods 102A and 107A is available. It tests within the −100 F to + 300 F range; can

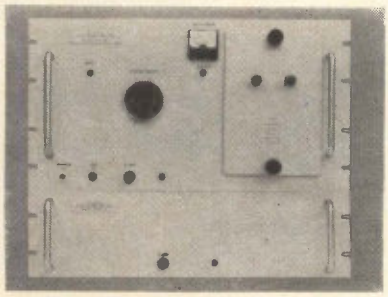
also be supplied for operating in a range of −300 F to +1,000 F. Operation is completely automatic with cycling timers for each test phase. Heating system is a series of electric heaters located behind baffling. Cooling for the unit is supplied by liquid CO_2. Conrad, Inc., Holland, Mich.

CIRCLE 313, READER SERVICE CARD



Universal Lab Set Fits in a Briefcase

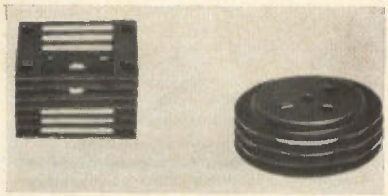
MODEL PHD-100 universal laboratory set contains the high gain Stethotracer signal tracer with six Stethotracer accessories: vibration pickup, miniature magnetic microphone, magnetic tape head, r-f microwave demodulator, input adapter, and output adapter. It may be used for fast analyzing, assisting in designing, and for testing in the laboratory, on the production line, quality control, and in the field. The set with its transducer probes can reach into tight spots of miniature products. The OEM price is $149.95. Don Bosco Electronics, Inc., 16 Littell Road, Hanover, N. J. (314)



Pulse Power Amplifier Has 300-W Output

GENERAL PURPOSE pulse power amplifier is designed for flexibility in driving a variety of loads. Model

330 provides a negative output pulse, continuously variable from 0 to 12,000 v, which is amplified from a driving source. Unit is normally supplied with plug-in output transformers to match twt's, magnetrons, klystrons, h-f triodes, and other h-v pulsed devices. Average output power is 300 w, with rise-and-fall time capability faster than 70 nsec. Unit weighs 61 lb, costs $2,490. Velonex Division of Pulse Engineering, Inc., 560 Robert Ave., Santa Clara, Calif. (315)



Heat Sinks for Circuit Board Use

SERIES 2900 heat sinks were designed to be used either as natural convection heat dissipators or with forced air in very compact assemblies. Units are easily mounted and well suited for very high packing densities. In particular, they are suited for circuit board applications. They are manufactured of copper with a black ebanol surface finish. Astro Dynamics, Inc., Second Ave., Northwest Industrial Park, Burlington, Mass. (316)

Frequency Counters Are Solid-State Units

NOW being marketed are a new range of Racal frequency counters. Available are 300 Kc, 1 Mc and 10 Mc versions, together with a full range of transducers. The SA520 pictured weighs only 7 lb, and can be operated either from 117 v line or from dry cells. Price is $495. Avnet Instrument Corp., 91 Commercial St., Engineers Hill, Plainview, L. I., N. Y. (317)

Literature of the Week

TEES Microwave Development Laboratories, Inc., Needham, Mass. Catalog TH62 describes in detail more than 70 E plane, H plane and magic tees covering EIA waveguide sizes from WR10 to WR2100.
CIRCLE 318, READER SERVICE CARD

PRECISION COMPONENTS Mechatrol, a division of Servomechanisms, Inc., 1200 Prospect Ave., Westbury, L. I., N. Y., has available its 130-page 1963 precision components catalog RC 630. (319)

DRAFTING METHOD Chart-Pak, Inc., 1 River Road, Leeds, Mass. Bulletin describes Trans-Pak, a new method that gives a choice of using a dull crepe paper or ruby red transparent die cut for the making of printed circuit master drawings. (320)

DIGITAL INDICATORS Patwin Electronics, Waterbury 20, Conn. Two-page bulletin illustrates and describes series 15000 digital indicators for relay logic. (321)

PRECISION POWER SUPPLIES Power Designs Inc., 1700 Shames Drive, Westbury, N. Y. Specifications of a complete line of semiconductorized, precision power supplies are given in a short form catalog. (322)

MICROMINIATURE RELAYS General Electric Co., Schenectady 5, N. Y., announces bulletin GEA-7241A on a line of all-welded relays magnetically latched for short power pulse operation. (323)

ATOMIC FREQUENCY STANDARD STL Products, 139 Illinois St., El Segundo, Calif. Product data sheet No. 70 covers a solid-state rubidium frequency standard. (324)

SURFACE ACTIVE AGENT Medical and Pharmaceutical Developments Ltd., 2 Erringham Road, Shoreham By Sea, Sussex, England. RBS25 concentrate, for the cleansing and removal of a wide range of materials such as silicones, various polymers, tars, organic materials and radioactive contamination, is described in a leaflet. (325)

DIRECT WRITING RECORDERS American Optical Co., Instrument Division, Buffalo 15, N. Y. Short form catalog describes a complete line of direct writing recorders. (326)

CIRCUIT-BOARD DAMPER Barry Controls Division of Barry Wright Corp., 700 Pleasant St., Watertown 72, Mass., offers an illustrated bulletin describing type 19010-1 circuit-board damper for reducing vibration in circuit boards and similar plate-type structures. (327)

ISOLATED POWER SUPPLY Elcor, Inc., 1225 West Broad St., Falls Church, Va. Data sheet describes model 124-EI Isoply designed to provide the necessary outputs for powering a

chopper stabilized differential amplifier. (328)

TRIMMING POTENTIOMETERS Weston-Instruments & Electronics Division, Daystrom, Inc., 614 Frelinghuysen Ave., Newark 14, N. J., offers a technical data sheet on the 510 series Transitrim trimming potentiometers. (329)

TUNNEL DIODE MEASUREMENTS Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y., is offering a brochure, "Technical Report on Tunnel Diode Measurements." (330)

DIRECT-WRITING RECORDER Brush Instruments, division of Clevite Corp., 37th and Perkins, Cleveland 14, O. Folder contains six catalog sheets on Mark 200 direct-writing recording systems. (331)

TUBE PINCH-OFF PRESS W. A. Whitney Mfg. Co., 636 Race St., Rockford, Ill. Two-page bulletin illustrates and describes model 704 pinch-off press that cuts off and seals copper tubing simultaneously. (332)

COIL WINDING MACHINES Geo. Stevens Mfg. Co., Inc., Pulaski Road at Peterson, Chicago 46, Ill. Condensed 2-page data sheet gives primary specifications on six representative types of high production and laboratory coil winding machines. (333)

TRANSISTOR MOUNTING PADS The Milton Ross Co., 511 Second Street Pike, Southampton, Pa. Dimensional drawings and samples of the complete line of Transipads are available in a 75-page unit, catalog 28. (334)

VACUUM TWEEZER Scientific Columbus, Inc., 840 Kinnear Road, Columbus 12, O. Single-page bulletin describes a positive vacuum pickup tool for handling miniature metal, ceramic and fragile semiconductor parts and elements. (335)

COAXIAL TRANSMISSION LINES The Mectron Co., 5 Jackson Ave., North Plainfield, N. J., offers a 12-page catalog No. 300A, covering 50 ohm rigid coaxial transmission lines and fittings. (336)

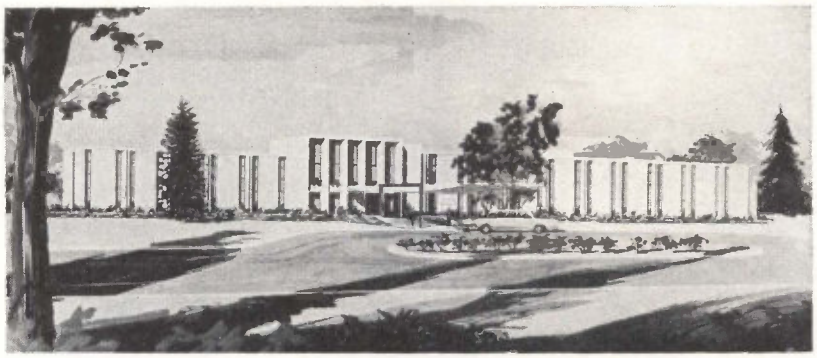
SOLID STATE RECTIFIERS Diodes, Inc., 9261 Independence Ave., Chatsworth, Calif. Data bulletin covers a line of high voltage stacked silicon rectifiers. (337)

DIGITAL VOLTMETER Industrial Instruments Inc., 89 Commerce Road, Cedar Grove, N. J. Catalog sheet describes model DVM-2 high-reliability digital voltmeter. (338)

PLUG AND SOCKET CONNECTOR Continental Connector Corp., Woodside 77, N. Y. Catalog sheet illustrates and describes series 683-40 and 683-41 right angle plug and socket connector. (339)

METALIZED CERAMIC TRANSISTOR PACKAGES Metalized Ceramics Corp., 25 Acorn St., Providence 3, R. I. Brochure describes and illustrates the MetCeram process for making metalized ceramic packages for high-reliability semiconductors. (340)

Philips Erecting Research Laboratory



GROUNDBREAKING ceremonies have been held on a 74-acre site in Briarcliff Manor, N. Y., where North American Philips Co., Inc., will build a laboratory for research and development in electronics, physics and chemistry. Since 1944, Philips Laboratories has been located in Irvington-on-Hudson, N. Y.

The new building, with approximately 80,000 square feet of work space, is scheduled for completion in 1964. In addition to areas for research and development, space will be provided for executive, administrative and patent offices, and for engineering, maintenance and employee dining. Approximately 175 persons will be employed initially.

Specific research investigations will involve magnetic and ceramic materials, thermionics, x-ray instrumentation and crystallography, semiconductors, electronic circuits, plasma physics and cryogenics. In addition, Philips Laboratories scientists conduct investigations in theoretical and solid state physics, physical chemistry and metallurgy.

Philips Laboratories also serves additional enterprises associated with North American Philips: Consolidated Electronics Industries Corp., and Philips Electronics and Pharmaceutical Industries Corp. The enlarged laboratory facilities will be an important factor in expansion plans for the two corporations.

Recent projects in which Philips Laboratories has played an active role include an x-ray diffractometer for lunar explorations, and development of a miniature refrigerator that weighs only 12 pounds and produces a temperature of below 30 K. This unit is said to hold great promise for scientific investigations and electronic applications where small, light-weight equipment to produce very low temperatures is critically important.

McBurney Joins The Deutsch Company

HOWARD MCBURNEY has joined The Deutsch Co., Los Angeles, Calif., corporate staff as a vice president concerned with the solution of production and distribution problems encountered by each of the company's five operating divisions.

McBurney spent more than 15 years with National Screw and Mfg. Co. of California where he was vice president.

Establish New Corporation

A NEW CORPORATION named Action Labs, Inc., has been formed in Minneapolis, Minn., to manufacture assemblies for builders of electronic and electromechanical equipment.

Founders are Richard Jensen, D. R. Thompson and W. R. Thurston, all of whom have held manufacturing positions with local electronics companies.

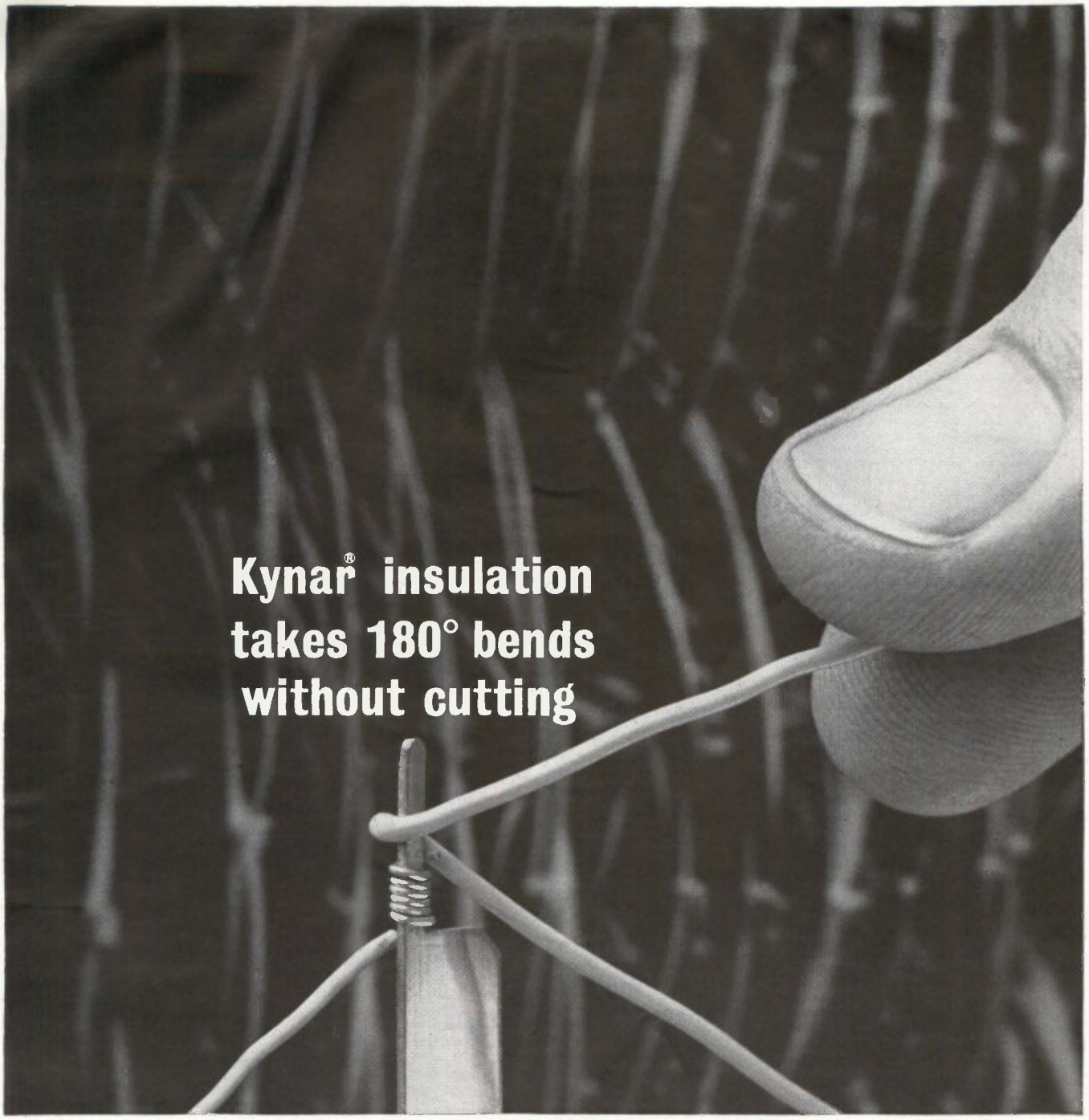
Appoint Jacques Operations Manager

GEORGE E. JACQUES has been named operations manager for the Thompson Ramo Wooldridge Microwave division at Canoga Park, Calif.

Formerly the division's engineering manager, Jacques assumes responsibility for all production, purchasing, product engineering and

Geotech Opens Data-Processing Center

SCIENTIFIC *data-processing center at The Geotechnical Corporation, Garland, Texas, will aid Project Vela-Uniform, the Department of Defense program for research into the detection and identification of underground nuclear explosions*



Now you can pull computer hookup wire around tight corners—even stretch it over sharp edges—without danger of insulation cutting through. The secret: Kynar, Pennsalt's vinylidene fluoride resin, a new high-performance fluoroplastic that's *tough!* □ Wire insulation of Kynar offers unmatched mechanical strength and toughness, even in 5-mil sections you may need for miniaturization. It cuts cleanly, strips readily, won't burn or melt. Dimensionally stable, Kynar doesn't stretch when wires are pulled. Wire insulated with Kynar has ample stiffness yet stays in place when harness is bent to shape. □ Write for our brochure and the names of leading manufacturers who supply wire insulated with Kynar. Plastics Department, PENNSALT CHEMICALS CORPORATION, 3 Penn Center, Philadelphia 2, Pa.

Kynar... a fluoroplastic that's tough!

Kynar is a Registered Trademark of Pennsalt Chemicals Corp.

Pennsalt Chemicals
ESTABLISHED 1850

quality control in the newly created post.

The TRW Microwave division manufactures and markets a broad line of r-f components for military applications.

GI Rectifier Division Hires Borneman

APPOINTMENT of Edmond H. Borneman as technical director of engineering of the General Instrument Corp., Rectifier division has been announced.

Borneman was formerly with Westinghouse Electric's Semiconductor division.

The General Instrument Rectifier division, with plants at Newark, N. J., and Brooklyn, N. Y., manufactures silicon and selenium devices.

EOS Elects Cook Vice President

LESLIE J. COOK has been elected a vice president of Electro-Optical Systems, Inc., Pasadena, Calif. He also continues in his present position as manager of the EOS Electric Propulsion Flight Test Program.

Cook was manager of West Coast operations for the Perkin-Elmer Corp., Norwalk, Conn., before joining EOS.

Lear Siegler Names Cohen

ABRAHAM L. COHEN has been named vice president in charge of engineering for the Data & Controls division of Lear Siegler, Inc., Long Island City, N. Y.

Cohen joined the Military and In-

dustrial Products Group of Olympic Radio & Television division in 1956 as systems engineering manager. He was named director of engineering in August, 1962 when the Group was merged into the new Data & Controls division.

PEOPLE IN BRIEF

Bernard M. Oliver, v-p of R&D at Hewlett-Packard, and a v-p of the IEEE, elected to board of directors of Spectra-Physics, Inc. **Lester L. Kilpatrick** resigns as president of California Computer Products, Inc., and is named chairman of the board. **Donald W. Gade,** senior v-p, is the company's chief exec officer pending election of a new president. **H. Dickinson** moves up to exec v-p and g-m of Varec, Inc., and Dynel, Inc., subsidiaries of Microdot Inc. **Norman Zachary,** formerly with General Telephone Co. of California, named a senior scientist at Operations Research Inc. Promotions at Neptune Meter Co.: **Edgar A. Gaudette** to exec v-p, and **Paul S. Wells** to v-p. **Mois Gerson** appointed v-p of United ElectroDynamics, Inc., continuing as g-m of the company's United AeroSpace div. **William H. Keppel** advances to mgr., engineering and mfg., for the Videosonic Systems div., ground systems group, Hughes Aircraft Co. **Richard W. Ehrhorn,** previously with Cal-Tech's Jet Propulsion Lab, named supervisor of advanced development for Electronic Communications, Inc. **John J. Foley,** ex-Sola Electric, now materials mgr. of the Relay div. of Leach Corp. **William A. Raatz** moves up to supervisor of the process systems section in California Research Corp.'s Richmond lab. **Gerald L. Sandberg** from Ampex Data Products Inc., to Halex, Inc., as director of thin-film microminiaturization programs. **William C. Anderson,** director of engineering, elected v-p, engineering, of Jefferson Electric Co. **Terry R. Savage** leaves IBM to join Documentation Inc. as mgr. of systems and programming.

EMPLOYMENT OPPORTUNITIES

SELLING OPPORTUNITY WANTED

Mfr' Export Reps with exc world-wide connect., on their toes around the clock, are eager to boost your sales. Aacor International, 198 Broadway, N. Y. 8, BA 7-0482.

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES

EQUIPMENT - USED or RESALE

INDEX TO ADVERTISERS

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CLASSIFIED ADVERTISING
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ADVERTISERS INDEX

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• See advertisement in the July 25, 1962 issue of Electronics Buyers' Guide for complete line of products or services.

electronics

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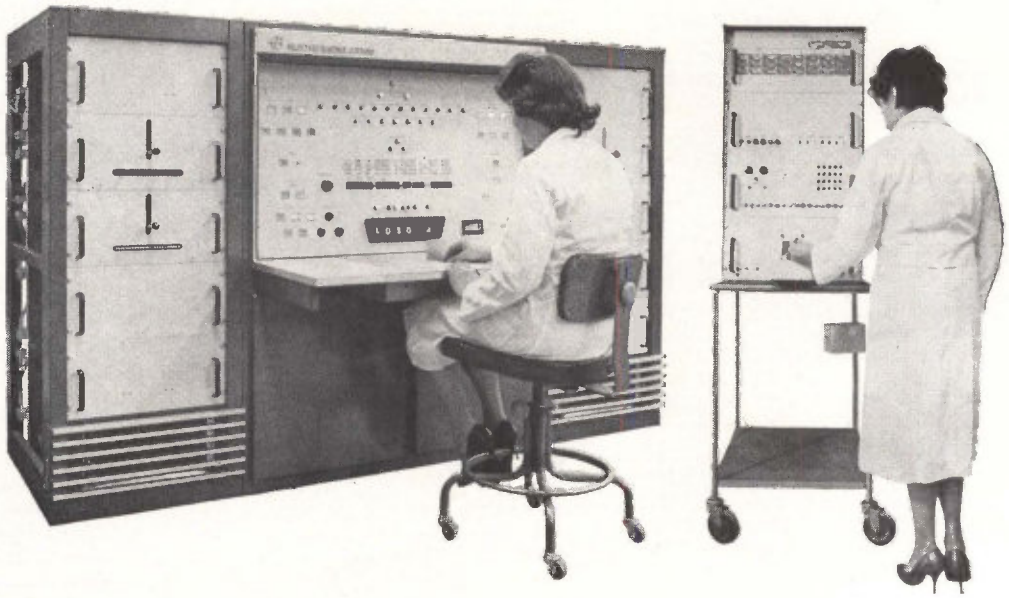
HIGH SPEED

From Fairchild—for economical volume testing



SERIES 900 Card Programmed Data Logger. All digital from test socket to readout. Performs up to 24 tests per device in any order. Completely programmed by four plastic punched cards. Self checking. Pulse testing eliminates junction heating effects to insure accuracy of high current tests. Data logger adaptable to drive recorders including typewriters, printers and tape punch systems.

SERIES 250 Go/No-go Multiparameter Tester. Tests 900 units per hour—16 variable go/no-go tests per unit. Features pulse testing. Like all Fairchild test equipment, the Series 250 can be operated by non-technical personnel after a few hours of training. Easily programmed with decade cards or fixed resistor cards. Test accuracy at 1μA: ±0.5% (±1% at 100nA). Optional priority sorting.

TESTERS

of transistors and diodes

SERIES 500 Multiparameter Tester. Quickly and easily programmed. Automatic direct digital readout with optional data logging capabilities. Readout test results are accurate to ±1%. Rugged modular construction easily adaptable to special needs and the entire system can be expanded to incorporate future tests as a safeguard against obsolescence. Features pulse testing methods.

SERIES 200 Transistor Tester/Sorter and Series 100 Diode Tester/Sorter. Automatic priority sorting. Series 200 handles 1500 transistors and Series 100 handles 3600 diodes per hour. 24 tests per device—or one test repeated 24 times. Completely programmed by four plastic punched cards. Features pulse testing. Self checks for incorrect programming and also during each test sequence.

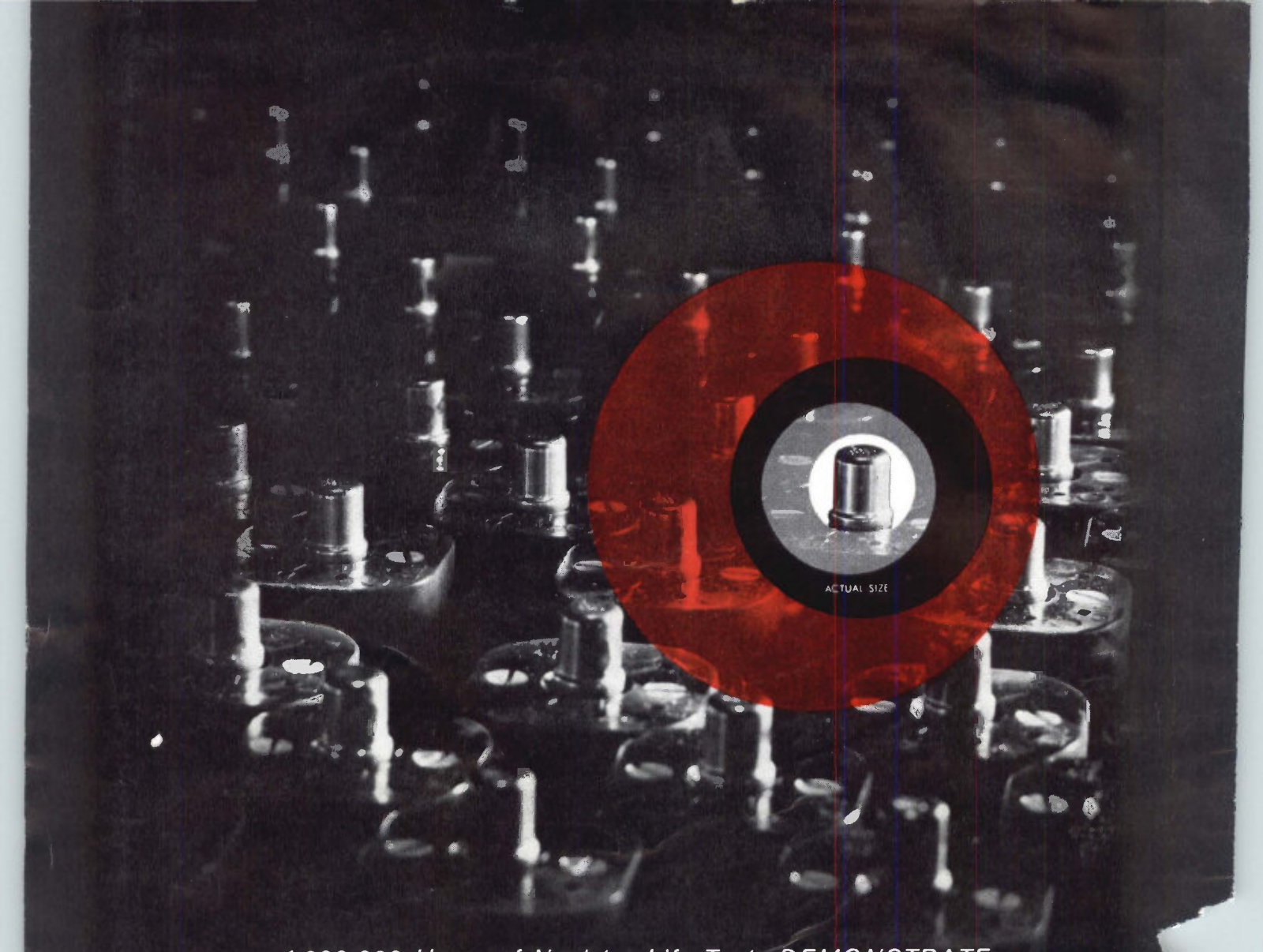
MODEL 50 Beta Tester. Tests all types of NPN and PNP transistors to an accuracy of ±1 digit or ±2%. Features pulse testing. A closed loop feedback system provides extreme circuit calibration stability and a built-in short detector protects both equipment and test units. Maximum time per unit tested: 2 seconds. Readout range: from 2 to 999, read directly. Also has data logging output cable.

Write for data sheets on the above models, or on others not shown. Fairchild has the widest selection of testers in the industry.

FAIRCHILD
SEMICONDUCTOR
(INSTRUMENTATION)

844 CHARLESTON RD., PALO ALTO, CALIF., DAVENPORT 1-8088 ■ TWX: 415-492-9414 ■ FAIRCHILD SEMICONDUCTOR, A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

CIRCLE 901 ON READER SERVICE CARD



1,600,000 Hours of Nuvistor Life Tests DEMONSTRATE:

99.53% RELIABILITY

per 1,000 hours over first 10,000 hours of operation at a

95% CONFIDENCE LEVEL

New data, from continuing tests, substantiate these exceptional reliability figures for RCA nuvistors.

1,600,000 tube hours of actual life tests on the RCA-7586 nuvistor triode have established a failure rate of only 0.47% or less per 1,000 hours—for the first 10,000 hours of operation—at a confidence level of 95%.

Furthermore, during the tests, involving 532 nuvistors, only one tube showed a reduction in transconductance to 50 percent or less of the initial value. The tests also revealed no sustained downward trend in transconductance distribution. Based on these findings, wear-out type failures should be virtually non-existent during the first 10,000 hours of nuvistor tube life.

These facts give you 95% assurance that:

- Of every 200 RCA-7586 type nuvistors in your sockets, 199 will satisfactorily complete each 1,000 hours during the first 10,000 hours of operation.
- Nuvistor characteristics are exceptionally uniform from tube to tube, and remain exceptionally stable throughout tube life.

This outstanding reliability is one more reason why you should specify nuvistors for all applicable circuitry. For technical data on specific types, see your RCA Field Representative or write: Commercial Engineering, RCA Electron Tube Division, Harrison, New Jersey.

Nuvistor Life Test Conditions		
	Test Conditions =1	Test Conditions =2
Heater volts	6.3	6.3
Heater-cathode volts	100	0
Plate volts	100	–
Plate-supply volts	–	75
Grid volts	−1.85	–
Cathode resistor—ohms	–	100
Grid-circuit resistance—megohm	0.5	0.5
Metal-shell temperature—°C	150	150
Plate dissipation—watts	1	0.75

RCA **The Most Trusted Name in Electronics**

FIELD OFFICES—EAST: 32-36 Green St., Newark 2, N. J., (201) 485-3900 • MIDWEST: Suite 1154, Merchandise Mart Plaza, Chicago 54, Ill., (312) 527-2900 • WEST: 6801 E. Washington Blvd., Los Angeles 22, Calif., (213) RAymond 3-8361 • 1838 El Camino Real, Burlingame, Calif., (415) 697-1620