

electronics

DECIMAL COUNTER

*Diode matrix cut
from wafer, p 51*

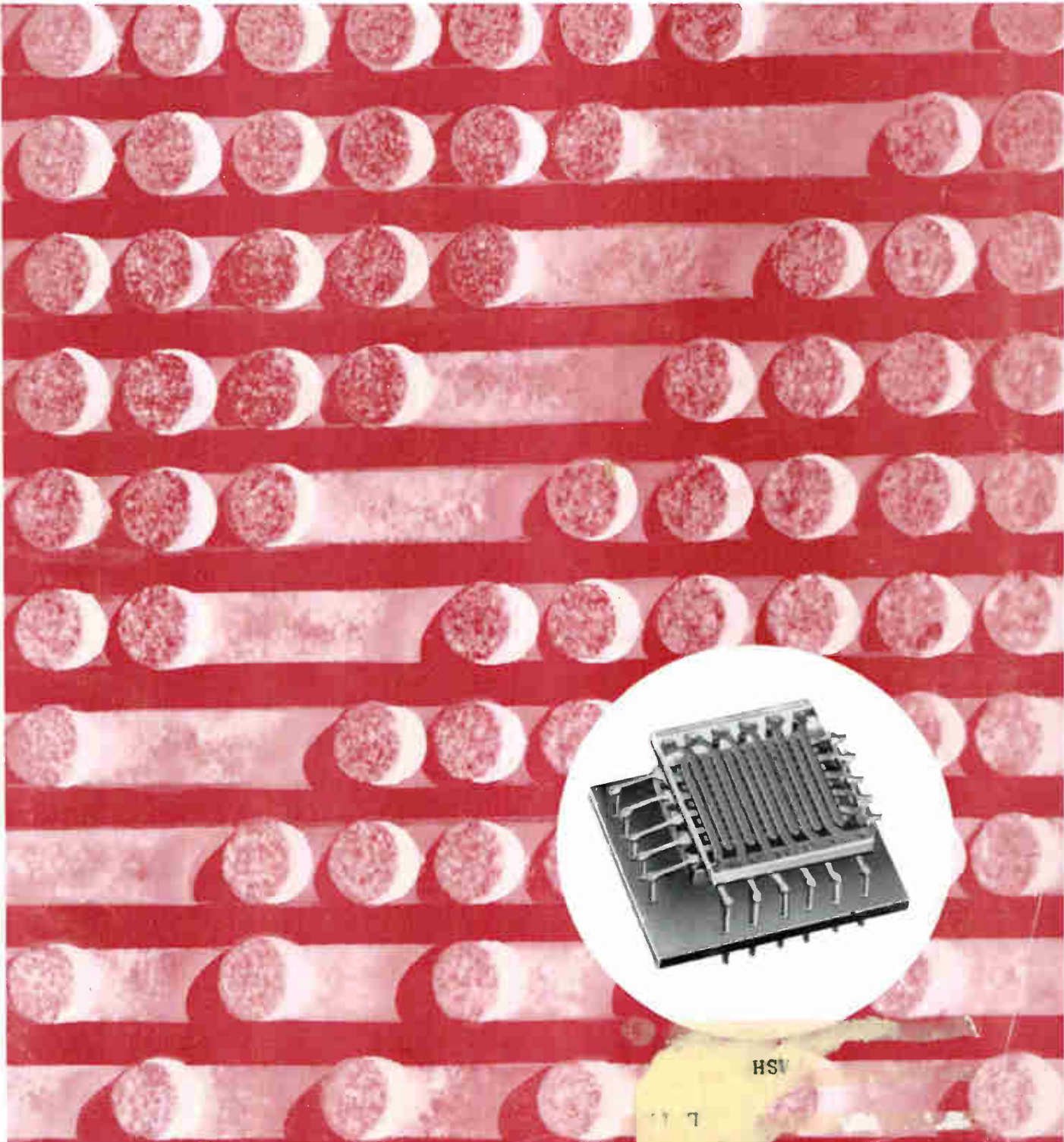
Photo below

TAPE STORAGE

*Fifty-two analog
channels, p 45*

ANALOG MULTIPLIER

*Magnetic pulse-time
modulation, p 55*





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NINETY-DIODE MATRIX in a 9-by-10 array is key element in a miniature decimal counter. A silicon slice 1 in. in diameter and 0.01 in. thick is diffused and individual diodes machined from it in the desired pattern. Then circuit boards (inset) are attached top and bottom. *Here's the trick in making it: the silicon slice is glued to a glass plate as the diode pattern is cut. Then the top plate is soldered in place and the glue dissolved so the bottom plate can be soldered on.* See p 50 **COVER**

LASERS PUMPED by Sun and Exploding Wires. Short, high-power pulses result when capacitor bank discharges into wire. *Focused sunlight is a feasible laser power source in space* 24

MISSILE RANGE INSTRUMENTATION R&D Still Faces Many Unsolved Problems. More accurate tracking and evaluation techniques are needed. *Also required: underwater equipment* 32

NEC REPORTS on Illinois R&D. Survey shows area lags in ratio of research to electronics production. *A bright spot: companies want to do something about it* 33

ARMY COMPUTER Matches the Biggest in Size and Speed. Its 72-bit, 4,096-word memory cycles in 1.5 μ sec. *Included in the report is a computer family tree* 34

ION ENGINES OUTGROW THEORY. Electric propulsion engineers are now working on nuts and bolts. *First flight test may be this year* 36

MAGNETIC-TAPE STORAGE of Wideband Analog Data. Problem was how to store 52 channels of analog information with each channel 15 Kc wide on magnetic tape without using 52 heads. The answer was to use only two heads and a time-division multiplex system to sample the analog channels. The author compared several pulse-modulation schemes and settled on pulse-amplitude modulation. *The circuit uses two cascaded delay lines since a single line with adequate tolerance was not available.* By M. H. Damon and F. J. Messina 45

DIODE MATRIX Shrinks Decimal Counter. The 90-diode matrix is used to form feedback paths for 10 transistor amplifiers that are, in turn, driven by a flip-flop. The result is a decimal counter that measures only 1.15 by 1.35 by 1.25. *Output of the transistors drives a glow-type decimal indicating tube.* By R. W. Wolfe 51

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Audited Paid Circulation

CONTENTS continued

NOISE-FREE Keying Circuit. Here is a way to switch audio signals without introducing noise or transients. Rise and decay time is approximately 100 msec for a 60-db change in signal output level. *The tube's grid bias network includes two photoresistors in a light-tight box with a lamp bulb. Lighting the lamp switches the tube.* By A. Martens 53

ANALOG MULTIPLIER Uses Pulse-Time Modulation. This so-called rectangle multiplier consists of a self-saturating magnetic amplifier and a transistor switch driver. *Voltage fed back through an auxiliary switch to a feedback winding on the modulator helps achieve an accuracy of 1 percent of full scale.* By W. R. Seegmiller 54

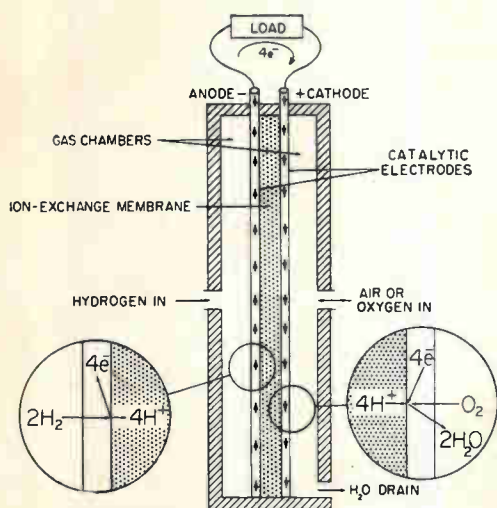
GIVING 111-KV BOOSTS to a Van de Graaff Generator. When a 3.6-Mev Van de Graaff was used to inject a proton beam into the Brookhaven Cosmotron, current drain caused an undesirable energy decay. The solution was to boost the Van de Graaff output during the injection pulse. *It is done with an octupler power supply and a 150-Kv pulser.* By E. J. Rogers 58

OVERLOAD PROTECTION With a Low-Power Transistor. This protection circuit detects excessive current and reduces output voltage proportionately. It is inoperative until a preadjusted current level is attained. *It makes up for one of the shortcomings of a zener-diode stabilizer.* By C. Yarker 60

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CROSSTALK



POWER SOURCES. For years, portable electronic equipment has depended on batteries and small generators for power. These have been augmented in recent years by thermoelectric generators, nuclear-fueled power sources, solar cells and other devices, all part of the search for more watts per pound, longer life and less maintenance.

One of the newer and more promising power sources are fuel cells, which combine some aspects of both batteries and generators. Like batteries, fuel cells produce energy from a chemical reaction. But the ingredients, fuel and oxygen, need be added only as power is required. In this respect, fuel cells are like engine generators.

There are many approaches to fuel cell design. Fuel may range from organic compounds to gases. Illustrated is a GE design for an oxy-hydrogen cell. One of the subsidiary uses for this class of cell is as a self-powered oxygen monitor. If it is fed only hydrogen, the electrical output indicates the amount of oxygen in, say, a spaceship cabin.

Note the water drain at the bottom of the cell. It has been suggested that fuel cells be used on spaceships because they could supply not only power, but fresh water for the crew. Or, the water might be broken down into refueling gases for the cell.

An interesting power source is the human body. Researchers are attempting to get enough

electricity out of people to operate miniature biological monitoring devices.

And, taking their clue from animal processes, battery developers are trying to duplicate in biochemical cells the energy-producing reactions of the body.

We could go on about all the other types of power sources now in use and in development. But that would take eight pages—the length we've assigned to a really thorough roundup of power sources next week.

The author is David Linden, of the U.S. Army Signal R&D Lab at Fort Monmouth. He has written a full-scale updating of a report on power sources that he coauthored in our issue of March 20, 1959.

CHANGING BANDS Recently, we received from Hallicrafters a complimentary copy of a large wall chart showing in color all the electronic countermeasures spectrum. We were startled to see the radar band designations all changed around.

Should we throw out the old bands (p 58, June 2, 1961) and publish an article about the new ones? Cooler heads prevailed. A copy of the pertinent military regulation (AFR 55-44) was obtained. The bands are only different for ECM purposes.

This little incident makes us sympathetic to the problems facing missile range instrumentation people (p 32, this week). On top of all their other worries, they'll have to vacate the vhf telemetry bands and move into higher frequencies during the next several years.

ANOTHER FIFTY. This is the year for golden anniversaries in radio. The IRE celebrated theirs a few days ago at a banquet. In the fall, a group of organizations will throw a party for amateur radio operators licensed 50 years.

All hams who can prove they were licensed in the first year of the Radio Act of 1912 and who are still active today are eligible for awards at a banquet to be held in New York October 12. Proof should be sent John Huntoon, ARRL, West Hartford, Conn., before August 15.

The banquet is sponsored by ARRL, AFCEA, IRE, QCWA, HARC, SSBARA and Radio Club of America.

500kc to 100mc

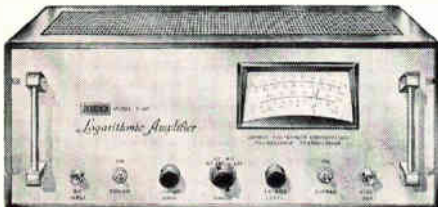
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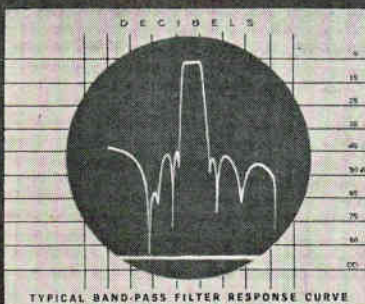
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COMMENT

Negative-Resistance Diode

Mr. Barry C. Dutcher has kindly pointed out an error in my mathematical analysis given in the article, Negative-Resistance Diode Handles High Power (p 44, Aug. 25, 1961). The corrected analysis leads to the prediction of modes of operation impossible for a device of this kind.

The model upon which my analysis was based was in error, and this error, combined with the error in the sign of β under the radical in the solution for s , leads to results which were substantially correct.

The proper model is not new, but the reason for its use is sufficiently subtle to excuse a few words of explanation.

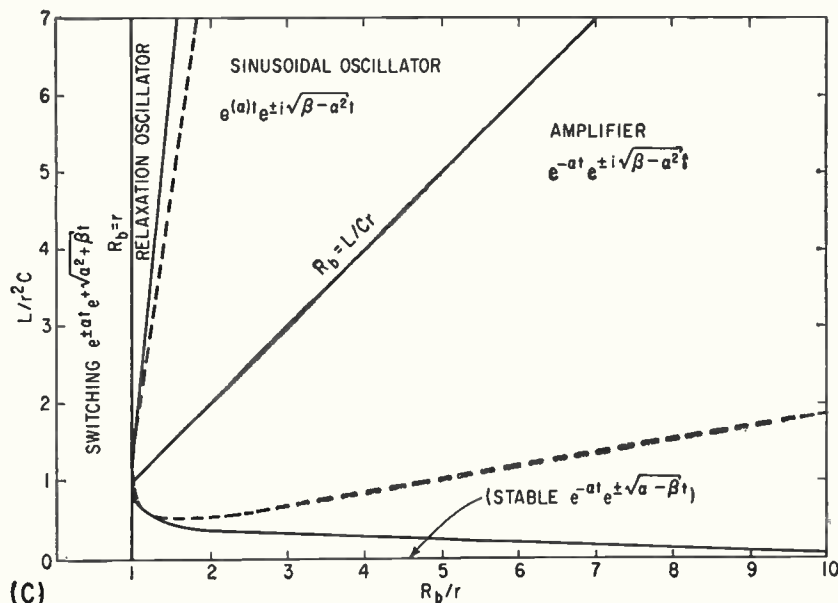
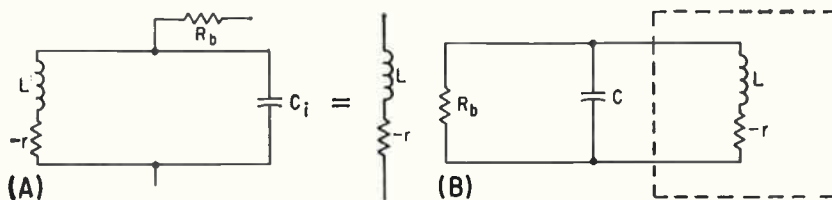
While a capacitive reactance C_i can be measured in shunt with the junction, this is not the phase-shifting element of the device in the active region. A current-controlled device having a negative resistance represents a phase shift which is inductive in nature. This can most readily be seen by considering the device operating with a small value of load resistance so that it functions as a switch. As the peak or

turnover point is reached, the device will switch at constant current to some high voltage and then decay to the stable current value. That is, the voltage leads the current, as through an inductor. The external reactance necessary to produce unstable conditions is then capacitive, the equivalent circuit becomes as Fig. A below, and the circuit to be analyzed becomes as Fig. B. The analysis proceeds in the same fashion as that in the original article to produce the new stability relations which are shown as the solid lines in Fig. C. The dotted lines are the old stability relationship. The same two dimensionless ratios are used because the reactance is still related directly to the quantity L/r^2C . In the active region the correct curve is remarkably similar to the old curve.

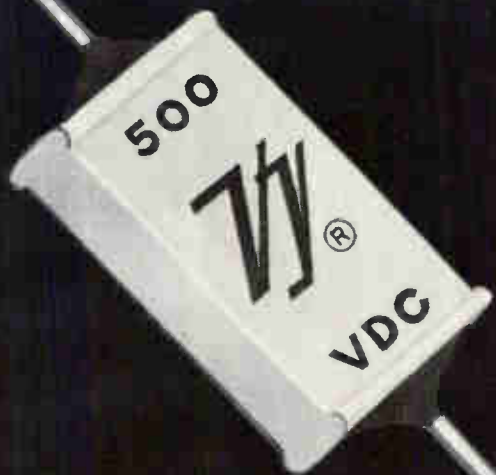
The experimental data fits both curves about equally well. Results and interpretations are unchanged at high frequencies, but a capacitor is necessary to obtain oscillation at low frequencies. I wish to thank Mr. Dutcher for his information on his results which caused me to re-examine the premise on which my analysis was based.

A. P. SCHMID

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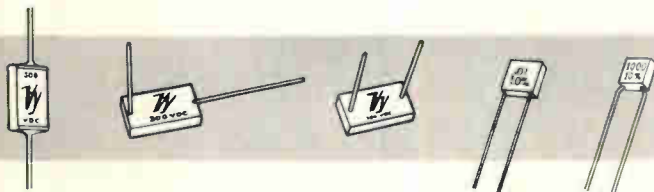
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Transient Voltages... Cause and Cure

A transient voltage can be generated whenever a magnetic component is energized, or de-energized. The peak amplitude of the spike can be many times the normal steady state peak inverse voltage, and is dependent on the amount of magnetic energy stored in the circuit and the rate of change of the collapse of the resultant flux field.

The amount of magnetic energy stored in various circuit reactances can be approximated by $L \frac{I^2}{2}$, and this energy, when current is interrupted can produce a voltage equal to $L \frac{dI}{dt}$. It is apparent, therefore, that under severe load or overload conditions, a high level transient voltage with substantial energy can be generated.

In actual applications, transients are generated mainly through interruption of current by switching, although circuit characteristics and phenomena can contribute to the problem. Full advantages to be gained from silicon rectifiers are available only if they are properly applied and protected. Silicon rectifiers have low inverse voltage capabilities and thermal capacity, so any overvoltage condition, even for a few microseconds, can destroy the junction. The circuits illustrated are typical of those where problems have been found.

In addition to the three most common causes, less obvious circuits and phenomena can generate transients. Among these are minority carrier recovery, switching magnetic amplifiers, lightning or random line conditions and motor regeneration.

The problem of computing C or RC filters is complicated because of the possibility of changing circuit operating parameters or causing oscillation.

Tarzian's recently developed line of "klipvolt" selenium transient voltage suppressors, therefore, offers a relatively low cost, simply applied method of positive protection. In many applications, a "klipvolt" suppressor will reduce overall circuit cost and increase reliability. The accompanying table covers the important design factors

of voltage and current that govern typical application of suppressors; however, special designs and ratings are available on request. There are two basic types of suppressors, the non-polarized for use primarily across AC components, and the polarized for use in DC load circuits. In some instances, however, it may be preferable to use non-polarized suppressors in output circuits for more positive clamping or non-interference with circuit timing or operation.

Switching in Primary—Transients are caused by interruption of "magnetic" current, or by energizing the primary and causing oscillation between inductance and distributed capacity.

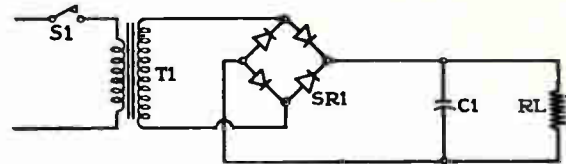


FIGURE 1

Switching Load—When the load is switched, the magnetic energy stored in the input circuit generates a voltage across the rectifiers and switch.

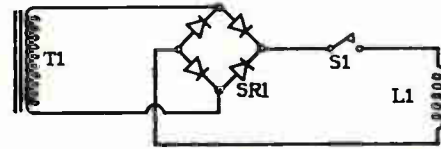


FIGURE 2

Magnetic Components on Common Line—Other magnetic components like motors, solenoids, relays or breakers can generate a transient peak when input is interrupted. The generated voltage will appear across the rectifier.

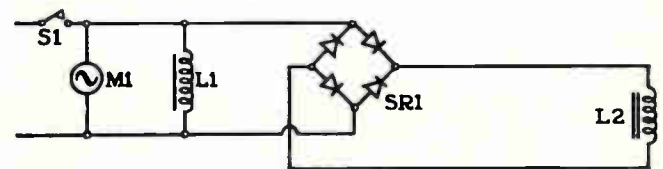
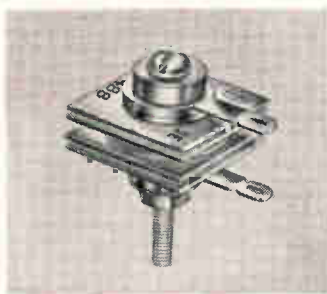


FIGURE 3

TYPICAL *klipvolt* SUPPRESSORS—SINGLE PHASE



DC LOAD CURRENT		0-35	36-55	56-100	101-110	110-200	201-350
PIV	RMS VOLTS	AMPS	AMPS	AMPS	AMPS	AMPS	AMPS
50	35	S-487	S-487A	S-487B	S-487A	S-487B	S-487C
100	70	S-488	S-488A	S-488B	S-488A	S-488B	S-488C
200	140	S-490	S-490A	S-490B	S-490A	S-490B	S-490C
300	210	S-492	S-492A	S-492B	S-492A	S-492B	S-492C
400	280	S-493	S-493A	S-493B	S-493A	S-493B	S-493C
500	350	S-494	S-494A	S-494B	S-494A	S-494B	S-494C
600	420	S-495	S-495A	S-495B	S-495A	S-495B	S-495C

TYPICAL THREE PHASE SUPPRESSORS

DC LOAD CURRENT		0-60a		61-115a		116-200a		201-450a	
PIV	RMS VOLTS	H.W.	BR	H.W.	BR	H.W.	BR	H.W.	BR
50	35	S-539	S-539	S-539	S-539A	S-539A	S-539B	S-539B	S-539C
100	70	S-540	S-540	S-540	S-540A	S-540A	S-540B	S-540B	S-540C
200	140	S-542	S-542	S-542	S-542A	S-542A	S-542B	S-542B	S-542C
300	210	S-544	S-544	S-544	S-544A	S-544A	S-544B	S-544B	S-544C

Note: All types without suffix letter use plates 1" square; with "A"—1¼", with "B"—1.6"; and with "C"—2" square. Length depends on voltage rating and varies from 1¾" to 4¾".

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ELECTRONICS NEWSLETTER

policy has affected about \$100 million in spare parts, mostly aircraft, with reductions from original prices ranging from 31 to 75 percent.

British Group Proposes Satellite Net

LONDON—A \$600 million plan for worldwide telephone communication via nine satellites in equatorial orbit has been submitted to the British government by an industrial consortium of 11 major British firms, called the British Space Development Co.

After a 12-month survey and expenditure of \$300,000, BSDC estimates that a network of nine satellites in a 6,000 to 9,000-mi-high orbit and 16 major ground stations could provide 500 duplex telephone channels by 1968-1970. Later developments would extend capacity to 2,000 channels plus tv links.

Preliminary financial estimates based on a \$2.80 a minute tariff anticipate an operating revenue of \$50 million by 1970. Revenue would rise to \$140 million by 1980. Total profit for the first 18 years is estimated as high as \$1.4 billion dollars.

BSDC proposes to finance capital cost by investment of industrial firms plus assistance of British and Commonwealth governments. Among members of BSDC are Associated Electrical Industries, Decca Radar, Elliott Automation, Pye Radio and Television, and Rolls Royce. The proposal is likely to be discussed in April at the Commonwealth Satellite Communications Conference in London.

NATO Decides to Make U.S.'s Bullpup Missiles

PARIS—United Kingdom, Denmark, Norway and Turkey have decided to participate in NATO-sponsored European production of the Martin Bullpup, a radio-commanded air-to-ground missile. The U. S. will provide technical aid and reportedly may procure some of the European-built Bullpups.

This will be the third missile program sponsored by NATO. Five nations have joined a \$500 million program for Hawk and nine nations are producing \$40 million in Sidewinders. Bullpup expenditure will reportedly be similar to Sidewinder, but could grow if other nations, notably West Germany, join in.

NATO sources declined to say

that Bullpup has been selected over Nord Aviation's AS-30. It was pointed out that the British have ordered both missiles and that Nord is expected to sell the AS-30 to other NATO members.

Most NATO nations are also participating in an effort to establish an advanced air-to-surface missile.

Pentagon Spreads Around Its Spare-Parts Orders

WASHINGTON—Defense Department reports progress in its drive to expand contract competition. During July-December, 1961, 40 percent of contracts were let after advertised bidding, informal or negotiated price competition, or design competition. The rate was 37 percent in the previous six months.

Emphasis is on replacement spare parts, normally bought in the past from the original producer. The policy is now to seek new sources of supply through price competition. The Pentagon says the new

Teaching Machine for Languages and Mathematics

CHICAGO—McGraw-Edison expects to start deliveries later this year of a machine to teach languages and mathematics. Touching keys on a specially adapted computer readout typewriter causes automatic pronunciation of the selected symbol and display of characters, words and sentences on a display with an automatic pointer.

The device will also deliver audible explanations and read stories and can be set so that only correct keys will respond to a child's touch.

It was developed in collaboration with Omar Moore, Yale University behavioral scientist. Used at a laboratory school in Hamden, Conn., the device has assisted children, 2½ to five years old, to read, spell, write and pronounce up to several hundred words after using it a half hour daily for 16 to 33 weeks.

Six Firms Vie for Air Traffic Control Contract

BOSTON—Air Force Electronic Systems Division has invited bids for its Emergency Mission Support system from Collins Radio, Hazeltine.

U. S. Hopeful for Space Concord with USSR

WASHINGTON—Reaction here to the Kennedy-Khrushchev exchange of letters on space cooperation is one of guarded optimism. The Soviet offer centers around areas where the U. S. clearly has the lead over the Soviets—in communications, meteorological and scientific satellites (the USSR has just announced a new series of scientific satellites).

Considerably less cooperation is offered for deep space exploration and manned lunar expeditions that would involve the big Russian boosters. Joint efforts on this front would expose the boosters to U. S. evaluation and indicate the reliability of Soviet missiles. Khrushchev said prospects hinge on disarmament agreements.

Meanwhile, negotiations are underway at the United Nations between Hugh L. Dryden, for the U. S., and A. A. Blagonravov, for the USSR. The U. S. attitude is described as hopeful optimism

Lockheed, North American Aviation, RCA and Westinghouse Electric. The air-transportable, all-weather, air traffic control system is to be operational in 1963. Bids are due next Tuesday.

Digital Controls Run Fast-Drafting Machine

CLEVELAND—Orthomat division of Universal Drafting Machine Co. will show a numerically controlled drafting machine at the ASTME Show here in May. The machine, which uses digital circuits rather than analog-digital, is reported to draw at a rate of 200 in. a minute, with tolerance of 0.005 in.

One feature is a transducer which controls the stylus movement according to 1-mil taped command pulses and also reads out the stylus' absolute position with reference to a predetermined point. Absolute position is displayed continuously within 0.001 in. on the control panel.

Electron Beam Seen as Key To Dense Storage of Data

BOSTON—Electron beam storage and readout are seen achieving the "giant step" needed for microspace information storage, according to a report scheduled for presentation yesterday at the Fourth Electron Beam Symposium.

S. P. Newberry, of GE, says that a writing beam can be at least 100 times smaller than optical, magnetic or mechanical means. Advantages include: no perceptible inertia, direct readout into electrical signals, 25 times greater depth of focus and greater energy density, permitting higher writing and storage speed.

GE researchers' design goal is 10^{10} bits per sq cm, recorded on a solid surface, Newberry reports.

Gaps in Radar Tracking Are Bridged by Computer

AIR FORCE has placed in operation at Cape Canaveral and Ascension Island a real-time data handling system to improve radar tracking along the 5,000 mi Atlantic Missile

Range. Stored trajectory information, tracking data transmitted from Cape Canaveral and radar tracking data available at Ascension Island are combined. The system issues a series of predictions to help other radar stations lock on and track missiles or satellites. Tracking information is also converted for transmission back to Cape Canaveral.

The system is expected to provide more accurate data, especially during periods of radar blackout as in missile reentry. The system includes Univac's recently developed 1206 real time military computer and converters, buffer units and data recorders by Milgo Electronic Corp., Miami.

System Monitors Nuclear Weapons Test Circuits

BOSTON—Edgerton, Germeshausen & Grier reports development of a pulse-duration modulation system to monitor status of circuits between control point and detonation site during proposed nuclear weapons tests in the Pacific. The company says it will radically reduce complexity of cabling and increase reliability.

EG&G is responsible for the countdown system to trigger hundreds of recording and analysis instruments before a nuclear device is detonated, and for gathering blast and post-blast data.

Thermionic Converter Uses Liquid Cesium Collector

MORE THAN 30 watts of power have been obtained at 1,500 C in a thermionic converter under development at Thermo Electron Engineering Corp., Waltham, Mass. The collector is liquid cesium instead of a solid.

A cesium vapor barrier forms between emitter and collector, allowing the emitter to be any shape. Evaporated emitter material, such as uranium carbide, does not collect on the liquid surface.

The company plans to build a converter which will continuously produce practical amounts of power. One use would be direct conversion of heat to electricity in a reactor core.

In Brief . . .

NATO AND SHAPE are sponsoring a laser symposium next week at The Hague, Netherlands. Attendance is by invitation only.

GENERAL PRECISION is buying out Royal McBee's interest in Royal Precision. Royal McBee gets \$5 million.

STATE FARM MUTUAL is renting 37 IBM 1401 and 1410 computers worth \$21 million for its home and regional offices.

SUBCONTRACTS on the CENTO nations communications net include \$1.2 to Collins Radio, multiplex equipment at 23 stations, and \$1.1 million to Onan division of Studebaker Packard, 267 generator sets.

PHILIPS, Netherlands, will build Ghana's telecommunications net and radio station. First year's cost is 30 million guilders.

BAILEY METER will engineer and make \$2 million control system for AEC's Hanford atomic works. Also, company sold 300-input, computer-based, information system to a Cleveland utility.

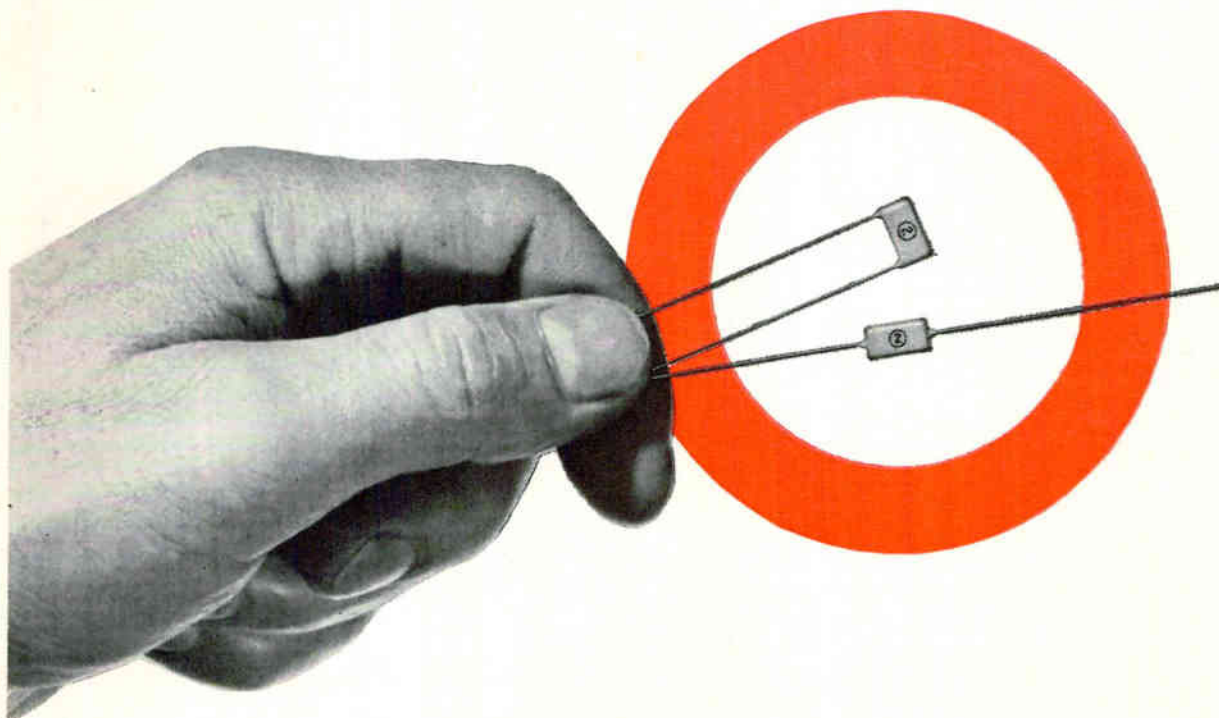
AIR FORCE SAC will have clock system independent of external calibration. System's frequency generator will be a National Co. Atomichron.

RADAR contracts include \$4.75 million to Ryan, target augmenters for Firebee system; \$600,000 to Servionics, target simulators; \$230,000 to GE, Mistram antennas.

MISSILE system component orders include \$1 million to Emertron, classified items; \$750,000 to Transitron, semiconductor devices; \$750,000 to American Electronics and \$425,000 to Varo, generators; \$175,000 to Kearfott, flight control parts.

OTHER MILITARY contracts are \$1.6 million to RCA, missile test equipment; \$400,000 to Tracerlab, nuclear survey meters; \$259,000 to Rixon Electronics, teletypewriter multiplexers; \$100,000 to Dorsett Electronics, missile test telemetry equipment; \$100,000 to Leach, tape recorders.

New from Sprague!



N030 MONOLYTHIC[®] Ceramic Capacitors **offer unparalleled size and circuit stability**

|| Here is a new kind of capacitor . . . with a combination of stability, weight, and size advantages never before achieved in a "compact" capacitor!

|| Layer-built by a unique automated process, MONOLYTHIC Ceramic Capacitors exhibit extremely low capacitance change with temperature (about one-fourth that of comparable capacitors using other dielectrics). Their special construction also permits a new order of compactness—MONOLYTHICS pack more capacitance per unit volume, resulting in substantial reductions in size and weight.

|| In addition to single-section capacitors, MONOLYTHICS can also be obtained as multiple-section units, allowing circuit designers to replace several conventional capacitors with a single compact device. The availability of these tiny yet highly stable units with either axial or radial leads offers further flexibility to the circuit design engineer.

|| Cumulative test data prove the low failure rate of these epoxy or phenolic coated capacitors in service—established by thousands of life, moisture resistance, shock, and vibration tests.

For application engineering assistance without obligation, write to Commercial Engineering Section. For complete technical data, write for Engineering Bulletins to Technical Literature Section. Sprague Electric Company, 35 Marshall Street, North Adams, Mass.

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March 30, 1962

CIRCLE 9 ON READER SERVICE CARD 9

three
10 cm
oscilloscopes
with following
features:

- calibrated amplifiers
- calibration voltages for adjustment of the amplifier available
- calibrated sweep speeds
- stable and sensitive triggering
- modern design and good accessibility
- suitable for all normal mains supplies
- delivered with a complete set of accessories and a manual with operating- and service instructions



X-Y Oscilloscope, type GM 5639

Both amplifiers

Bandwidth: 0 - 1 Mc/s (-3dB).
Sensitivity: Y-amplifier 100 mV/cm,
X-amplifier 200 mV/cm.
Attenuation: up to 50 V/cm in 9
calibrated steps, accuracy 3%, con-
tinuous adjustment to at least
150 V/cm. Relative phase shift: less
than 2° for frequencies up to 1 Mc/s.

Time Base

Sweep speeds: 2 μ sec/cm -
100 msec/cm in 8 calibrated steps,
accuracy 5%.

Trigger facilities

Internally or from an external source
for pulse repetition frequencies up
to 1 Mc/s, adjustable trigger stability.

Cathode ray tube

10 cm flat-faced tube with 2 kV ac-
celerating voltage. Different grati-
cules for curve tracing and phase
measurements are supplied
with the instrument.

PHILIPS *electronic measuring*

Sold and serviced by Philips Organizations all over the world

Further information will gladly be supplied by:

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

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



HF Oscilloscope, type GM 5601

Vertical Amplifier

Bandwidth: DC - 5 Mc/s (-3dB).
Sensitivity: 100 mV/cm - 5 V/cm in 6 calibrated steps, accuracy 3%, continuous adjustment to at least 15 V/cm. Input impedance: 1 M Ω in parallel with 35 pF. An attenuator probe 10 : 1 is delivered with the instrument.

Time Base

Sweep speeds: 0.5 μ sec/cm - 200 msec/cm in 18 calibrated steps, accuracy 3%. Magnification: 5 x, accuracy 5%.

Trigger facilities

Up to 1 Mc/s, internally, externally, or line frequency with adjustable trigger level and stability control.

Cathode ray tube

10 cm flat-faced tube with 3 kV accelerating voltage.



LF Oscilloscope, type GM 5606

Vertical amplifier

Bandwidth: DC - 200 kc/s (-3dB).
Sensitivity: 10 mV/cm - 50 V/cm in 12 calibrated steps, accuracy 3%, continuous adjustment to at least 150V/cm. Input impedance: 1 M Ω in parallel with 40 pF.

Time Base

Sweep speeds: 2.5 μ sec/cm - 1 sec/cm in 18 calibrated steps, accuracy 3%. Magnification: 5 x, accuracy 5%.

Trigger facilities

Up to 200 kc/s, internally, externally or line frequency with adjustable trigger level and stability control.

Cathode ray tube

10 cm flat-faced tube with 3 kV accelerating voltage.

instruments:

quality tools for industry and research



WASHINGTON OUTLOOK

PURCHASE RULES TO GIVE MORE INCENTIVES

ARMED SERVICES Procurement Regulations have been revamped to allow higher profits for contractors who assume greater financial risks, cut costs, beat delivery dates, or improve performance and reliability. But there'll be penalties—lower profit allowances—for contractors who exceed target costs or otherwise fall short of contract requirements. The changes reflect Defense Secretary McNamara's aim for a "closer relationship between a company's performance and its profit on a defense contract."

Specifically, the new rules will mean increased use of firm fixed-price contracts, less dependence on cost-plus-fixed-fee contracts in major weapon development projects, greater use of incentives in fixed-price and cost-reimbursement contracts, broader range of fees on cost-plus contracts, and a larger contractor share of savings on incentive contracts.

Cost-plus-fixed-fee contracts, now accounting for about 37 percent of all orders, have been criticized for not curbing mounting development costs. Plans are to restrict them to research and other situations where objectives cannot be closely defined.

SCIENCE AGENCY SOUGHT

THE WHITE HOUSE proposes to set up an office of science and technology. The proposal must be approved by Congress. The new agency would presumably be headed by Jerome W. Wiesner, the President's science adviser. It would coordinate government-supported scientific projects and would take over some of the responsibility for national science policy now held but not fully used by the National Science Foundation.

The new agency would have the same relationship and responsibility to the President and to Congress as the Council of Economic Advisers and the Budget Bureau. This would bolster Wiesner's political stature and the role of scientists in federal policy making.

BOMBER FUNDS NOW OPTIONAL

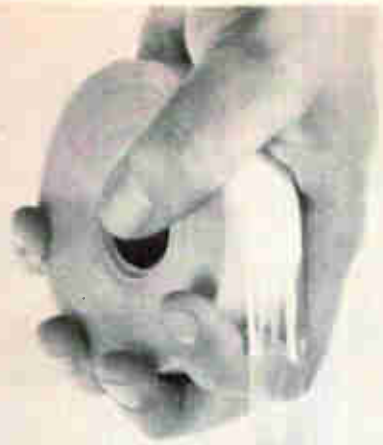
IN A FACE-SAVING MANEUVER to get both the administration and Congress off the hook, the House Armed Services Committee toned down its weapons authorization bill which had "directed" the Defense Department to spend \$320 million more than it wanted for B-70 development next year. Now, expenditure of the extra money is authorized, but not mandatory.

In return, the administration promises to make a "new study . . . of technological developments" to see whether the project can be fruitfully accelerated. Air Force plans a detailed reevaluation of the B-70—RS-70, now—within the next month. It will again propose additional prototypes, plus a stepup in electronic subsystems development.

Pentagon insiders bet that McNamara—with the President's approval—will again reject Air Force recommendations. Even after Air Force began its new study, McNamara doubted that Air Force could make an impressive argument for expanding RS-70 development work. McNamara is skeptical of potential development of high-resolution, side-view radars and other subsystems for the reconnaissance-strike version.

CHECK ON HEARING AID PRICE

SENATE ANTITRUST and Monopoly Subcommittee says it has received numerous complaints about high prices for electronic hearing aids, and is conducting a preliminary investigation into pricing practices. A questionnaire was sent to most major U. S. makers of hearing aids. A final decision on whether to hold a hearing will not be made until analysis of the response is completed.

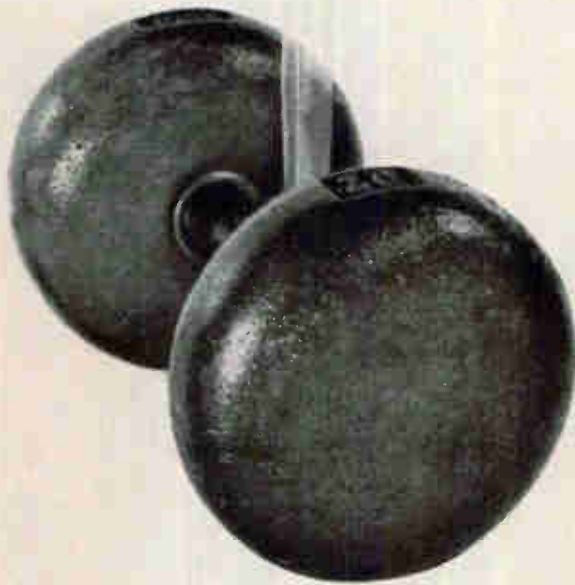


SAVE SPACE WITH THIN, EXTRA-STRONG ELECTRICAL TAPES OF MYLAR®

Here's a pressure-sensitive tape that packs great strength into thinner gauges (20,000 psi for 1 mil). Tape of Mylar* polyester film saves space because manufacturers can use thinner gauges with no loss in performance... at lower cost per linear foot.

Want more? "Mylar" also provides —flexibility for snug wraps—high dielectric strength (4,000 v/m†)—dimensional stability at high humidities —moisture and chemical resistance —resistance to temperatures from -60°C to 150°C. And "Mylar" lasts and lasts because there's no plasticizer to dry out with age.

Insulation of "Mylar" gives motors 50 to 100% longer service-free life. Gives capacitors longer-lasting stability, greater reliability. In a wide variety of electrical applications, the advantages of "Mylar" can improve the performance, lower costs. Evaluate "Mylar" for your product. Write for free booklet (SC) detailing properties. Du Pont Co., Film Dept., Wilmington 98, Delaware.



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BETTER THINGS FOR BETTER LIVING
... THROUGH CHEMISTRY



*Registered Du Pont trademark.
†ASTM D-149



NEW INSTRUMENTS and COMPONENTS from PRD!



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1. PRD N680 Calorimetric Power Meter 2. PRD 668 Peak Power Meter 3. PRD 809-A Klystron Power Supply 4. PRD 277-B Standing Wave Amplifier 5. PRD X712 Signal Source 6. PRD 904-A Noise Generator 7. PRD S712 Signal Source 8. PRD 279 Ratiometer 9. PRD 650-C Microwave Power Meter 10. PRD 4000 Series Waveguide Switches 11. PRD 6608 Bolometer Mounts 12. PRD 3302 Calibrated Susceptances (For PRD 219) 13. PRD 232 & 233 Slotted Line and Carriage ...and many, many more! Send for data! PRD Electronics, Inc., 202 Tillary St., Brooklyn 1, N. Y.

MORE POWER TRANSISTORS FROM BENDIX

90 NEW TYPES!

This newly expanded line of Bendix Power Transistors is especially valuable for use in DC-DC converter and DC-AC inverter circuits and for switching up to 400 watts as drivers for relays, relay replacements, solenoids, magnetic clutches and other high current applications. Characteristics of typical types are listed in the table below. Included in the expanded line are power transistors which offer unusually flat beta curves for less amplifier distortion, increased current gain (up to 200 at 3 Adc), and increased power ratings. Each power transistor is 'Dynamically Tested,' an exclusive Bendix quality control process that tests each unit to assure uniformity and maximum reliability. For data on the complete line of Bendix Power Transistors and Power Rectifiers, write to Holmdel, N. J.



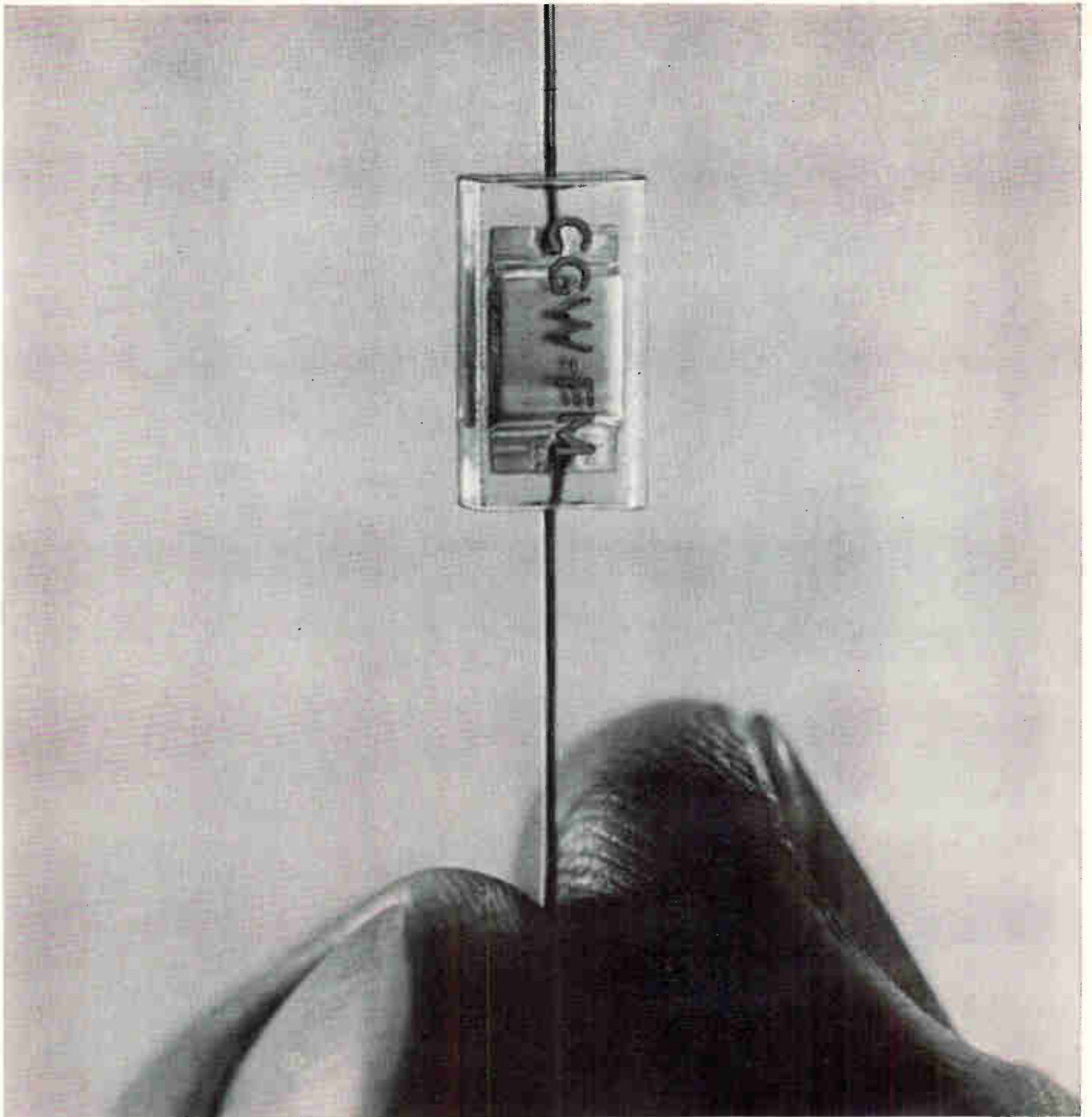
Type Number	MAXIMUM RATINGS			CURRENT GAIN	
	V _{CES} Vdc	I _C Adc	P _C W	h _{FE} @	I _C Adc
2N297A*	50	5	35	40-100	0.5
2N456A-8A	40-80	7	50	30-90	5
2N637-8,A,B	40-80	5	90	20-60	3
2N1011*	80	5	35	30-75	3
2N1136,A,B	40-80	5	90	50-100	3
2N1137,A,B	40-80	5	90	75-150	3
2N1138,A,B	40-80	5	90	100-200	3
2N1359-2N1365	40-100	3	90	35-150	1
2N1529-38,A	30-90	5	90	20-70	3
2N1539-43,A	30-90	5	90	50-100	3
2N1544-48,A	30-90	5	90	75-150	3

*Also available per MIL S-19500/36A & MIL-T-19500/67

Bendix Semiconductor Division



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SECOND BEST?

That's the Corning CYFM capacitor. It's topped only by the Corning CYFR—the first one that completed the Autonetics/Minuteman hi rel program.

We learned how to make the CYFM while working to improve reliability. It's electrically and environmentally interchangeable with the CYFR. The major difference is price, and that's because we use refined processes on the CYFR for applications requiring guaranteed failure rates and reliability.

All in all, the CYFM is a positively sealed capacitor for complete environment-proof performance (it goes far beyond MIL-C-11272B), and it sells for less.

Developmental testing of the CYFM went 6,000,000 test hours, and included load life, boiling salt, salt spray, fluxes, and solvents.

You can get its reliable capacitive element of foil and ribbon glass, *frozen* inside glass with hermetic seals at the

leads, in four types. The CYFM-10 gives *pf* values from 0.5 to 300; CYFM-15, 220 to 1200; CYFM-20, 560 to 5100; CYFM-30, 3600 to 10,000. Your Corning distributor can give you fast delivery at factory prices.

But, when you must have the ultimate in *guaranteed* reliability to your specifications, specify the CYFR. It's available in the same sizes and capacitance range. The CYFR is second to none.

For complete information, write for data sheets to Corning Glass Works, 539 High St., Bradford, Pa.

CORNING

Electronic Components

NEW... Weston Series 1900 Meters Give You *Integrated Design*

- 7 1/2"
- 5 1/2"
- 4 1/2"
- 3 1/2"
- 2 1/2"

Function Movement	D-C		A-C	Thermo	A-C Rect.	VU
	1%	2%				
Cormag®	✓	✓			✓	
Ext. Magnet	✓	✓				
Iron Vane						
Cormag®	✓	✓			✓	✓
Ext. Magnet	✓			✓		
Iron Vane			✓			
Cormag®	✓	✓			✓	✓
Ext. Magnet	✓			✓		
Iron Vane			✓			
Cormag®		✓			✓	✓
Ext. Magnet		✓		✓		
Iron Vane			✓			

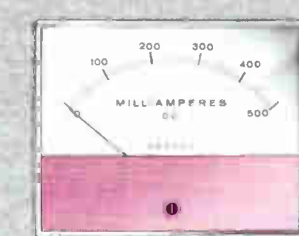
Weston offers the widest choice of instrument types and styles available in a single matching line. All instruments listed above are available with conventional pivot and jewel movements. The new Weston Taut Band Suspension offers highest accuracy and sensitivity, is available in 3 1/2" and larger sizes.

Weston's new concept of design (illustrated below) makes possible a fully integrated family of instruments for your every need. Layout problems are simplified since all meters of the same size are *directly interchangeable* . . . regardless of the mechanism you choose. All meters meet ASA elec-

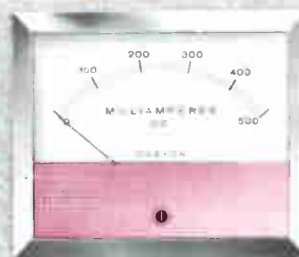
trical requirements in Specification Number C-39.1 for indicating instruments with 2600 V A-C dielectric test, and are available with
 ■ Bakelite or clear plastic faces
 ■ Color inserts for coding or styling
 ■ 100° scale arcs for both A-C and D-C instruments.

In addition, only Series 1900 Meters offer . . .


THREE TYPES OF MOUNTING



1. SURFACE
Use same dimensions whether you choose a meter with taut band or pivot and jewel movement.



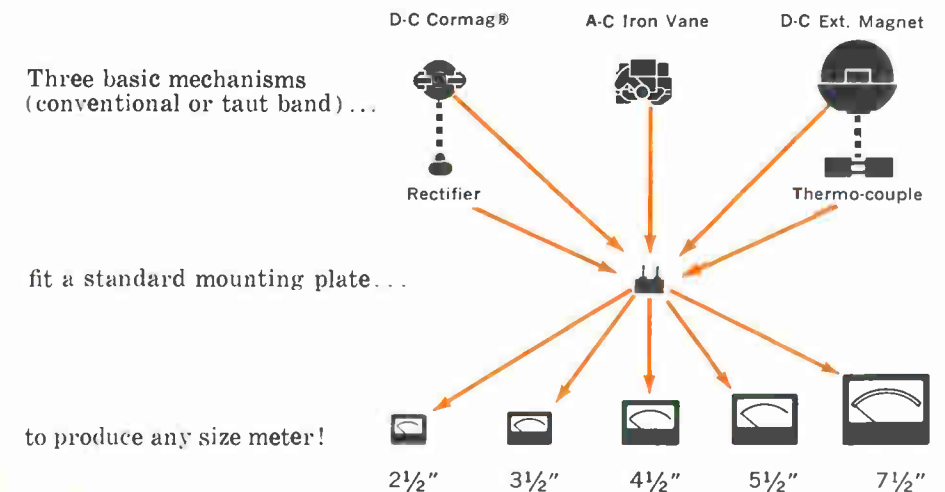
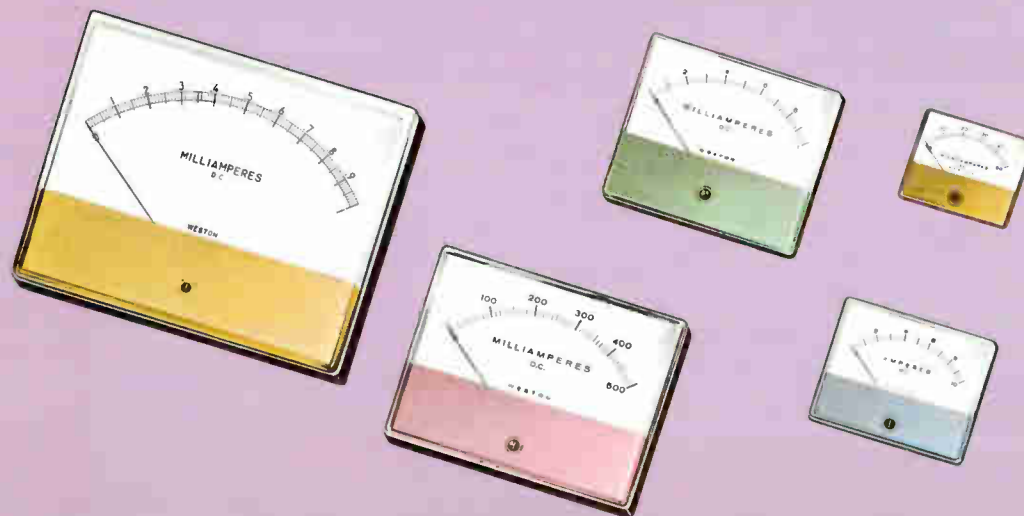
2. FLUSH
Full bezel permits mounting flush with panel through rectangular cutout.



3. RECESS
Only the scale is visible since meter is mounted behind the panel . . . half bezel fits into window. Available with internal illumination.

New Concept of Design...Series 1900 PANEL METERS

Series 1900 Meters



WESTON TAUT BAND Gives You These Outstanding Benefits!

■ *Modern in every way*

■ *Series 1900 Panel Meters are*

now available in...

any

size

from 2½" to 7½"
(Taut Band from 3½" to 7½")

any

function

DC, AC, VU, Thermo, Rectifier,
or Log-scale

any

range

from 2 µa, full scale, to highest
needed

any

accuracy

1% and 2%, standard...
higher accuracy on request

any

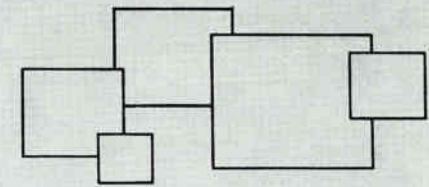
style

traditional Bakelite or modern
static-free plastic

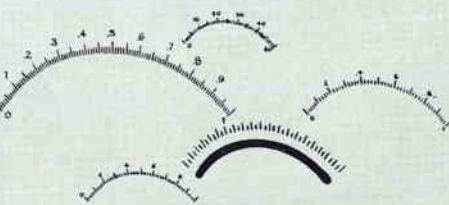
any

mounting

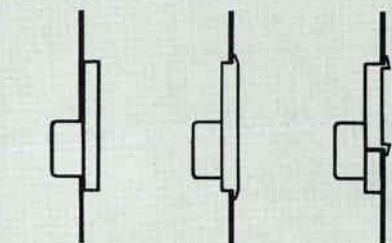
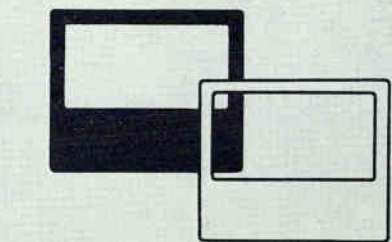
surface, flush or recess



a-c thermo
log-scale rectifier d-c



1% 2%



Because taut band instruments have no pivots and jewels...

- pivot friction is eliminated,
- error due to pivot fall-over is eliminated.

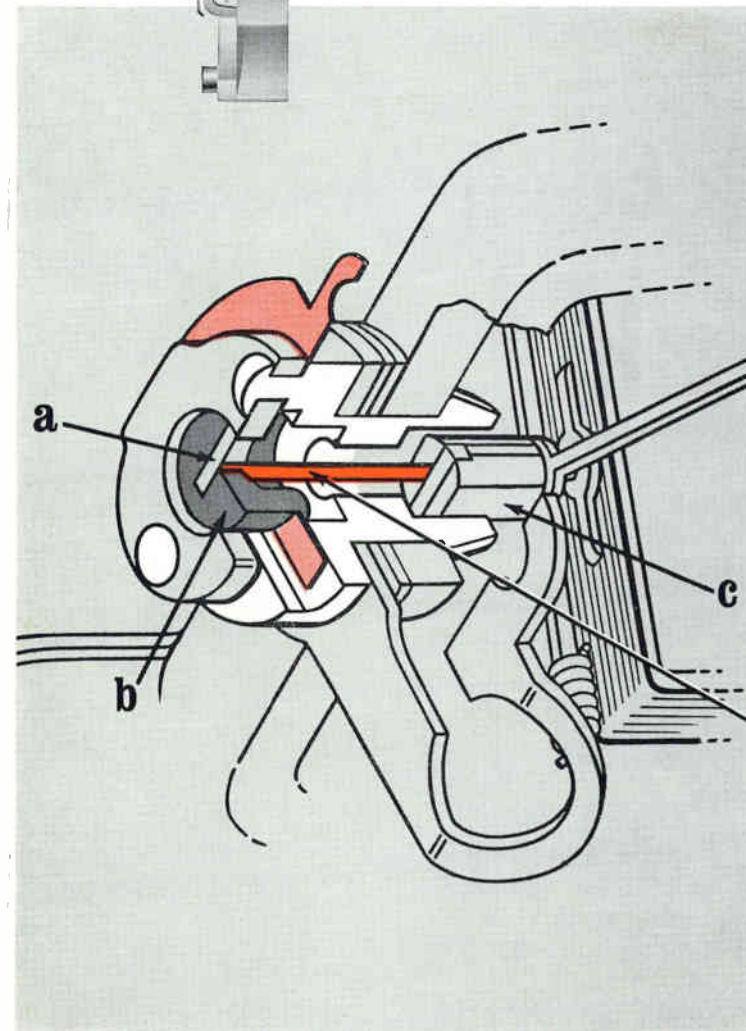
Because there are no movement springs...

- spring-set or hysteresis is eliminated.

Taut band instruments...

- require less driving energy,
- may be operated in any position without degrading performance,
- are 4 times more sensitive than conventional meters.

Here's what Weston's exclusive design means to you



Weston Co-planar™ termination is the only method of construction which assures complete control of taut band ribbon length and tension. This type of suspension also: assures precise centering of the moving coil for highest accuracy; guarantees uniform torque of the flat movement ribbon throughout the scale; and eliminates soldering within ribbon's active length. Important features of Weston's Co-planar™ design are illustrated in the drawing:

- 1 **Small hub** has wedge "a" which securely locks the taut band ribbon in place. The ribbon is then soldered at point "b". No soldering within active length of ribbon to disturb the ribbon's stress characteristics. Other end of ribbon is attached in like manner to the threaded anchor nut "c", into which the moving coil is attached.
- 2 **Tension spring** maintains firm pressure on band, absorbs shock, increases ruggedness of instruments.
- 3 **Nylon bushing** prevents excessive axial and lateral motion—further contributing to ruggedness.
- 4 **Special taut band ribbon** is produced by Weston's own metallurgical facilities. In-plant quality control assures precise characteristics in finished suspension ribbon.
- 5 **Weston mechanism** requires an active ribbon length of only 0.18" on each side of moving coil. That means Weston Taut Band Instruments are less bulky, and are completely interchangeable with pivot and jewel meters in Series 1900.

FACTS ABOUT WESTON TAUT BAND RIBBON

- Average size is only 0.0003" thick, 0.003" wide, and 0.18" long.
- Thickness is controlled within 1% — or ± 0.000003".
- Ribbon is supporting a weight equivalent to 50-tons per square inch in the instrument.
- No degradation resulting from high shock or vibration.
- Short ribbon length of 0.18" permits higher sensitivity than with longer ribbons.
- A one-pound ingot of Weston Taut Band Alloy provides enough ribbon for 750,000 meters.
- The cross-sectional area of a bundle of 18 ribbons is equal to that of a human hair.

Complete technical information from: **WESTON INSTRUMENTS**
Division of Daystrom, Incorporated
614 Frelinghuysen Avenue
Newark 14, New Jersey

Special Pliers for the Highly Specialized Electronics Field

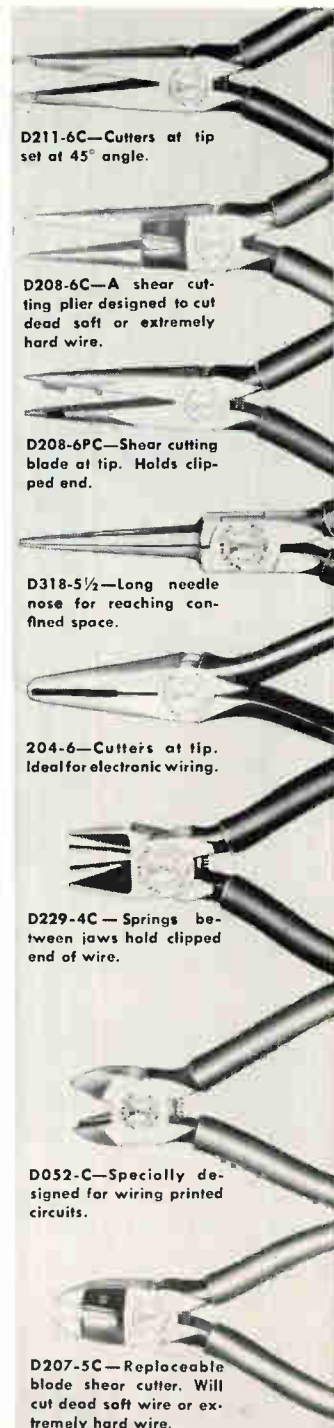
When the early transmission lines were strung in this country a century ago, it was Klein Pliers in the hands of linemen that helped do the job.

Klein has kept pace with the development of the electrical field, meeting each new challenge with tools specially designed to do the wiring job better . . . more economically.

Shown here are a few of the many highly specialized Klein Pliers carried in stock to meet the needs of electrical and electronics manufacturers.

You will find your assemblies go together more smoothly and wiring is done more rapidly when the right Klein Plier is used.

SEE YOUR DISTRIBUTOR



D211-6C—Cutters at tip set at 45° angle.

D208-6C—A shear cutting plier designed to cut dead soft or extremely hard wire.

D208-6PC—Shear cutting blade at tip. Holds clipped end.

D318-5½—Long needle nose for reaching confined space.

204-6—Cutters at tip. Ideal for electronic wiring.

D229-4C—Springs between jaws hold clipped end of wire.

D052-C—Specially designed for wiring printed circuits.

D207-5C—Replaceable blade shear cutter. Will cut dead soft wire or extremely hard wire.



Mathias KLEIN & Sons
Established 1857 Chicago, Ill., U.S.A.

INCORPORATED
7200 McCORMICK ROAD, CHICAGO 45, ILL.



Mathias Klein & Sons, Inc. 7200 McCormick Road, Chicago 45, Ill.
Please send me the Klein Plier Catalog and information.

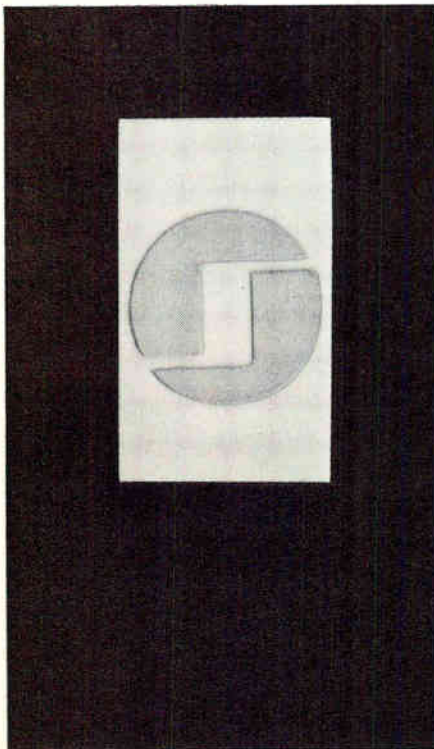
Name _____
Title _____
Company _____
Address _____
City _____ State _____



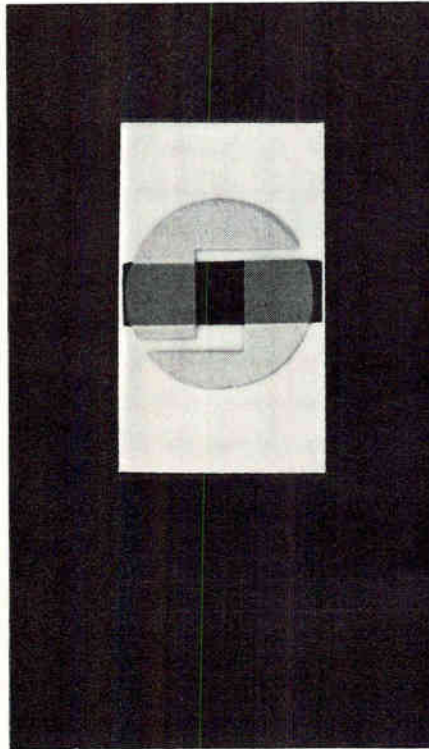
Ideas and uses for Du Pont

Conductive Compositions

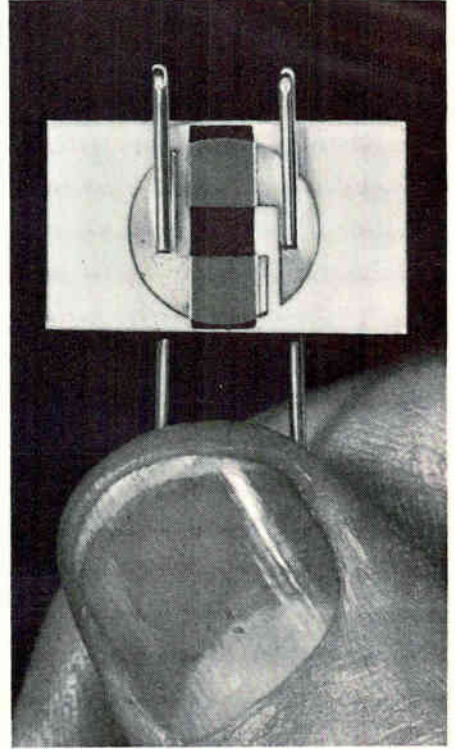
- Conductive silver, gold, palladium and platinum compositions
- Resistor compositions ■ Gold and silver cement compositions



1. Print conductive coating on substrate.



2. Print on resistor composition and fire.



3. Solder terminations (without electroplating).

Reduce circuit production steps with new Du Pont Resistor Composition

Now you can fire the conductor and the printed resistor simultaneously, using either Du Pont solderable silver #6320 or platinum-gold composition #7553 ■ Simply screen or brush either conductive coating on the ceramic substrate. When dry, print one of Du Pont's Resistor

Compositions directly over it and fire. You eliminate separate firing of the conductor ■ You get better electrical properties and can solder the terminations without electroplating ■ For further information, check #1 on the coupon.

Electroplated silver produces true hermetic seal

To hermetically seal resistors or other electronic components, simply fire on Silver #6216 in the 600-650°C. range and then electroplate. This produces a solid film and eliminates air pores. Any desired thickness can be deposited on the seal. Ideal for applications where seals do not have to be resoldered.

Check #2 on coupon to learn more about these materials.

How to get good metal-to-ceramic seals without plating

1. Platinum #6855. Provides strong bond for seals where resoldering is necessary. Requires no plating, should be fired in the 700-750°C. range.
2. Gold-Antimony Cement #7944. Tacky enough for temporary bond prior to heating, and requires only a low temperature firing range of 400°C. to produce seals.

For detailed information on these Du Pont compositions, please check #3 on coupon.



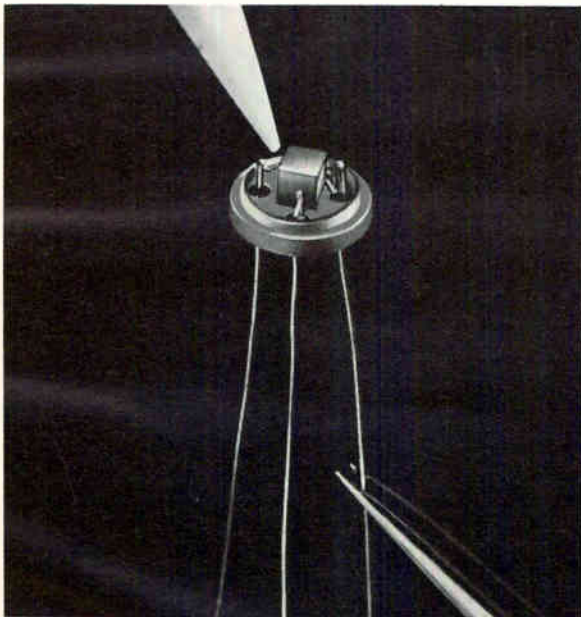
Silver Cements replace soldering of resistor terminations

Du Pont thermosetting silver cements are easy to apply and eliminate need for soldering on carbon resistors.

They have good adhesion, high abrasion resistance and withstand temperatures up to 200°C.

These cements can also be used for ohmic contacts to diodes or transistors, for leads to mica capacitors, and in place of solder for laminations.

For details check #4 on coupon.



How to replace solder preforms (and jigs) in semiconductors

During semiconductor assembly, apply Du Pont Gold-Antimony Cement #7944 by stylus to temporarily bond lead attachments to silicon crystals. Solder preforms and jigs are not needed.

After assembly, low temperature firing converts the temporary bond to a permanent joint that will withstand temperatures of 300°C.

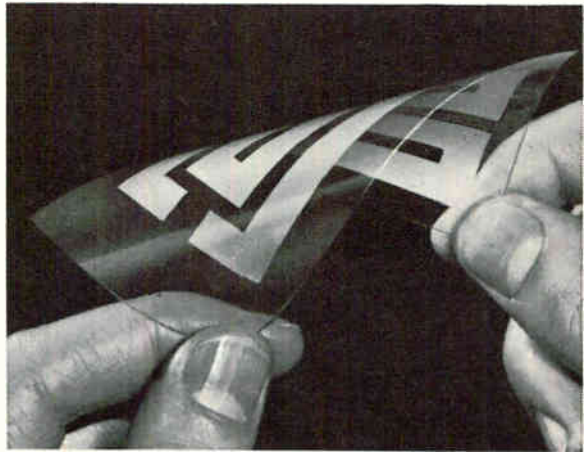
Du Pont's line of gold cements can be applied manually or by automated techniques. Temperatures as low as 160°C. will cure the cements making a bond operable at 200°C.

Check #5 for further information.

Silver electrodes for piezoelectric ceramics

1. Silver #4731. Especially developed for barium titanate, can be soldered or pressured contacted. Used with high-frequency application as electric shavers, recorders.
2. Silver #7095. Newly developed for very high frequency vibration uses on lead zirconate titanate. Can be soldered or pressured contacted, offers excellent adhesion. Uses include: ultrasonic cleaners, sonar equipment.

Check #6 for details.



For pliable materials... a new flexible conductive coating

Now there's a conductive coating that flexes with paper, plastics and other non-rigid materials.

Du Pont Air-Dry Silver #7941 is used to print conductive patterns, circuits, or static shields on flexible surfaces. After air-drying, it has good electrical and thermal conductivity—in addition to the unique combination of good adhesion and flexibility.

Check #7 for details.



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Please send me further information on the Du Pont
conductive compositions which I have checked below.

- | | |
|---|--|
| #1 <input type="checkbox"/> Resistor Compositions | #5 <input type="checkbox"/> #7944 Gold-Antimony Gold Cements |
| #2 <input type="checkbox"/> #6216 Silver | #6 <input type="checkbox"/> #4731 Silver |
| #3 <input type="checkbox"/> #6855 Platinum | #7 <input type="checkbox"/> #7095 Silver |
| #4 <input type="checkbox"/> #7944 Gold-Antimony | #7 <input type="checkbox"/> #7941 Air-Dry Silver |
| #4 <input type="checkbox"/> Conductive Cements for Terminations | |

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Sun and Exploding Wires Pump Lasers

By WILLIAM E. BUSHOR
Senior Associate Editor

WASHINGTON—Quick acceptance of lasers as an important scientific tool was brought into sharp focus last week at the spring meeting of the Optical Society of America. Perhaps the best evidence of this is that 28 of the 115 papers given related to laser operation and application.

Exploding-wire light sources for pumping pulsed lasers operating at room temperature were reported by experimenters from Westinghouse Electric's research labs. Because it is one of the most brilliant

light sources known and is capable of producing extremely high-energy inputs, the exploding wire gives high-peak power levels and extremely fast rise times. These are important factors in designing high-power pulsed lasers for operations where short pulses of very intense pumping light are required.

Efficient coupling of energy is achieved by focusing the small-diameter, line source light output with a polished elliptical stainless steel mirror onto the ruby rod. A glass and a plastic sleeve around the ruby filter out extraneous radiation not useful for pumping, and prevent shattering of the ruby by

acoustic shock waves or wire fragments. To date, Nichrome, aluminum, copper and tungsten wire have been exploded from capacitor banks with an output energy capacity of 33,600 joules.

Coherent light output of the system is only 0.4 joule compared with the several joule outputs obtained with gas-discharge pumping, but the researchers feel that greater refinement of exploding-wire sources should give 100 to 200 times the present output.

Sun-powering of a laser operating at room temperature was described by American Optical Co. An end-pumped system, the laser is capable of continuous low-power output operation and has been experimentally shown to be practical.

Prime application will be in space communications because the light beam can be modulated much as a conventional r-f carrier while giving bandwidth equivalent to the wavelength of light. Effective communicating range has been estimated at 240,000 miles, or approximately the distance from the earth to the moon.

Austrian Firms Seek Import Protection

VIENNA — Austrian entertainment electronics is slated for some new goals, say Viennese observers. Pressure for changes is being brought about by the challenge of automation and fear that the European Free Trade Association will mean more competition in radio and tv sets.

Radio set output last year averaged 31,609 units a month. In

1960, the monthly average was 34,839 a month. Most of 1961's production was in transistor units, with about 250,000 sold. The remainder were table radios.

During the first three quarters of 1961, 104,733 radios were sold outside of Austria for about \$2,419,000. Comparable figures for 1960 were 81,517 units at some \$1,900,000.

Television receiver production has increased sharply, an average monthly output of 1,529 units in 1957, to 9,337 in 1960 and 9,459 in 1961. Austrians exported 13,376 tv sets worth \$1,373,000 during the first three quarters of 1961. The comparable 1960 figures were 8,913 units and \$830,900.

Buyers for Austria's radio and tv output are in the Netherlands, Sweden, Great Britain, Yugoslavia, Switzerland, Belgium, Finland and Portugal.

Radio and television manufacturers are worried about competition from West Germany. They expect that their own domestic market will be periled in that West German imports are inundating Denmark, Switzerland and Sweden. Plans are now afoot to seek protective tariffs until mass production brings Austrian prices down.

Design for Solar Power

A 44-in. paraboloidal mirror collects one square meter of solar radiation and focuses it onto glass and sapphire lenses which further concentrate the light by a factor of five. All the light enters and is trapped in the ruby. Light flux at the end of the ruby would be almost three times that at the sun's surface if the device were operated in space. On earth, however, only 70 percent of the sun's energy is obtainable and performance suffers proportionately.

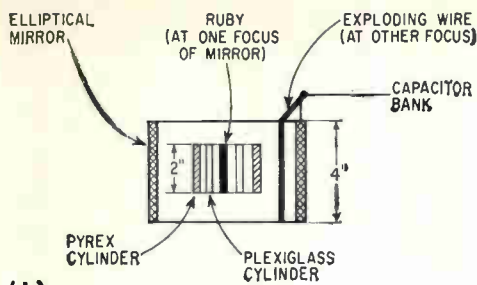
Joining the ruby to the immersion aplantic lens has been the major problem. In fact, optical contact has been completely lost after only a few flashes of the test source in some experiments. Presently, optical solder glass is used as the cementing agent and, if satisfactory, will give an added advantage because it is a non-scattering media.

Pumping both ends of the ruby

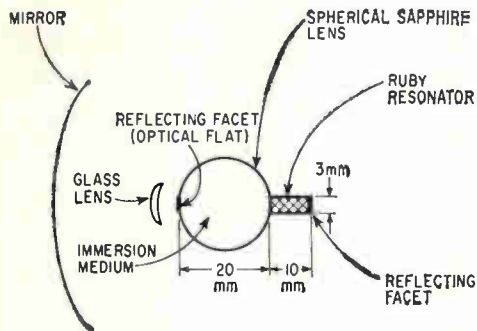
Listening for Leaks



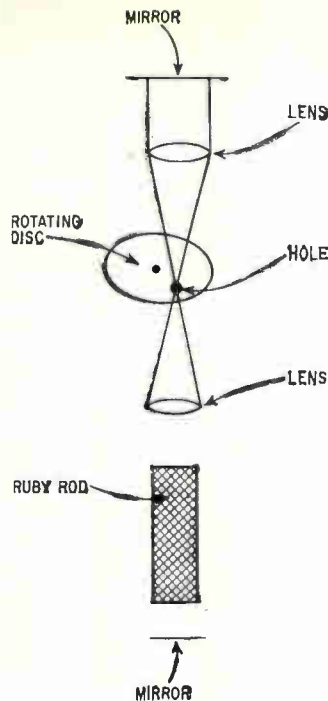
Delcon Corp., of Palo Alto, Calif., is making a battery-powered set which translates sound from the ultrasonic (35-45 Kc) to the audible range. It can be used to find leaks or flow obstructions in pressure or vacuum systems, or for engine analysis and other industrial applications



(A)



(B)



(C)

Arrangements to pump lasers with exploding wires (A), sunlight (B) and by modulating the light source (C)

Electronic Alarm Protects Parking Meter Nickels

CHIEF RADIO operator of the Spokane, Wash., police department has developed a device which flashes an alarm to the police radio room when someone tampers with a parking meter.

Since they began using several of the devices more than a year ago, police have caught 14 parking meter looters and cut losses "substantially." American Sign and Indicator Corp., Spokane, plans to produce the device.

Vela Net to Get Three More Seismic Stations

WASHINGTON—Department of Defense has announced plans to build three more seismological observatories under the Vela-Uniform program to develop techniques to detect underground nuclear weapons tests. They will be similar to the Wichita Mountains Observatory at Fort Sill, Okla., completed in 1960.

Texas Instruments has a contract to construct and operate, by this summer, an observatory near Sparta, Ore. Initial cost is \$700,000. It will have an array of 10 seismometers and 11 other seismometers in water-tight vaults, plus monitoring amplifiers and recorders.

Two other observatories will be located in Tennessee and Utah. The observatories are under technical supervision and management of the Air Force Technical Applications Center.

provide high energy absorption per unit volume. Trivalent niobium or calcium tungsten may permit lasing at light levels 300 times lower than with ruby crystals. It is possible that much cheaper electroformed mirrors can be used.

A Russian scientist gave a last-minute paper on a method for increasing power of pulsed ruby lasers by modulating the resonator quality factor. The switching mechanism shown permits pumping between pulses thereby giving high-energy pulsed output at room temperature. At least four U. S. laboratories have devised similar ways of accomplishing the same result. In fact, one U. S. approach is the same except for the introduction of lenses, but the nature of the work has not been revealed for publication.

Light from the laser is focused on a rotating disk moving at 50,000 rpm. When the beam is aligned with the hole, which is $\frac{1}{2}$ the diameter of the ruby rod, the energy stored in the laser is permitted to pass to a lens-mirror output arrangement. Reported output is one joule per pulse. Major output spike has been followed by as many as five much smaller spikes at time intervals of 10^{-6} sec.

Canada Readies New Microwave Network

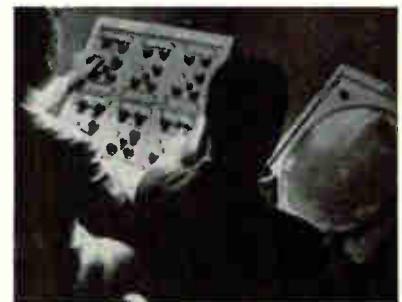
TRANSCANADIAN microwave network costing \$36 million, now through the planning stage, will go into construction this summer. Completion, scheduled for late 1963, will see Vancouver and Montreal linked.

The line will be owned and operated jointly by Canadian Pacific Telecommunications and Canadian National Telecommunications. Because of strategic reasons, facilities will generally be away from existing communications lines, but will be provided with spurs into major centers across Canada.

The system will be used primarily for commercial and business purposes and provide telex, data processing, facsimile transmission and standard message traffic facilities.

RCA Victor, Ltd., of Canada has been awarded a \$12 million contract for the electronic equipment. There will eventually be about 136 relay towers. Initially, the network will have two 600-voice channel circuits, with provision for superimposing additional channels in the future. Automatic control and monitoring equipment will be provided all along the route.

Radar Simulator



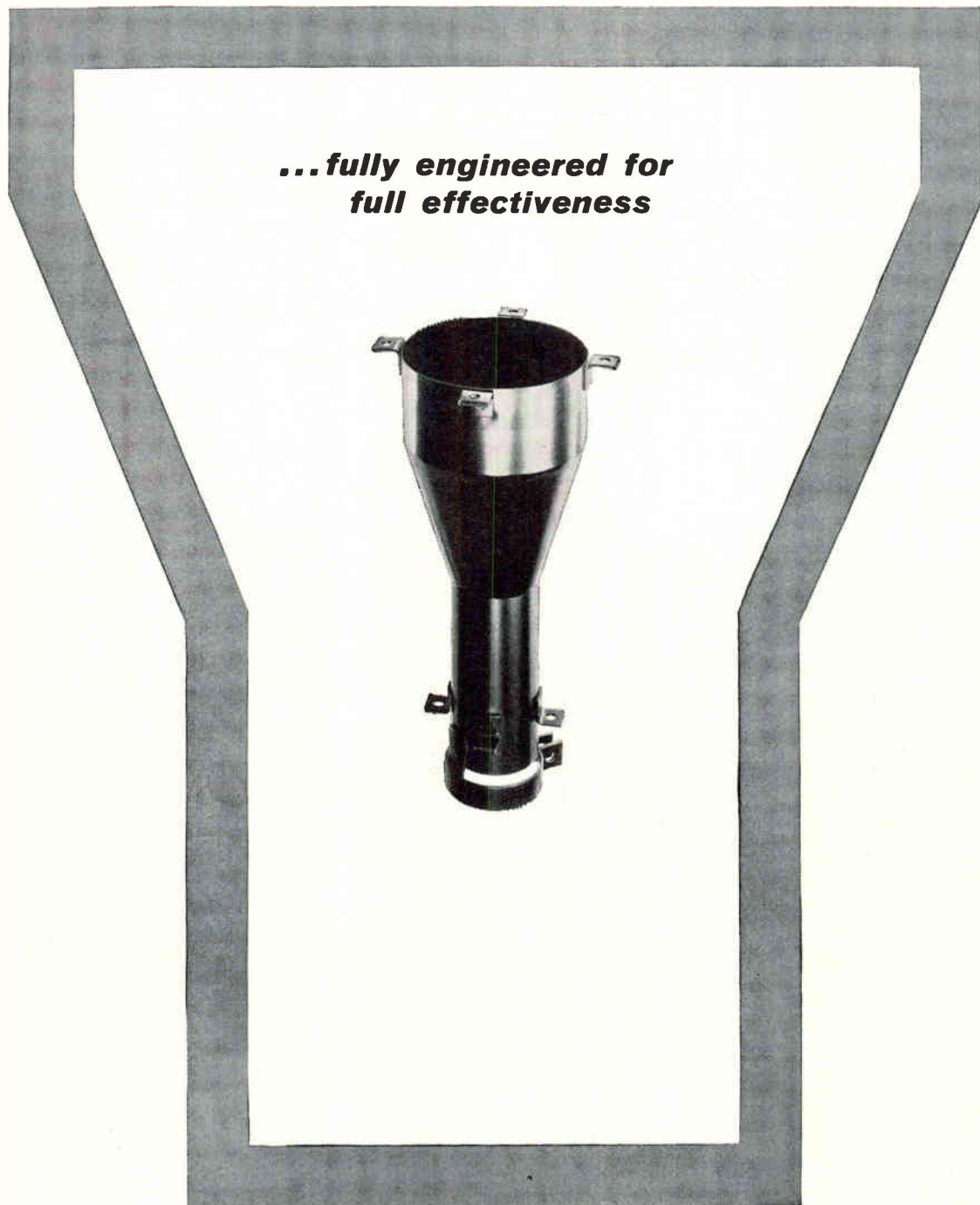
Curtiss-Wright is supplying FAA with 32 six-target radar simulators, for training air traffic controllers in radar hand-off and other procedures. Instructor (left) creates and controls the blips

Don't just drop any "can" over an electronic component and expect complete protection from stray magnetic fields. *Completely* protect tubes and transformers with carefully engineered, high-permeability shielding, fabricated to the exact requirements of your components. You get this complete protection with Magnetic Metals shielding. For highest permeability and full effectiveness, Magnetic

Metals shielding is made of carefully annealed molybdenum permalloy or magnetic equivalent, and fabricated to provide the level of magnetic or electrostatic shielding you require.

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NEW
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LARGE SCREEN OSCILLOSCOPE HAS RESPONSE TO 5 MC



The new ITT Model LS 421 is a sampling oscilloscope with a low frequency display capability. It has the advantages of a large screen with exceptionally high resolution, plus a small, compact, modular control console. It has application as a general purpose lab scope for research and development activities, as a high speed readout for computers and display systems and wherever detailed observation of pulses and complex waveforms with high resolution and linearity is required.

LS 421 FEATURES:

VERSATILITY

X and Y plug-ins are completely symmetrical, thus allowing interchangeability of plug-ins normally associated with X and Y functions.

EASY MAINTENANCE

There is easy accessibility for servicing. Side panels are removable at the push of a button. There are no screws to remove. The deflection amplifiers are on swing-out chassis for easy access.

LARGE SCREEN

A 14" rectangular Cathode Ray Tube provides a full screen of 9" x 12"

For further information about the LS 421 Large Screen Oscilloscope, write for Data File No. E-1654-1, or call your local representative for a demonstration.

XY PLOTS

A unique *random* sampling method which allows the unit to be used as an XY plotter for phenomena varying at a DC rate or as high as 5 mc.

The system takes 50,000 samples per second, independent of the frequency of the waveform being displayed.

MODULAR CONTROLS

A modular Control Unit contains sampling circuitry, the control panel for indicator functions, and spaces for X and Y plug-ins.

CONVENIENCE

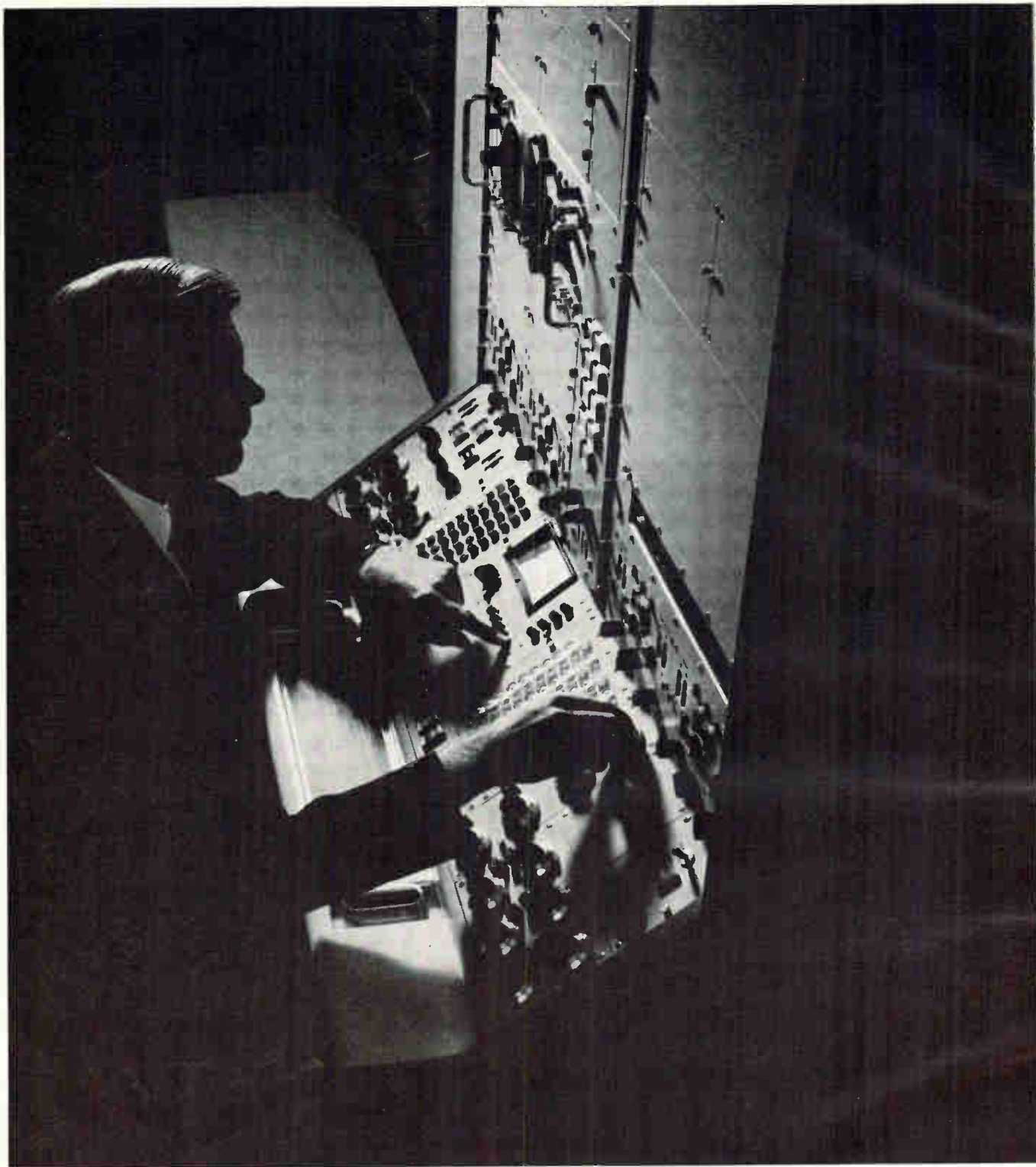
The Indicator and Control Unit are separate to allow the Indicator to be placed in the most convenient viewing position. The scope is packaged for rack, bench or mobile cart mounting.



Industrial Products Division

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Centralab feed-thru capacitors range from 10 to 25,000 V, high K or temperature compensating types. In addition to the standard type Centralab has developed many unique designs for unusual applications.

These feed-thrus do real double duty, because they can perform mechanical functions along with their electrical functions. A feed-thru can also serve as a bracket for separating a terminal board from the chassis—or other circuit components can be mounted directly on the capacitor.

CERAMIC FEED-THRUS BEAT PAPER AND VACUUM UNITS FOR SPACE, COST, AND RELIABILITY

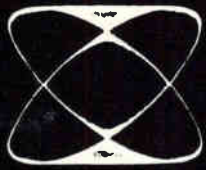
Centralab ceramic feed-thrus are smaller than equivalent paper or vacuum units. They never "go soft" like vacuum units, which cost twice as much—and they offer 10 times the reliability of paper capacitors.

A new catalog has just been prepared giving full information about Centralab feed-thru capacitors. Write for your free copy to .



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CIRCLE 103 ON READER SERVICE CARD



THE SERVO CIRCUIT

Published by SERVO CORPORATION OF AMERICA

TANK GUNNERS TAKE SHARP AIM

Gun/turret control system zeroed in by SERVOSCOPE® servo system analyzer

Armored vehicle gun-elevating and turret-traversing control systems developed by Minneapolis-Honeywell's Ordnance Division, Minneapolis, are used in a number of different type Army, Marine Corps, and allied tanks.

Latest Honeywell design, a "dynamic gun/turret control system," provides for gyroscopic stabilization and control, effectively isolating the gun and turret from motion-induced rotational disturbances which tend to blur the gunner's view and affect orientation of the weapon.

Designed for fast, stable response, the closed loop control system permits the gunner to aim and fire at stationary and moving targets, as the tank rumbles over rough terrain, with a high probability of scoring first-round hits.

SERVOSCOPE improves test accuracy, lowers development costs

Ordnance Division engineers credit the SERVOSCOPE® servo system analyzer with playing an important role in development of this latest M-H system.



SERVOSCOPE® was also used in the development and testing of armored vehicle turret components. Engineer, above, is shown analyzing stabilizer current using SERVOSCOPE.



Minneapolis-Honeywell Ordnance Division engineers using SERVOSCOPE® servo system analyzer to make dynamic analyses of new gyroscope-stabilized tank gun-elevating and turret-traversing control system.

The SERVOSCOPE was used to analyze transfer functions of open and closed loops and of damping and filter networks. Transient response and frequency response of systems and sub-systems components containing multi- and single-loop circuits could be observed.

Open loop frequency response measurements defined the characteristics of phase-correcting networks needed to achieve stable, closed-loop performance. Frequency response measurements were also used to verify filter network design. Closed loop transient and frequency response measurements tested total system performance.

The convenience of the SERVOSCOPE with its integral signal generator and phase shifter, note M-H engineers, simplified setup and operation. They also credit the servo system analyzer with improving test

accuracy and lowering development costs.

Measures phase, gain, transient response

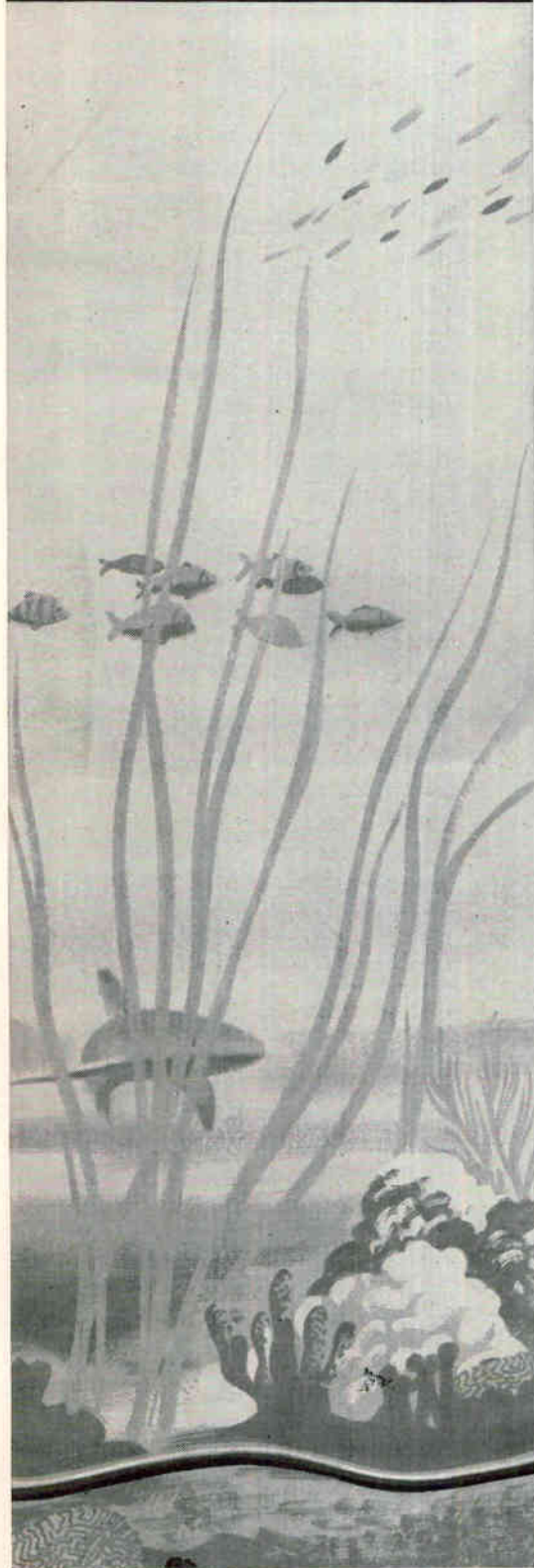
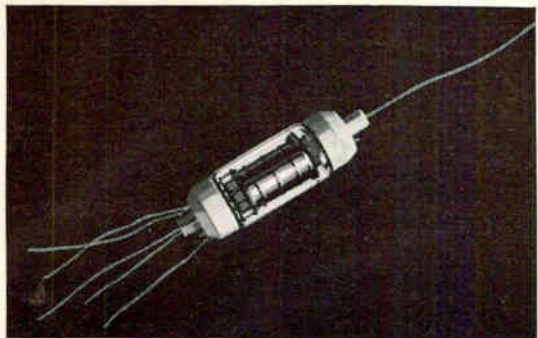
Using the SERVOSCOPE, an investigator can observe servo system phase, calculate gain, or measure transient response. Because the analyzer is a single, integral instrument, it can be used for final system inspection as easily as in design laboratory evaluation.

Fast direct setting and readout, coupled with high accuracy measurement, provides precise and rapid results. No calibration is required, making the analyzer immediately applicable to different problems.

Send for technical bulletin and free SERVOSCOPE Worksheets and Servo Slide Rule.



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50,000,000 tube hours... an unusual electron tube still keeps undersea voice signals strong

Deep on ocean floors, from North America to Europe, between Key West and Havana, Florida and Puerto Rico, under the Pacific to Hawaii and Alaska—in 20,000 miles of undersea telephone cable—a special kind of electron tube is setting a remarkable record for reliability.

This four-inch-long electron tube was designed, developed and fabricated at Bell Telephone Laboratories to operate with no attention for 20 years or more. It is part of the submarine cable repeater manufactured by Western Electric which faithfully and reliably amplifies voice signals transmitted along undersea coaxial cables.

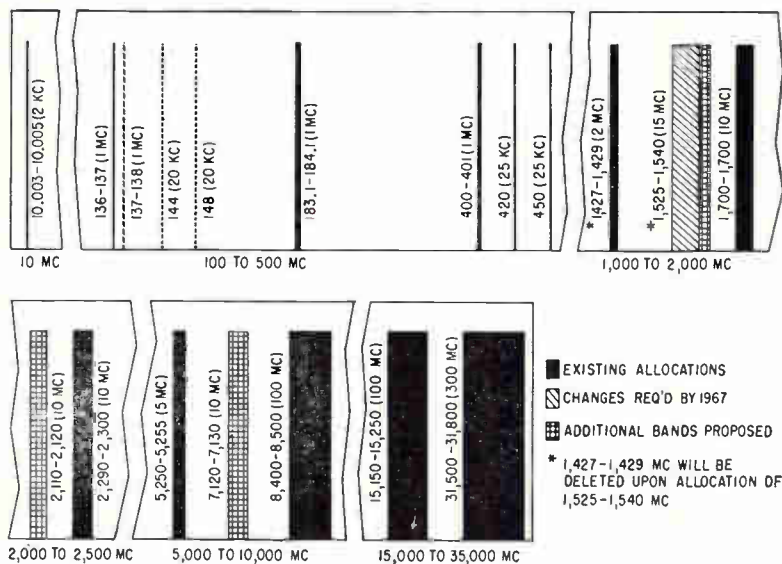
All of the 1608 tubes built into the repeaters have operated to date without failure for a total of over 50,000,000 tube hours, or an average of three-and-a-half years. The oldest have been in service since the first deep-sea repeated telephone cable was laid 12 years ago.

Years before it was put to use, Bell Laboratories scientists and engineers began developing this undersea tube, another example of forward-looking technology that has made the Bell Telephone Laboratories the world center of communications research and development.



BELL TELEPHONE LABORATORIES

Missile Range Instrumentation R&D



Existing frequency allocation for space telemetry and planned changes. Vhf and other major telemetry bands are not shown. Long duration space missions would interfere with use of those bands for other test use at the ranges

PATRICK AFB, FLA.—Trends, problems and new electronic instrumentation needed at the national missile ranges were described by government and industry officials at a symposium sponsored by the Air Force's Missile Test Center and Electronics Systems Division, assisted by AFCEA.

One prime need, according to Kurt H. Debus, of NASA's Marshall Space Flight Center, is better automatic checkout equipment. Important by-product will be analog-digital conversion that will do away with conventional blockhouses. Instead, remote checkout installation will double as a launch control center connected to the launch pads only by digital links.

Debus also described another potentially large role for electronics. To utilize fully large multiengine boosters, an elaborate, ground-based, operational flight control network will be needed. If failures or deviations can be evaluated on the ground, new commands can be sent to the space vehicle for an alternate mission.

Transmission of onboard data to command centers, highly-accurate tracking techniques, computers, and displays of all interdependent data will be needed. Propulsion phases of new space vehicles may extend half way around the world. For over-the-horizon communications, stationary satellites might be used.

One of the more serious problems at White Sands Missile Range is measuring missile attitude in flight. A solution could also lead to measuring the true tangential velocity of a missile. Lester W. Roane said the primary effort at White Sands is developing a single integrated range system for attitude, trajectory and other measurements in real time. Double doppler systems may give excellent roll rate data. Most of the promising approaches require special onboard radiating equipment and antenna arrays.

Roane describes a "dream" system for attitude and tangential velocity measurements: ground-based, passive; data display available within 5 msec; data sampling

Light-Operated Range Gear

PATRICK AFB, FLA.—Breakthrough in the technology of light-operated ranging and communication systems for missile ranges is at hand. This view was taken by T. A. Coffee, of the White Sands Missile Range, at the symposium.

Among possible instrumentation uses for modulated-light systems listed by Coffee are air-to-ground telemetering, reflectance homing, beam riding, ranging, surveying and plotting, command and control, and beacons.

He reviewed materials, devices and system approaches that will make operation possible with infrared, visible and ultraviolet light.

These include high-output, organic, liquid phosphors with 2-nsec phosphorescence decay time, a soon-to-be-developed 20-Kw cathode ray tube with 100-Kv accelerator and 0.2-amp beam current capability, lasers and new uses of ultraviolet and piped-light systems.

Bandwidth capability inherent in modulated-light systems is of the order of 2 Gc. Secure communica-

tions are automatically obtained with narrow beam light systems, an important military feature.

Receivers will use multiplier phototube where possible to take advantage of their high sensitivity. High-intensity background light of steady characteristic, such as sunlight, can be discriminated against by band-pass filters. The effect of nonsignal light entering the receiver would be d-c offset only.

Air turbulence produced by heat causes 5 to 15 cps variations in signal amplitude. These can be eliminated at the receiver of a digital pulse communication system by using saturation amplifiers.

Modulated-light transceivers with a bandwidth of 250 Kc and power output of 0.3 watts have been built and tested. They use R1168 glow tubes for transmission and type 7200 multiplier phototubes for receiving. Both analog and digital data were transmitted over two miles in bright sunlight. Beam spread of the system was about 7 ft per mile.

Still Faces Many Unsolved Problems

rates up to 100/sec; resolution one part in 10°; accuracy not less than ± 0.1 deg attitude position, ± 1.0 deg/sec attitude rate and ± 0.01 ft/sec tangential velocity; range of 600 mi without significant inaccuracy; missile size or trajectory not critical; standard IRIG timing signals used; data reduction by standard machine techniques; line-of-sight not necessary; substantial use of existing range facilities.

Systems being studied include inertial techniques, reverse interferometers, and horizon scanners using infrared, ultraviolet or visible light. Nuclear radiation and magnetic field measurement techniques may be applicable.

Uhf telemetry equipment will be demanded before the end of the decade and the time to develop it is now, pointed out W. M. Stout, of the Martin Co. New requirements are inevitable since telemetry serv-

ices must vacate the bands from 215 to 225 Mc by 1970.

To alleviate crowding at uhf, two telemetry bands were authorized in 1959—at 1,435 to 1,535 Mc and 2,200 to 2,300 Mc. These frequencies are proving suitable, Stout said, but additional activities can be transferred to uhf only if airborne and range facilities get fully-developed equipment in quantity.

Susceptibility of lower frequencies to signal interference means uhf telemetry will improve propagation, lower noise figures and give greater dependability, Stout said. He cited masers, solid-state parametric and beam type amplifiers, and traveling-wave tubes as components vital to the future of uhf telemetry.

Kenneth I. Lichti, of the Pacific Missile Range, listed a number of problems at PMR: new telemetry frequencies, acquisition and track-

ing of short wavelength signals, calibration of highly precise tracking instrumentation and measurement of new environmental parameters.

Hardware procurement previously planned for S band will now require operation at both S band and in the 1,500-Mc region, he said. The long range problem, however, is probably development of telemetry for higher frequencies.

Another problem is obtaining adequate underwater test and evaluation equipment. Navy will spend more and more on undersea warfare in the years ahead, Lichti said. Needs include a system to track simultaneously several underwater targets in three dimensions, surface tracking system to pin-point 10 or more ships in a 3,000-sq-mi area, underwater miss-distance system contained in the target and a tactical underwater target simulator.

NEC Finds Illinois R&D Scanty

CHICAGO—National Electronics Conference—which plans to highlight the R&D capabilities of midwestern universities at its show in October—has released a survey of R&D activities in the Chicago area.

The year-long study, jointly sponsored by the IRE's Professional Group on Engineering Management, confirms earlier reports that R&D in the Chicago area electronics industry needs beefing up.

Among recommendations in the 98-page report were that companies consider R&D of a more advanced level, upgrade R&D staffs, encourage new research-based companies and work for closer industry-university ties.

The study was financed by NEC and 25 Chicago-area electronic companies. It was conducted by a team directed by Albert Rubenstein, professor of electrical engineering at Northwestern University. Among the findings were:

- Although Illinois produces 18.1 percent of U. S. electronic products,

only 3.1 percent of U. S. members of the IRE live in the state. Universities within 150 miles of Chicago produce about a third of the nation's electronic engineers. Yet of 200 of their Ph.D. graduates entering industry between 1954 and 1960, only three joined Chicago industries.

- The fastest growing growth electronic companies outside the Chicago area are expanding one and a half times as fast as the fastest growing Chicago electronic firms. The Chicago area claims fewer than 15 research-based companies, while this type of company abounds in such locations as Boston, Washington, D. C., San Francisco and New York.

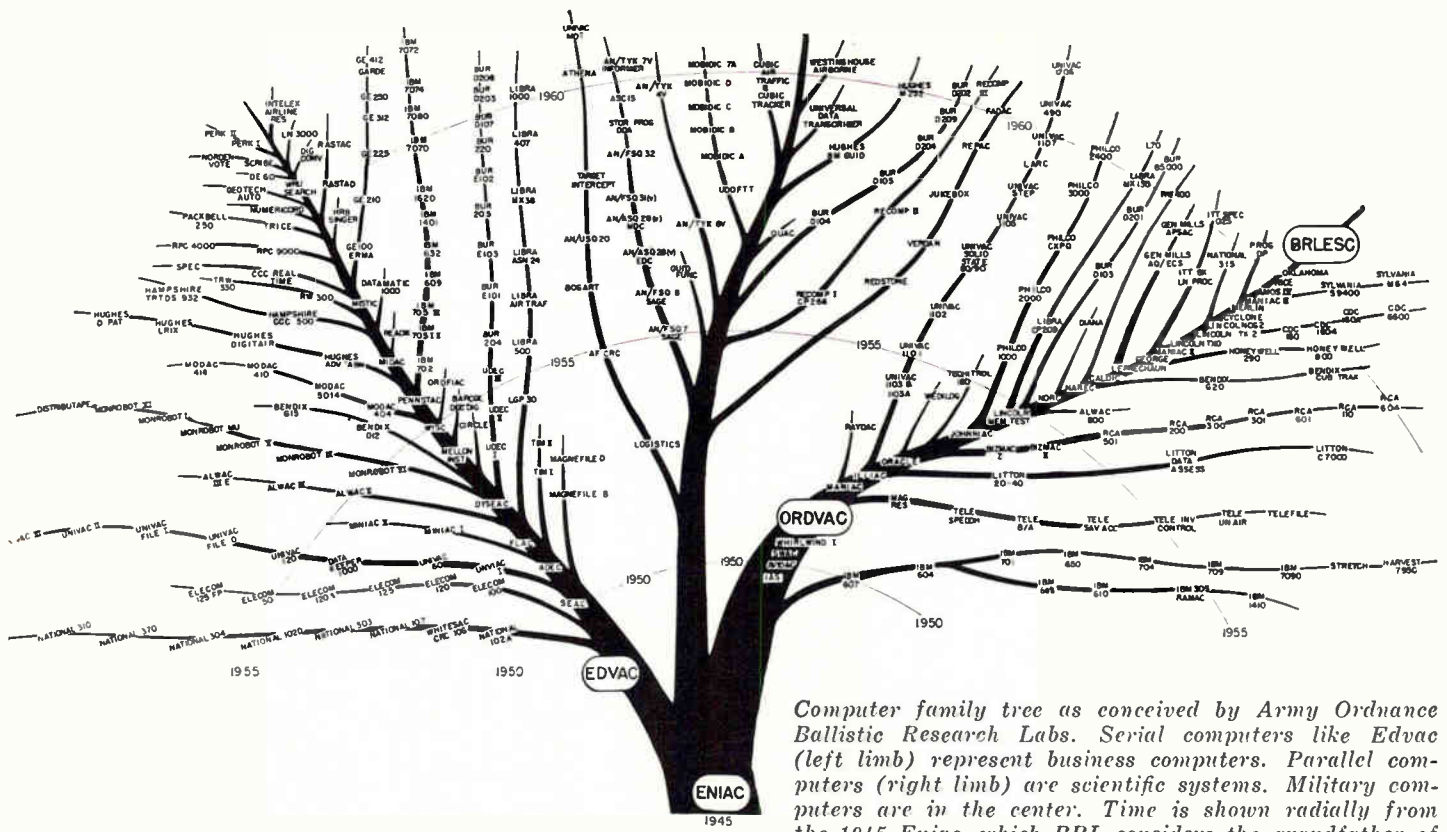
- Only 2.9 percent of technical papers in 44 journals and meetings on electronics and related R&D were written by employees of Chicago electronic companies.

- Half of 60 Chicago companies reporting 1960 sales over a million dollars won't take on R&D projects

with expected maturities over a year, or do so only occasionally. Sixty percent of 58 companies responding don't seek university help with research problems. In 55 companies, 38 do not permit time off for advanced degree work and 47 don't give leaves of absence.

Angus MacDonald, chief engineer for Motorola's military electronics division, reported these bright spots in the Chicago research outlook: Armour Research Foundation is setting up a research park for industry, including electronics, and Northwestern University is planning another; the Chicago Association of Commerce and Industry has set up a council to accelerate Chicago's R&D growth and reputation.

Although Hallicrafters has suggested a plan for increasing defense department participation in Chicago-based research, Rubenstein urged caution in considering military proposals "which might achieve more total R&D, but at the cost of lowered scientific levels."



Computer family tree as conceived by Army Ordnance Ballistic Research Labs. Serial computers like Edvac (left limb) represent business computers. Parallel computers (right limb) are scientific systems. Military computers are in the center. Time is shown radially from the 1945 Eniac, which BRL considers the grandfather of them all

Army Unveils Another Big Computer



Console of Brlesc at Aberdeen



Magnetic core storages hold 4,096 26-bit words

COMPUTER that "will rank in size and capability with any computer in the nation today" has been announced by the Ballistic Research Laboratories. U. S. Army Ordnance, Aberdeen Proving Ground, Md.

The new system, named Brlesc (pronounced "Burlesque") for Ballistic Research Laboratories Electronic Scientific Computer, was designed by BRL in cooperation with National Bureau of Standards. It was assembled by BRL technicians.

BRL is responsible for Eniac (Electronic Numerical Integrator and Computer) and Edvac (Electronic Discrete Variable Automatic Computer). Eniac was designed and built by the University of Pennsylvania in 1945 and Edvac in 1949 under Ordnance contracts.

Brlesc, Army says, will take its place in a mushrooming market which consists of approximately 260 computing systems, about 159 of which are still in use. The active systems, produced by 65 manufac-

turers, are responsible for more than 9,000 operating electronic computers.

Brlsc's high-speed magnetic core storage unit has a capacity of 4,096 words, of up to 72 bits each—equivalent to approximately 19 decimal digits—the word length necessary for scientific research. Developed by Ampex, the storage unit was also supplied to a number of computer manufacturers for integration into other defense systems.

The complete read-write cycle time of the Brlesc memory is 1.5 μ sec, the fastest large-scale memory in operation today, Army says.

There are larger computers than Brlesc and two that are faster. Brlesc is roughly one-half the speed of Univac's Larc and one-third the speed of IBM's Stretch. However, Brlesc is twice as fast as the IBM 7090, according to the Army. The faster machines use overlapping memory cycles from separate banks

of memories to achieve high effective memory speed.

Supplementing the high-speed storage element, magnetic drum storage units will be installed as back-up memory. It is expected that the capacity of the drums will be about 3,500 words.

Brlesc has facilities for reading and punching cards, reading and recording on magnetic tape. A maximum of 16 magnetic tape handlers are directly accessible to the programmer. Any two magnetic tape handlers, one drum, the card-reader and the cardpunch may be operated concurrently under separate automatic controls.

Brlesc has the ability to change addresses in instructions by fixed amounts, automatically. Called indexing, this feature permits the programmer to use the same set of instructions to process as many sets of data as he desires, simply by changing the index value, instead of modifying the basic over-all instructions.

High-Resolution Antenna To Use Array of Plates

BOSTON—Antenna designed at Air Force Cambridge Research Laboratories gives promise of high resolution at a fraction of the cost of conventional dish-type reflectors of comparable resolution.

Conceived by Allan Schell, of AFRL, the antenna will have an effective aperture diameter of 2,400 ft. yielding a beamwidth of one minute of arc. It will consist of 7,000 flat reflecting plates, each 20 ft square, arrayed as a giant cloverleaf pattern with an 800-ft tower in center for the feed. Each plate is positioned to redirect radiation to the feed mechanism on tower.

The antenna could be scanned over a 90-deg cone, with a central computing unit to determine adjustments of plates for a specific direction and wavelength. Adjustability of plates would permit operation over range from 200 to 2,000 Mc and rapid beam steering.

A model is now under construction at AFRL field site in Concord, Mass., for noise temperature measurements and to evaluate optimum spacing of plates. The model will have 220 reflecting plates, each five ft square, and a tower 100 ft high.

ML-8087 Precision Scan Conversion Tube Fast Erase High Resolution



- 1 High resolution: a minimum of 180 range rings/diameter at 50% amplitude modulation; equivalent to 900 TV lines.
- 2 Fast erase: less than 2 seconds erase cycle to reduce stored information to noise level.
- 3 Wide storage range: to meet FAA 1213b specification and beyond.
- 4 High signal/noise ratio, typically 80:1 (peak signal to rms noise).
- 5 Rapid set-up time: only a few minutes installation time is required to adjust tube for optimum operation. No need for critical dynamic focussing of electron beams.
- 6 No variation of output signal with size of written area.
- 7 Only simple video circuits are needed for readout.

Send For Data

MACHLETT

The Machlett Laboratories, Inc.
A division of Raytheon Company
Springdale, Connecticut

Ion Engines Outgrow Theory

SAN FRANCISCO—Electric propulsion engines have moved into the nuts and bolts stage.

During the American Rocket Society's recent Electric Propulsion Conference in Berkeley, Ernst Stuhlinger, of Marshall Space Flight Center, told ELECTRONICS that both ion and arc-jet engines are at the point where flight testing is warranted and necessary for further development. He said NASA plans to flight test models of an ion engine and an arc-jet engine in 8 to 10 months. The primary problem of space charge neutralization in ion engines is now pretty well in hand, he said.

Stuhlinger said the power source is now the big problem, but that the probable first electric propulsion mission—a slow spiral through the Van Allen belts—could be done with a 30-Kw Snap 8 rather than the projected 60-Kw unit. He said a mission of this kind may be possible around 1966-67.

With engineers confident about theoretical principles, papers delivered at the conference dealt largely with the mechanics of engine development: problems of efficiency, reliability, long life, corrosion and propellant feed. State of the art appears far enough along for discussions of manned and unmanned missions beyond the moon.

Myron Levoy, of Thiokol, reported that a 1,500-ton spacecraft propelled by a nuclear reactor in combination with six plasma engines would be 37 percent lighter than a ship with an all-nuclear engine. Such a craft could carry seven men to Mars and back.

Design of a power source for the 1-Kw arc engine to be used with the Scout electric rocket test program (ELECTRONICS, p 87, Nov. 17, 1961) was described in a paper by R. J. Boehme and E. H. Cagle of Marshall Space Flight Center. They reported demonstrating feasibility of a d-c to d-c static converter power supply that would use a constant current type saturable reactor for regulation. They said the reactor promises an attractive degree of arc stabilization and control. A

zinc-silver oxide battery system was chosen.

In discussing NASA's electric propulsion program, William Woodward estimated \$17.6 million is presently being applied to electric engines, with a total for both engine and power generation programs of more than \$50 million expected in fiscal 1963. System performance objectives are 10 pounds or less per kilowatt, sizes in the megawatt power range and an unattended operating life of years.

Procurement Policies Are Reported to EIA

WASHINGTON—Criteria that will determine what electronics are purchased by the new Defense Electronics Supply Center (ELECTRONICS, p 28, Jan. 19) were outlined at the Electronic Industries Association's spring conference by Brig. Gen. W. V. Veal, DESC commander.

The agency will not buy items of specialized design and limited use if complexity requires repair by a major maintenance facility, if cost is high enough to warrant specialized management, or if the items are made by military service facilities for immediate use.

DESC will buy all common-use parts, including a long list of components. Veal said volume purchasing should result in price breaks, standardization and opportunities for greater automation.

Army Is Installing Last of the Birdies

LAST OF 18 operational Birdie Systems (Battery Integration and Radar Display Equipment) will be installed at defense centers by April 1. The semiautomatic facility links each Army Nike missile unit to NORAD's entire air defense system. The transistorized Birdie costs about \$1 million each, was built by the Martin Co. for the Army. Ten defense areas use the earlier Missile Master costing \$9 million each.

TWO OUTSTANDING HIGH-TEMPERATURE MAGNET WIRES



Tetroc

FOR CONTINUOUS OPERATION AT
HOTTEST SPOT TEMPERATURES
UP TO 200°C



Ceroc

FOR CONTINUOUS OPERATION AT
HOTTEST SPOT TEMPERATURES
UP TO 250°C

For continuous operation at hottest spot temperatures up to 200°C (392°F) and up to 250°C (482°F) for short periods of time—depend upon TETROC—an all Teflon-insulated wire available in both single and heavy coatings.

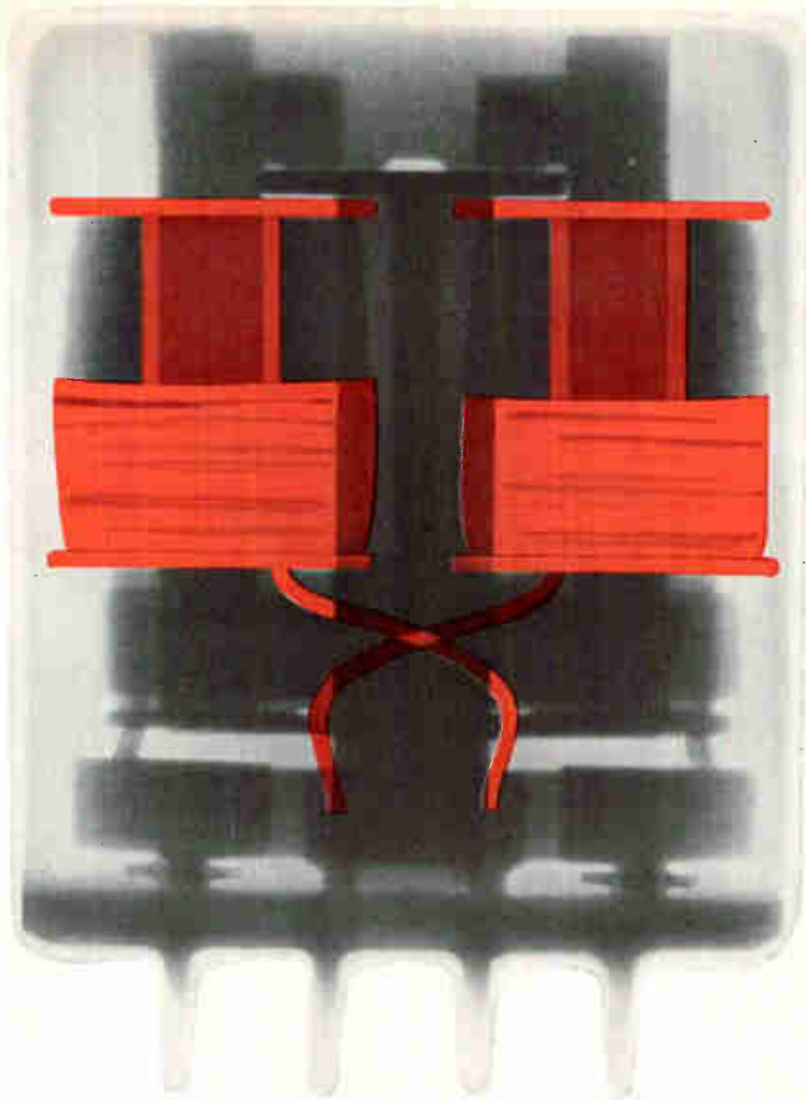
CEROC is Sprague's recommendation for continuous operation at hottest spot temperatures up to 250°C (482°F) and up to 300°C (572°F) for short periods of time. Ceroc has a flexible ceramic base insulation with either single silicone or single or heavy Teflon overlays. The ceramic base stops "cut-through" sometimes found in windings of all-fluorocarbon wire. Both Tetroc and Ceroc magnet wires provide extremely high space factors.

Write for Engineering Bulletins 405 (Tetroc Wires) and 400A (Ceroc Wires).

SPRAGUE ELECTRIC COMPANY
35 Marshall Street, North Adams, Mass.

SPRAGUE®

THE MARK OF RELIABILITY



Injection-molded coil form of **TEFLON® FEP** helps subminiature relay meet tough specs

In this versatile subminiature relay, the coil form is molded of Du Pont **TEFLON FEP**-fluorocarbon resin. Because FEP resin is melt-processible, the coil form is rapidly and economically produced by injection molding. These coil forms require insulation resistance of 10,000 megohms minimum at temperatures from 65°C to 150°C. Babcock Relays Division of the Babcock Electronics Corp. found that Du Pont **TEFLON FEP** resin was the only practical material offering the necessary insulating characteristics over this range of temperatures. The new relay meets the rigid MIL specifications for virtually all aircraft and missile applications.

The molding of the coil form of a **TEFLON FEP** resin also made possible miniaturization of the relay—only 1.3" high and slightly over one ounce in weight. And the stability

of **TEFLON** at high temperatures eliminates the major problem of contact contamination by outgassing. The superior electrical properties of **TEFLON** are also utilized in tape and in lead wire in this relay.

This is another example of improved electrical design made possible by the new melt-processible FEP resins, which make **TEFLON** available in the form of easily molded components and in long, continuous lengths of extruded wire insulation. For more information, write: E. I. du Pont de Nemours & Co. (Inc.), Dept. E-330, Room 2526T Nemours Building, Wilmington 98, Delaware.

In Canada: Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec.



TEFLON®
FLUOROCARBON RESINS

TEFLON is Du Pont's registered trademark for its family of fluorocarbon resins, fibers and film, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resins.

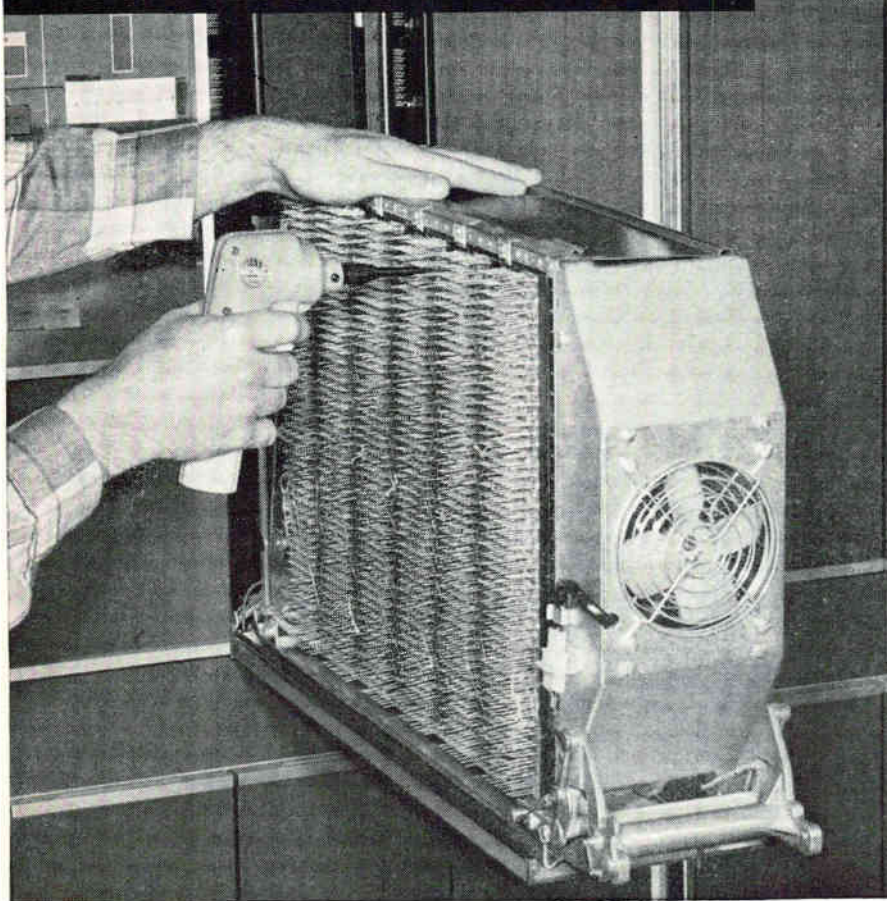
BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

March 30, 1962

CIRCLE 37 ON READER SERVICE CARD

37

NEW DIMENSIONS IN RELIABILITY



NOW make solderless connections...anywhere ...without plugging into a power source

All the power you need is stored in the handle! Here's important news for people who make electrical connections. It's the new Gardner-Denver battery-powered "Wire-Wrap"® tool that brings new time-saving convenience to the production line. And it's a must for the serviceman's kit.

No more dangling extension cords or trailing air hose that can damage delicate assemblies. No dependence on elusive power outlets.

This handy new tool weighs only 16 oz., yet makes thousands of perfect electrical connections without recharging. And recharging is easy . . . simply plug the battery into a wall outlet overnight.

The new battery-powered model 14R2 "Wire-Wrap" tool is another new dimension that Gardner-Denver has added to the reliability of electrical connections. Get the whole story in a hurry—phone or wire for new Bulletin 14-3.



NEW

**Gardner-Denver
battery-powered
"Wire-Wrap"
tool.**



EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER - DENVER

Gardner-Denver Company, Gardner Expressway, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario

MEETINGS AHEAD

MICROWAVE MEASUREMENTS LECTURES, IRE-PGMT & T; Babson Institute, Wellesley, Mass., April 4, 11, 18, 25.

CHEMICAL & PETROLEUM INSTRUMENTATION SYMPOSIUM, Instrument Soc. of America DuPont Country Club, Wilmington, Delaware, April 9-10.

PLASMA SHEATH SYMPOSIUM, AF Cambridge Research Labs; New England Mutual Hall, Boston, April 10-12.

AEROSPACE SYSTEMS RELIABILITY SYMPOSIUM, Instit. of Aerospace Sciences; Salt Lake City, Utah, April 16-18.

HIGH SPEED COMPUTING & MATHEMATICAL RESEARCH SYMPOSIUM, Assoc. for Computing Machinery and Amer. Math. Society; Chalfonte-Haddon Hall Hotel, Atlantic City, N. J., April 16-18.

FREQUENCY CONTROL SYMPOSIUM, U. S. Army Signal Research and Development Laboratory; Shelburne Hotel, Atlantic City, N. J., April 25-27.

WESTERN SPACE AGE INDUSTRIES & ENGINEERING EXPOSITION/CONFERENCE, sponsored by various business and governmental organizations; Cow Palace, San Francisco, April 25-29.

MANNED SPACE FLIGHT SYMPOSIUM, IAS; Chase Hotel, St. Louis, Mo., April 30-May 2.

INSTRUMENTAL METHODS OF ANALYSIS SYMPOSIUM, Instrument Soc. of America; Daniel Boone Hotel, Charleston, W. Va., April 30-May 2.

JOINT COMPUTER CONFERENCE, IRE-PGEC, AIEE, ACM; Fairmont Hotel, San Francisco, Calif., May 1-3.

HUMAN FACTORS IN ELECTRONICS, IRE-PGHFE, Lafayette Hotel, Long Beach, Calif., May 3-4.

ELECTRONIC COMPONENTS CONFERENCE, IRE-PGCP, AIEE, EIA; Marriott Twin Bridges Hotel, Washington, May 8-10.

NATIONAL AEROSPACE ELECTRONICS CONFERENCE, IRE-PGANE; Biltmore Hotel, Dayton, Ohio, May 22-24.

POWER INSTRUMENTATION SYMPOSIUM, Instrument Soc. of America; Hotel Texas, Fort Worth, Tex., May 6-9.

COMPUTER CONFERENCE, Michigan State University; at the University, East Lansing, Michigan, May 7-8.

WESTERN ELECTRONICS SHOW AND CONFERENCE, WEMA, IRE; Los Angeles, Calif., Aug. 21-24.

ADVANCE REPORT

SPACE ELECTRONICS & TELEMETRY SYMPOSIUM, IRE-PGSE&T; Fontainebleau Hotel, Miami Beach, Fla., Oct. 2-4. One-thousand word summaries of papers in the following fields should be sent to Dr. Joachim Muzhner, Lockheed Aircraft Corporation, Missiles & Space Division, Bldg. 204, Plant 2, P.O. Box 504, Sunnyvale, Calif., not later than April 20: (1) Telemetry (civilian & military projects, missiles & space vehicles, space crafts & satellites, system-performance analysis & reliability); (2) Space Electronics (communication systems, tracking, subsystems, components).

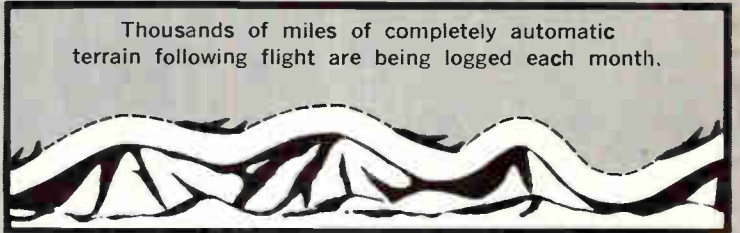
SURVIVABILITY*

Success of a military mission is measured in terms of accomplishment. For manned and unmanned aircraft, a major parameter of accomplishment is survivability (*ability to fly to, and return from, the target).

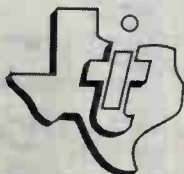
Survivability is currently being studied at very low altitudes. Texas Instruments Incorporated, working with the U.S. Army Signal Corps, the Air Force, and prime aerospace contractors, conceived and developed a completely automatic low-altitude navigation system. This system is light, simple, and relatively inexpensive. It flies the aircraft accurately over an extremely low-altitude terrain profile . . . automatically!

For complete technical information, write Apparatus Division, Texas Instruments Incorporated, P. O. Box 6015, Dallas 22, Texas. Qualified "NEED TO KNOW" respondents only, please.

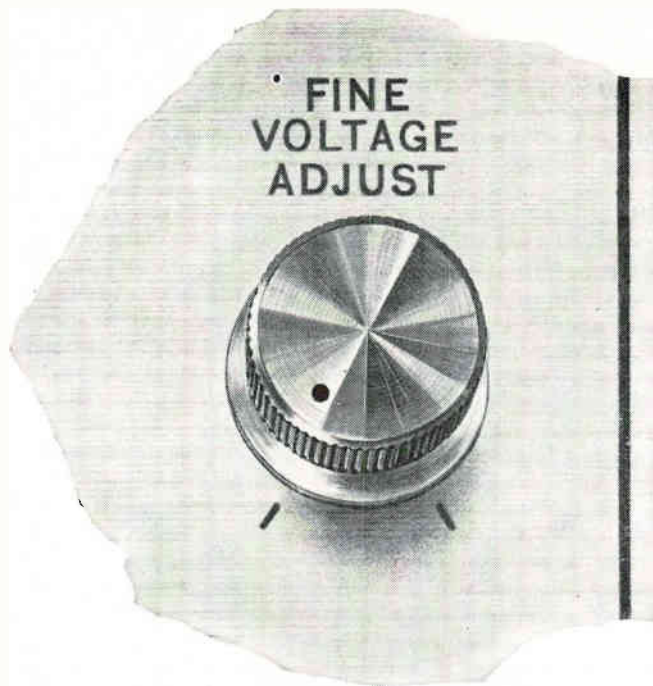
Thousands of miles of completely automatic terrain following flight are being logged each month.



APPARATUS DIVISION
PLANTS IN DALLAS
AND HOUSTON, TEXAS



TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE
P. O. BOX 6015 • DALLAS 22, TEXAS



DETAIL FROM A WORK OF ART

A power supply control knob is a detail. We love details and give them the importance we feel is their due. For an electronic instrument, as well as a work of art, is the sum of all details. Technical details, electronic details, human factor details.

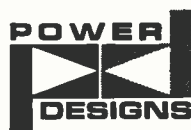
The fine voltage adjust control of our model 5015A is a case in point. We human-engineered this anodized aluminum knob for durability, appearance, torque/diameter ratio, panel protection against fingernail scratches, and just downright "feel." Nor did we stop here. We inspect every instrument we ship to make certain this "feel" is just right.

Turn this knob and you will find another detail:

smooth mechanical control translated into smooth electrical control. There is no need to twiddle to find the right voltage. You won't find parallax on the main voltage control. It has been eliminated by a unique mechanical linkage between the variable autotransformer and its tracking potentiometer.

You will also discover that the performance characteristics of this instrument far exceed our published ratings. That's because our specifications are based on performance at the end of five years of operation rather than at the time of shipment.

We think the model 5015A is a work of art. Won't you give our sales representative an opportunity to exhibit his artistic pride in a demonstration.



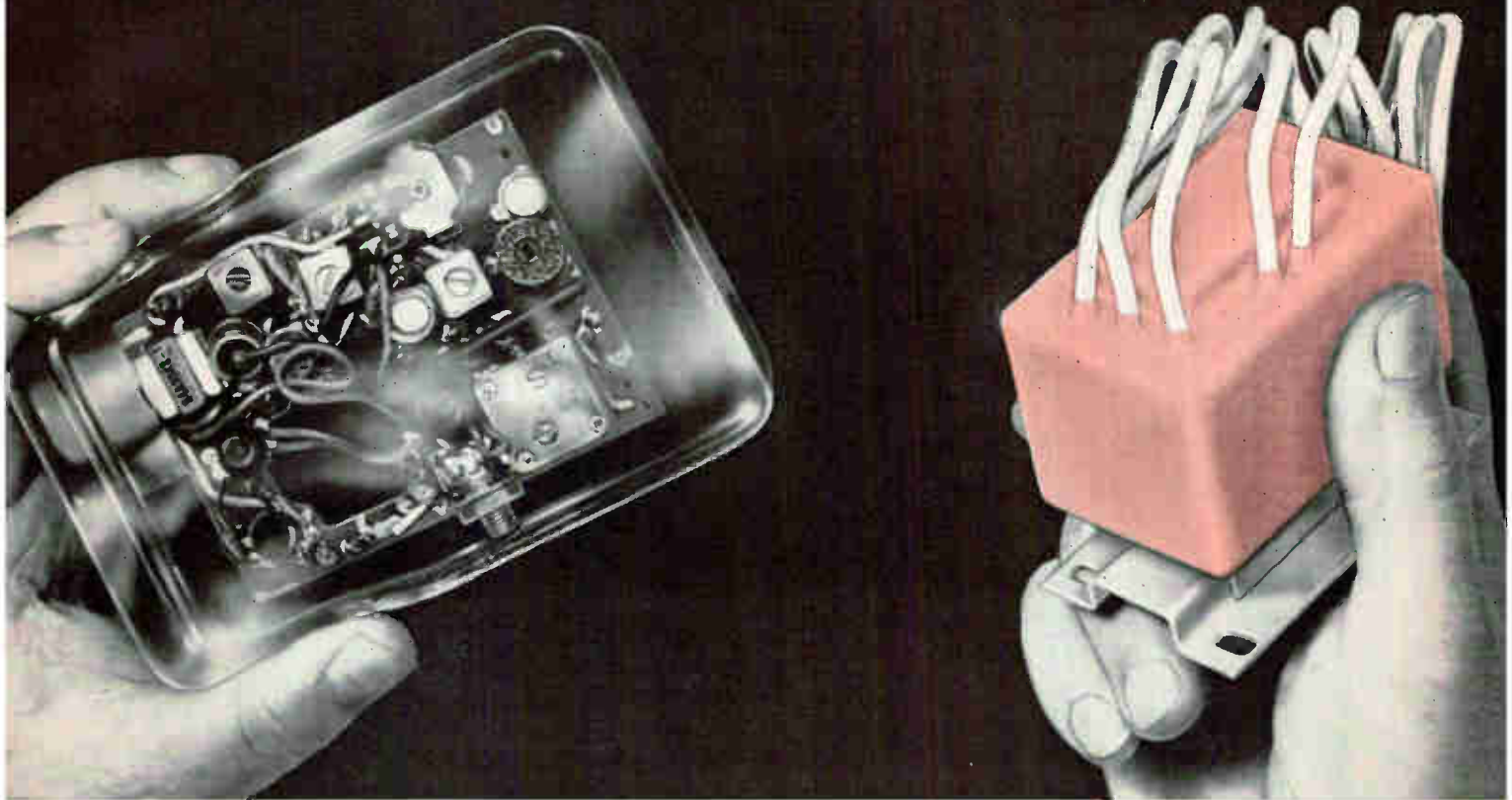
MODEL 5015A

See us at Booth 1516 IRE Show

POWER DESIGNS INC.

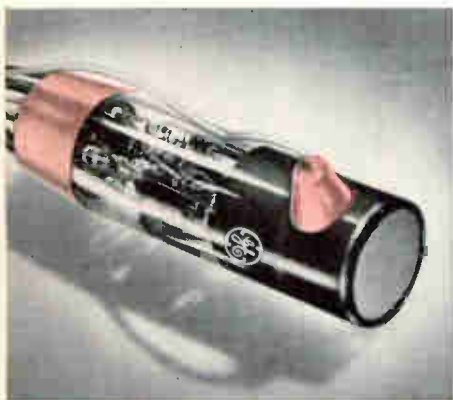
1700 Shames Drive, Westbury, L. I., N. Y.
EDgewood 3-6200, Area Code 516

Different potting and encapsulating problems require different solutions. That's why General Electric offers a family of eight RTV and LTV silicones. LTV-602, for instance, is transparent, resilient and very easy to repair, curing in two hours. RTV liquid silicone rubber compounds offer good physical strength, resiliency and a selection of viscosities for impregnation, potting, conformal coatings or sealing.



8 fast cures for potting and encapsulating problems

General Electric Silicones protect against temperature, moisture, ozone, thermal and mechanical shock



	COLOR	VISCOSITY POISES	CONSISTENCY
LTV-602	Clear	15	Easily Pourable
RTV-11	White	120	
RTV-20	Pink	300	Pourable
RTV-40	White	450	
RTV-60	Red	550	
RTV-77	White	8,000	Spreadable Thixotropic Paste
RTV-88	Red	10,000	
RTV-90	Red	12,000	Stiff Paste

Why are G-E silicones used? To protect against temperature extremes from -65°F to 600°F . . . to provide a resilient, shock-absorbing cushion for delicate parts . . . for outstanding electrical properties . . . for their very low (0.2%) shrinkage . . . for their resistance to moisture, ozone and thermal shock.

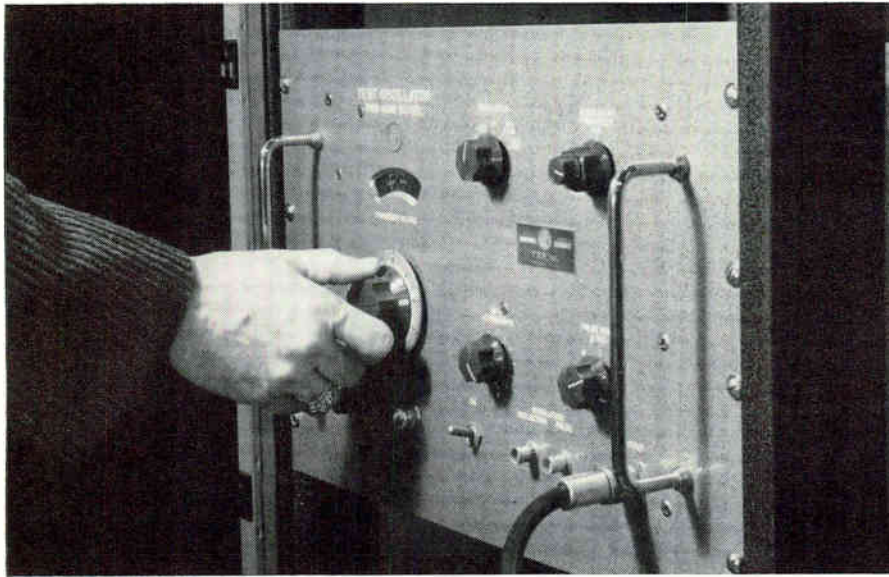
How are G-E silicones used? By dipping, pouring, spraying or buttering. Cure times can be varied from minutes to hours, depending on catalyst used and the heat applied (from room temperature to 125°C). They bond easily to properly primed surfaces, are easily removed from unprimed surfaces.

Which is best for you? G-E encapsulants vary in viscosity from a readily pourable liquid to a thick paste to fit special requirements. Applications range from deep impregnation of transformer coils to caulking of large equipment . . . from printed circuit encapsulation to making flexible molds.

Write for complete data. If you would like a free sample for evaluation, write on your business letterhead describing your proposed application. Section N364, Silicone Products Dept., General Electric Co., Waterford, New York.

GENERAL  ELECTRIC

- Rack-mounted signal sources for 900-11,000 mc.
- High-power coaxial cable that's really flexible
- New crimp-type subminiature connectors



Rack-mounted signal sources for 900-11,000 mc.

Now you can mount FXR's series 772 test oscillators in standard 19-inch racks—for use in laboratories and other permanent test applications. Like the FXR portable models, these new rack-mounted signal sources provide ample RF power in the 900 to 11,000 mc. range.

In all signal sources, power supply and klystron are combined in a single unit. This makes operations safer—exposed klystron wires are eliminated. Klystron replacement is faster and less expensive—as little as 1/4 the cost of klystron replacement in separate power supply and klystron set-ups.

MODEL	FREQUENCY RANGES	PRICE
L772A	0.95 to 2.0 KMC	Portable \$1235. Rack \$1250.
S772A	1.9 to 4.0 KMC	\$1035. \$1050.
C772A	3.95 to 8.2 KMC	\$1340. \$1355.
X772A	7.0 to 11.0 KMC	\$1340. \$1355.
Power Output	10 MW to 100 MW max CW output. Power variable through use of an internal level-set attenuator.	
Modulated Outputs	Internal: CW, pulse or square wave External: Pulse, square wave or FM	
External Modulation Requirements	Pulse: Positive pulse of 30 v. amplitude across 100 K ohms. Pulse width from 0.5 microsecond to square wave. Reflector: sine wave or sawtooth FM, sensitivity from 100 to 200 kc/v.	
Connectors	RF Output: Type N jack. External pulse: Type BNC jack. Reflector modulation: Type BNC jack.	
Power Requirements	115/230 v. AC, 50 or 60 cycles, 150 w.	
Dimensions & Weight	Portable: 11" high X 16" wide X 15" deep; 45 lbs. Rack: 11" high X 19" wide X 15" deep; 45 lbs.	

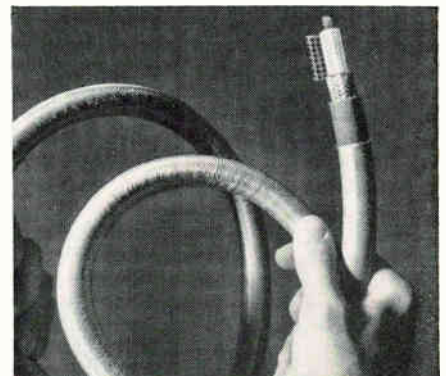
Single-control tuning lets you set frequencies faster and more accurately ($\pm 1\%$). Frequency remains constant, no matter how you vary the power output, because the klystron reflector voltage automatically

changes with the positioning of a broad-band, non-contacting tuning plunger inside the oscillator cavity.

RF power output ranges from 10 to 100 MW. It's controlled from the front panel, through a level-set attenuator.

The portable models are available from stock; the rack-mounted models are shipped within a month. For more information, circle Reader Card Number 253. ■

High-power coaxial cable that's really flexible



This is a new FXR product—Amphenol type RG-281/U coaxial cable. It was developed for an Air Force electronic counter measures system, where small space required a cable that bends and flexes easily without changing electrical properties. Now, it is available commercially.

Perforated Teflon tape dielectric gives this cable extra flexibility. The tape continuously supports the center conductor...keeps center and outer conductors concentric even when the cable is bent over small radii.

Teflon tape also cuts down moisture condensation at dielectric interfaces because it eliminates voids between cable and connector dielectrics.

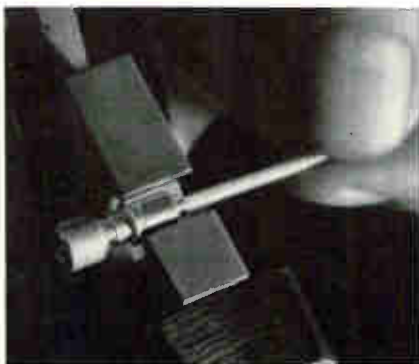
Type RG-281/U power cable gives you a VSWR of less than 1.2... a dielectric constant of 1.55... serves as general purpose RF transmission line, easy to install and operates at high temperatures. *For more information, circle Reader Card Number 254.* ■

New crimp-type subminiature connectors

FXR's new Subminax® Series 5116 quick-crimp micro-miniatures make faster, more reliable, less costly cable assemblies. And you don't have to redesign your product to use them, because Series 5116 micro-miniatures are interchangeable with competitive counterparts. In fact, the addition of this new Series to the Subminax line means that you can now specify a Subminax connector that mates with or is interchangeable with any known sub-miniature or micro-miniature coaxial connector on the market today.

The new Subminax Series 5116 has at least three major advantages over other micro-miniatures:

□ *Faster Assembly*—Quick-crimping feature, plus standard crimping tool, makes child's play of cable assembly. For example, Series 5116 plugs and jacks have only three parts, including body assembly. Easier, less critical cable stripping. No braid soldering.



□ *Dependable Delivery*—new FXR micro-miniatures are immediately available from factory stocks or your Amphenol distributor.

□ *Lower Price*—Series 5116 coaxial connectors are priced substantially below current prices for competitive "equivalents."

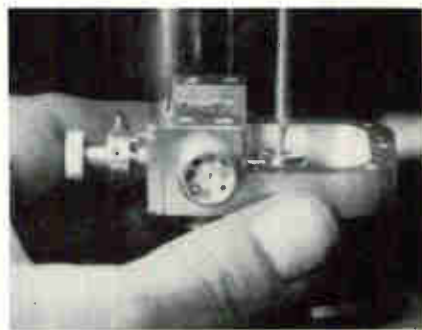
□ *Technical Facts*: 500 VRMS; impedance: 50, 75 or 95 ohms; gold-plated captivated contacts (solder type); Teflon* insulation; silver-plated body; screw-on or push-on coupling; color coding boots—optional. For use with coaxial cables in the .075 to .115 OD range. *For more information, circle Reader Card Number 255.* ■ *Registered trademark of DuPont

It takes a jeweler to make waveguides at new FXR facility

FXR recently expanded its microwave facilities at Woodside, New York, to meet the growing demand for millimeter waveguides. But expansion is only part of the story. Precision is the other.

The waveguides made here are used in space communications equipment. They have to be extremely

small and extremely accurate. The combination calls for some of the most delicate machining operations you'll see outside a jeweler's shop. Tolerances—as small as 0.0001 inch—are so critical that FXR technicians at Woodside put parts through a final diamond-lapping operation to achieve the necessary accuracy in dimension and surface.



FXR uses Starrett Depth Gauge to check accuracy of slotted waveguide parts within ± 0.0001 inch.

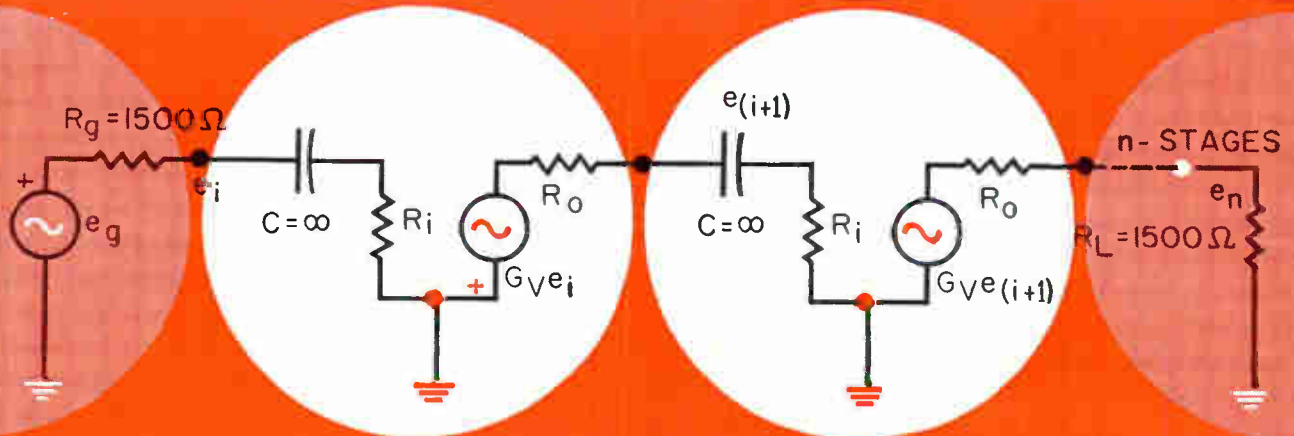
A large engineering staff supports these precision manufacturing facilities. It works with customers in developing special products for microwave applications. ■

The RF Products and Microwave Division Amphenol-Borg Electronics Corporation; 33 East Franklin Street, Danbury, Connecticut.

Visit us at IRE: Booths 1802, 1901, 1903, 1905.

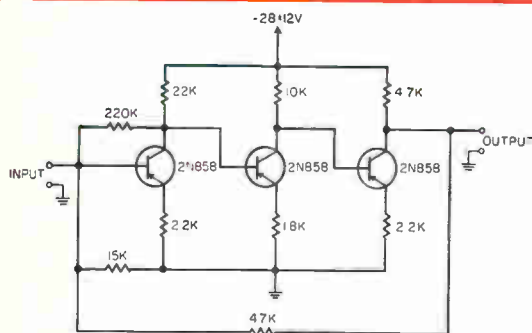
FXR™

■ New Circuitry Made Possible By Philco Transistors

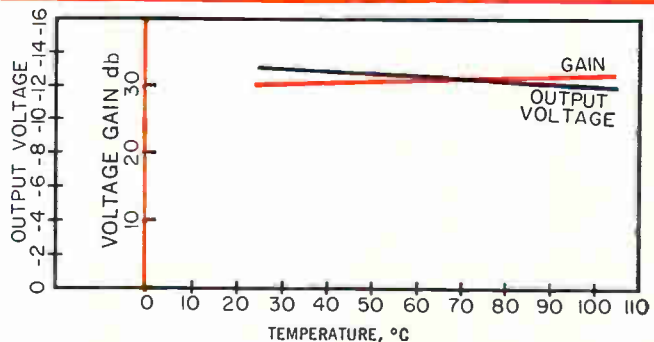


GAIN CHAIN

A compact direct-coupled utility amplifier, with identical input and output impedances, can be duplicated and cascaded in an iterative chain for extremely high gain. And the "links" (amplifiers) in this chain are adaptable to many applications. The amplifier's 3 direct-coupled Philco 2N858 Silicon Precision Alloy Transistors deliver high gain, over a wide temperature range. ■ The 2N858 transistor, as a result of Philco's fully-automatic SPAT* process, features low cost and process-controlled uniformity, in addition to the device's superior temperature stability. ■ Send for Application Lab Report 746, and data on Philco SPAT type 2N858. Write Dept. E33062.



DIRECT-COUPLED UTILITY AMPLIFIER



DC OUTPUT VOLTAGE AND VOLTAGE GAIN VS. AMBIENT TEMPERATURE

Philco SPAT
Types 2N858—2N865
are immediately available
from your Philco Industrial
Semiconductor Distributor.

*Trademark Philco Corp.

PHILCO

A SUBSIDIARY OF *Ford Motor Company*

LANSDALE DIVISION, LANSDALE, PA.



HIGH-DENSITY STORAGE OF Wideband Analog Data

System overcomes need for 52 separate record-playback heads by time-division multiplexing of input signals. Two-track video recorder accommodates the resulting high density information

By M. H. DAMON and F. J. MESSINA, ITT Federal Laboratories, Nutley, N. J.



STORING multichannel wideband phase-coherent analog information on magnetic tape with reasonable tape playing times is a formidable problem. However, a system for recording fifty-two individual 15-Kc bandwidth channels in real time has been developed. The system requires a recording bandwidth of better than 750 Kc, plus strict channel-to-channel phase and amplitude integrity.

Superficial consideration suggests several methods by which multichannel analog information may be multiplexed for recording on magnetic tape. The important methods are multiple-track recording, frequency-division multiplex, and the time-division multiplex techniques of pcm, pdm and pam. However with the exception of the latter technique, each method has various disadvantages for this application.

Direct recording of 52 tracks needed for this application is beyond the present practical state-of-the-art. The maintenance of channel-to-channel phase relationships becomes a difficult problem due to head alignment, gap scatter and dynamic skew. While the electronic

Executive engineer M. H. Damon checks circuit module used in analog storage apparatus

correction of these parameters is technically feasible, it becomes complex when machine-to-machine timing tolerances and interchangeability of tapes is considered.

Frequency-division multiplex on parallel tracks also has some intrinsic difficulties. There is the problem of maintaining accurate phase relationships between the various channels, which are being recorded in widely different frequency bands. Great care must be used in avoiding distortion within the spectrum of the full bandwidth tracks to be used, since harmonics of the lower frequency channels fall into the higher frequency channels. This distortion can be avoided by using only the upper half of the frequency range so that second harmonics will fall outside the pass-band; however, this process reduces the utilization factor of the available bandwidth by two-to-one on each of the magnetic tape tracks. In addition to the problem of maintaining integral phase relationships, it is difficult to maintain amplitude consistency, particularly for those channels whose frequencies lie near the upper end of the pass-band.

Since most of the difficulties in multiple-track recording are a function of the tape transport and recording medium itself, all information channels must be treated identically by the transmission medium. Single track wideband recording using time-division multiplex is the only system having this characteristic, and even then the wideband track must be used judiciously to avoid nullifying its advantages.

There are several methods of time-division multiplex. Pulse dura-

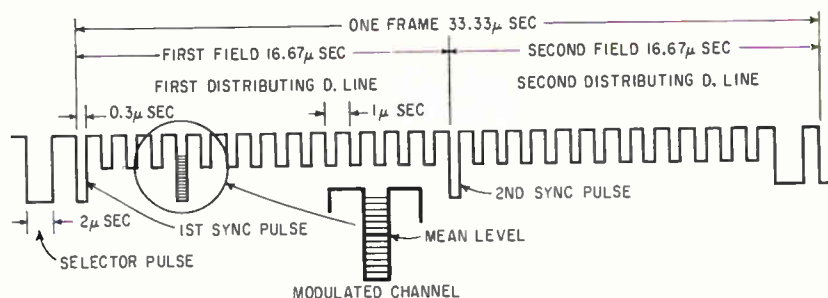


FIG. 1—The data recording system uses two recording tracks, each accommodating 26 channels. Pulse pattern shows disposition of individual channels on one track

Typical circuit module is easily interchanged

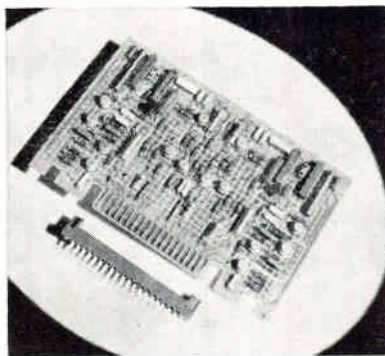


FIG. 2—Two cascaded delay lines are needed for timing since a single delay line with adequate tolerance is unavailable. Same basic timing circuit is used for both recording and playback.

tion modulation (pdm) is a system of pulse modulation wherein the width of a pulse in a particular time slot (corresponding to a channel) is varied in proportion to the amplitude of the wave being sampled. Pulse duration modulation is hardly ever used in transmission systems owing to its poor bandwidth efficiency. Pulse position modulation (ppm) is a more practical multiplexing system, and demonstrates improved bandwidth utilization; however it is still not suitable for this 52-channel recording application.

Pulse code modulation (pcm) is more precise than any of the pulse modulation methods in the sense that the transmitted, or in this case recorded signal, can be reproduced

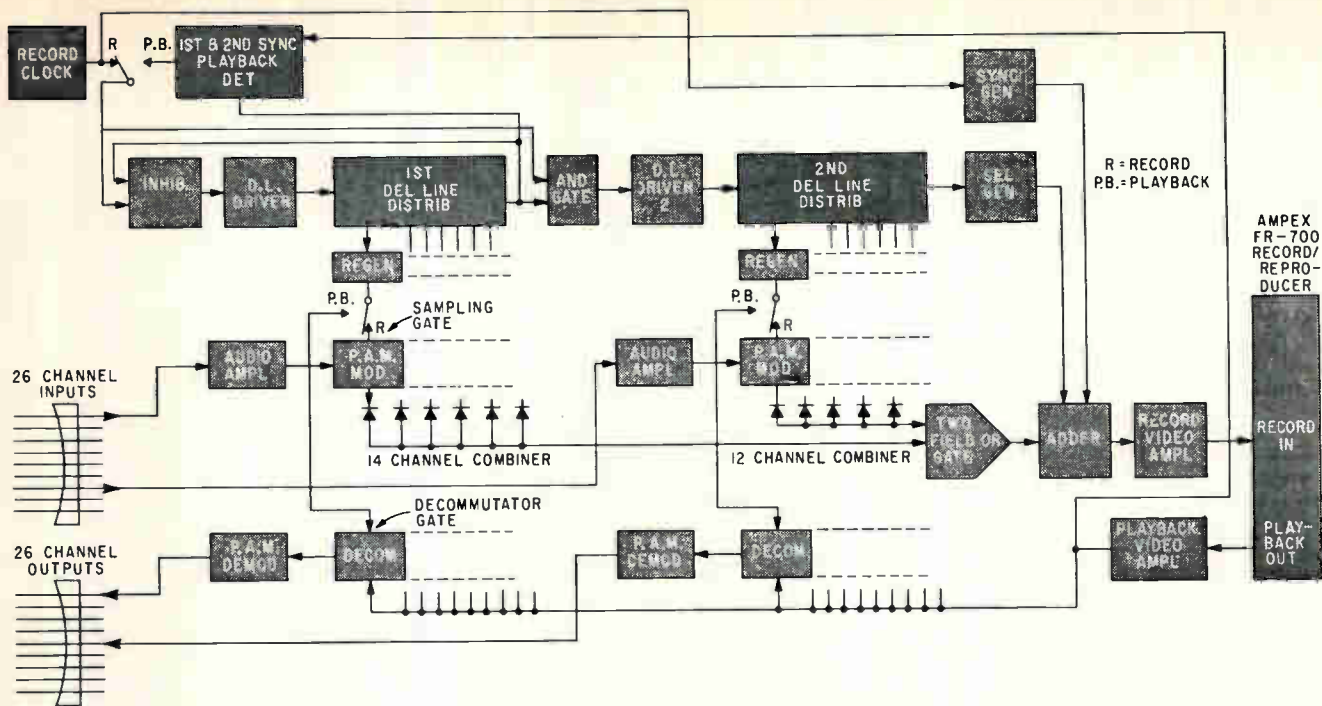
as accurately as is desired, provided there is sufficient bandwidth. The audio wave to be recorded is first amplitude sampled, and then the amplitude sample is quantized into a binary level corresponding to its amplitude. Accuracy is determined by the number of quantum steps selected, each quantum step being represented by a binary pulse. The utilization factor of this system (number of channels for a given bandwidth) is poor, since a relatively large number of pulses must be used for any one channel to ensure a respectable degree of accuracy and sufficient dynamic range.

In a pulse amplitude modulation (pam) system, the signal information is contained in the amplitude of a train of pulses. Sampling theory dictates that if a magnitude-time function is sampled instantaneously at regular intervals and at a slightly higher rate than twice the highest significant signal frequency, then the samples contain all the information of the original signal. The repetition rate can be considered as a frame rate, and the discrete time slots that can be allotted in the time period determines the number of channels that can be multiplexed.

A pam system cannot be considered where the transmission medium has an unpredictable amplitude characteristic. The magnetic tape medium has a predictable am-

TABLE I—CHARACTERISTICS OF RECORDER

Two Wideband Channels	
Frequency Response	10 cps to 4 Mc \pm 3 db
Rise Time	0.18 microsecond, 10 percent to 90 percent signal level
Signal-to-Noise	30 db peak signal to rms noise
Timing Accuracy	\pm 3 microseconds over any 1-millisecond period
Two Auxiliary Data Channels	
Frequency Response	300 cps to 15 Kc \pm 3 db
Signal-to-Noise	3 db rms signal to rms noise
Flutter	0.25 percent rms maximum at 25 ips, 30 to 300 cps in auxiliary channels
Taps Speed	12.5 ips for 1 wideband channel and 1 hour record time 25 ips for 2 simultaneous wideband channels



plitude stability, making a pam time-division multiplex system the best for this particular application.

In all time-division systems, time synchronization is essential between transmitter and receiver. Synchronization is usually achieved by setting aside time slots or intervals exclusively for monitor or synchronization pulses.

The practicality of using a conventional linear tape machine for recording wideband single track information is influenced by two important restrictions in tape-recording techniques.

(1) The reproduce-head design for linear tape machines determines a reasonably fixed bandwidth. A 6 db-per-octave drop in output can be expected, normally starting at the highest frequency to be reproduced. The lower frequency limit is fixed by a specific signal-to-noise ratio and will rise octave by octave, as the upper frequency is increased. For a minimum signal-to-noise ratio of 30 db, the maximum bandwidth that can be effectively reproduced is a spectrum of approximately ten octaves.

(2) When gap length of the reproduce head has been reduced to realistic manufacturing tolerances, the extension of frequency response can be accomplished by an increase in tape-to-head velocity. In a linear machine an increase in this velocity quickly reduces playing time.

Both of these problems are reduced in a transverse recording system. The first problem is solved by using a frequency modulation process to shift the recorded signal into a more suitable part of the spectrum. The head-to-tape speed necessary to perform this processing at the required frequencies is attained by sweeping a magnetic head transversely across the tape at a high speed while the tape moves longitudinally at a lower speed.

To meet the requirements of this high density recording system, the Ampex FR-700 wideband recorder/reproducer was selected. This tape transport mechanism has characteristics given in Table I. Additional reference and synchronizing information is recorded on the auxiliary tracks.

Using time-division-multiplexing of pam signals, twenty-six channels are recorded on each of the two wideband tracks as a pulse train. The amplitude of each individual pulse in this train carries the sampled amplitude of the channel it represents. Sampling rate is 30 Kc. Monopolar type of pulse amplitude modulation is used in this system—a pulse having a nominal amplitude is varied from its mean value by channel amplitude information, having only a single polarity as it goes through its maximum excursion. This is in opposition to the more commonly used bipolar form

of pulse amplitude modulation where both pulse amplitude and polarity are dictated by the input information. Monopolar modulation was selected not only for economical reasons (component saving approaching 2 to 1) but for the improvement of signal-to-noise and reduction of interchannel crosstalk. Signal-to-noise improvement can only be obtained if the multiplexed monopolar pam signal is stored on magnetic tape by f-m recording. The FR-700 recorder/reproducer uses this type of wideband recording.

In all time-division systems a distributor is necessary to establish the time base for the sampling system. Each output from this distributor is connected to a channel modulator. The distributor controls the time and duration that a channel's information is sampled. If the modulation outputs are all combined after sampling, a train of multiplexed channels results.

A delay-line distributor, because of its simplicity, was selected for this timing control. A multitap delay line is driven from a clock-standard and forms the time base for the sampling system. Sequential outputs then appear at discrete intervals. In the playback mode, the same delay line generates decommutation gates, but of longer pulse-width.

To use delay lines that are within

TABLE II—DELAY LINE
FEATURES

Total Delay	16.7 microseconds
Rise Time (last tap)	0.16 microsecond
Characteristic Impedance	400 ohms
Tap Tolerance	±0.1 microsecond
Attenuation	20 percent maximum
Temperature Coefficient	0.00007 $\mu\text{sec}/\text{deg C}$

the present state-of-the-art, two delay lines were necessary for recording each track, rather than one long line for which the requirements for rigid tap tolerances and the long time delays could not be met. The frame interval is described as the time elapsed for all the channels to be sampled once, and is divided into two fields. Each field corresponds to a time interval determined by the total delay in a distributing delay line. Figure 1 illustrates the systems' time philosophy. In Fig. 1, one frame is 33.33 microseconds in duration and represents the pam sampling rate of 30 Kc. The initiating pulse in each field is termed a sync pulse and represents the time at which the distributing delay lines are driven. The first sync pulse drives the first distributing delay which in turn generates channel sampling pulses that are approximately 0.3 microsecond in duration and are spaced 1.0 microsecond apart. The second sync pulse

provides the drive for the second distributing delay line.

Figure 1 also illustrates the condition where all the channels are unmodulated except one. This channel is shown in the expanded view as a monopolar pulse in its fully modulated state.

The composite signal shown in Fig. 1 is stored on one of the two wideband magnetic tracks of the tape-transport mechanism. Included in this composite signal are the 26 multiplexed channels, the first and second sync pulses and a selector pulse. The selector pulse is 2 microseconds wide and precedes the first sync pulse. This pulse is necessary in the playback mode to allow the decommutation process to detect the first sync pulse from the composite playback signal. The detected first sync pulse will then be used to initiate the decommutator gates which will occur in synchronization with the playback channel pulses.

A simplified system block diagram is shown in Fig. 2. When recording, a 60-Kc crystal oscillator provides clock signals. The clock rate is twice the 30-Kc sampling rate to facilitate the driving and synchronizing two distributors during one frame. The record clock output pulses are directed to three places; a sync generator, an inhibitor gate preceding the first delay-line driver, and an AND gate preceding the second delay-line driver. At the occurrence of the first record clock pulse the inhibitor gate is closed, since it has only one input,

and the clock pulse is allowed to trigger the first delay-line driver. This in turn drives the first delay-line distributor with a 0.3-microsecond pulse. At the same time the AND gate preceding the second delay-line driver is open since it also has only one input; this prohibits the first clock pulse from passing through. As the driver pulse travels down delay line 1, a series of channel sampling gates are generated. These are later shaped by regenerators. Approximately 16.6 microseconds later a pulse is applied to the inhibitor gate and the AND gate from the final delay line tap. This pulse will coincide with the second clock pulse and will open the inhibitor gate and close the AND gate. This action will trigger the second delay-line driver and inhibit the first delay-line driver. A similar generation of channel sampling gates for the second field occurs. Since the first delay-line distributor was not driven by the second clock pulse, neither the inhibitor gate nor the AND gate are pulsed when the third clock pulse arrives; the third clock pulse causes the (drive) to the first distributing delay line to be repeated. The fourth clock pulse will of course drive the second distributing delay line. The distributing delay lines are then alternately driven by the clock pulses to generate channel sampling gates at 30 Kc.

All of the wideband channel inputs are amplified through separate audio amplifiers. The audio amplifier outputs are applied to pam Modulators. The block diagram shows only one audio amplifier and one pam modulator in each 26-input field. There are actually 14 such amplifier-modulator pairs in the first field and 12 in the second. Each of the pam modulators samples the output from its audio amplifier at a time governed by its regenerated channel sampling gate. Since the pam modulator outputs occur sequentially they can be combined through a 14-channel OR gate for the first field and a 12-channel OR gate for the second. These two fields are now combined in the two-field OR gate, and its output is applied to an adder. This adder combines the first and second sync pulses, produced by a sync generator, with selector pulse from the selector generator and the two

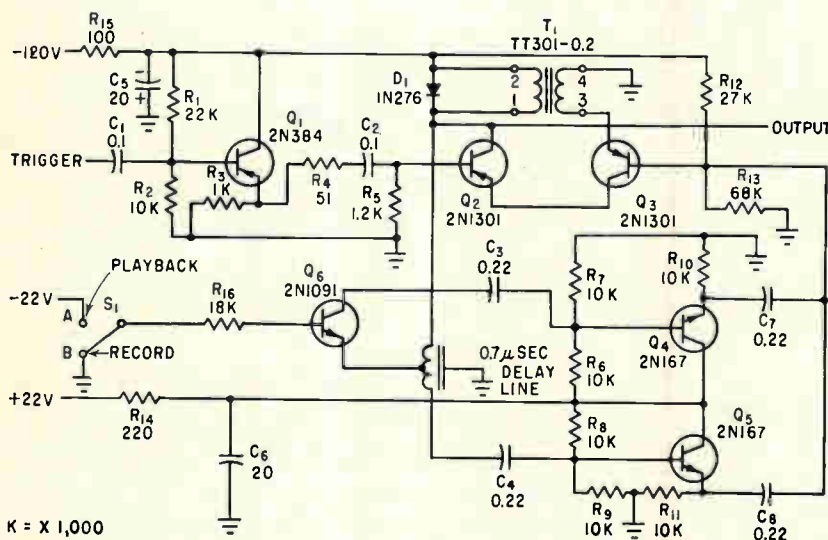


FIG. 3—Delay-line pulses are generated by blocking oscillator, with pulse width switched 0.3 μsec for recording and 0.8 μsec for playback

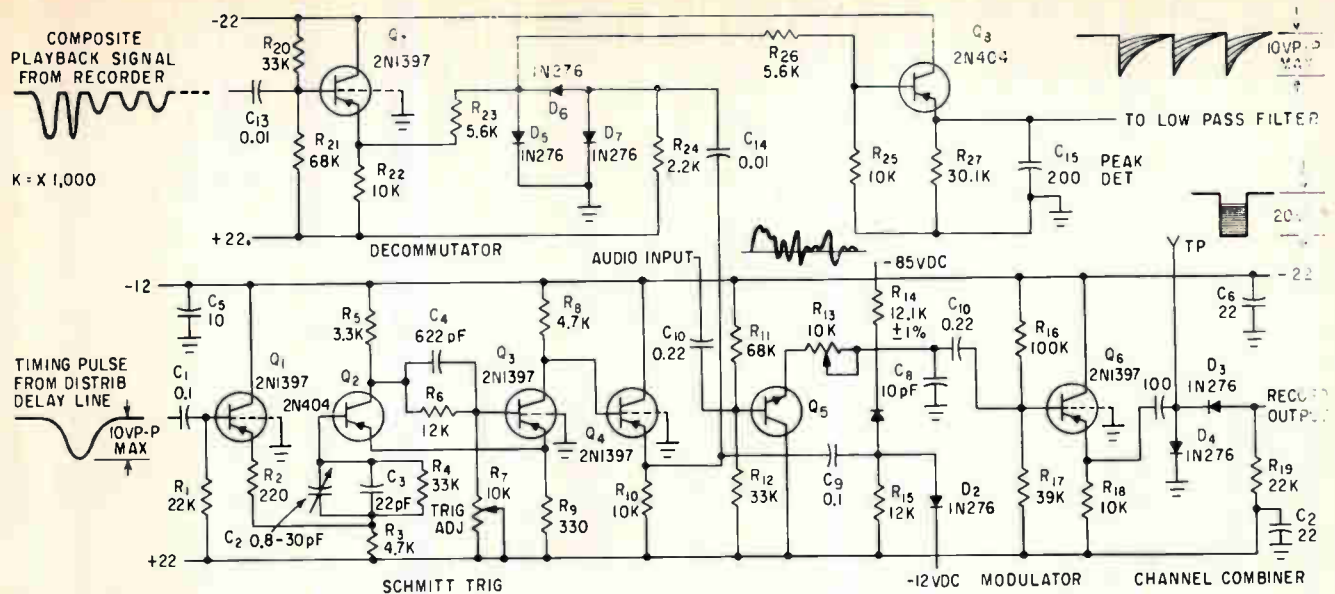


FIG. 4—Schmitt trigger reshapes delay-line output pulses and feeds them to modulator and decommutator. Emitter follower Q_8 delivers output on receiving delay-line-controlled gating pulses

fields of multiplexed channels. The adder output is applied to the record video amplifier and from there to the record electronics of the FR-700 for storing on magnetic tape.

During playback it is necessary to decommutate each channel from the composite playback signal so they may be processed separately and applied to their output lines. Consequently decommutating gates must be generated at the proper time and duration to straddle the playback channel pulses. The first and second sync pulses in the composite playback signal carry the information to generate these decommutating pulses since there is a direct time relationship between the sync pulses and the channels in the respective fields. The first and second playback sync detector selects the sync pulses from the output signal of the playback video amplifier. In this mode of operation, the detector operates as a playback clock and alternately drives the first and second distributing delay lines. Pulses that function as decommutating gates, occur at the delay line taps. These gates are applied to individual decommutators after they are regenerated. The width of these gates is a function of the delay-line drivers.

In the playback mode the delay-line drive circuits supply both lines with a 0.8-microsecond pulse rather than 0.3-microsecond pulses. These

0.8- μ s pulses straddle the playback channel pulses. Each of the decommutators are fed with the composite playback signal after it has been amplified by the playback video amplifier. A decommutator output occurs only when there is coincidence between a decommutator gate and a channel of the composite signal. The output from the decommutator is then applied to a pam demodulator where the original channel information is recovered.

In the delay line, a pulse from the clock circuit appears sequentially at each tap and generates the basic timing format for the sampling system. In the record mode the regenerated pulses from each tap are approximately 0.3-microsecond duration and are used as sampling pulses in a pam modulator. During the regenerated pulse from each tap is 0.8 microsecond wide, and decommutates the composite playback signal into individual channels for demodulation.

Some of the more important delay line distributor specifications are given in the Table II.

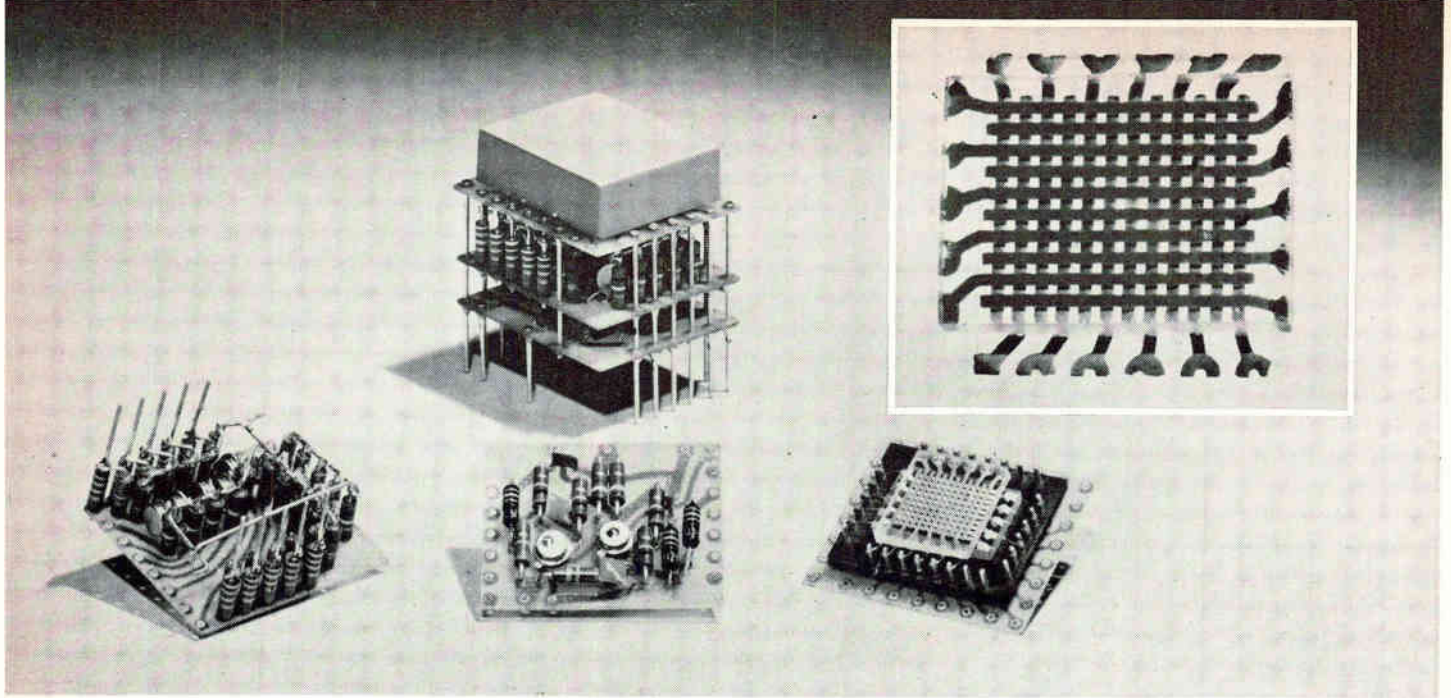
The delay-line driver (Fig. 3) provides drive pulses for the delay-line distributor in a time sequence established by the record or playback clock circuits. The delay-line driver provides a pulse length to the delay-line distributor that is either 0.3 microsecond or 0.8 microsecond, depending on the posi-

tion of S . The delay-line driver is a variable width delay-line-controlled blocking oscillator.

The pam modulator decommutator Fig. 4 consists of the Schmitt trigger, which regenerates the degraded pulses from the distributing delay line, the modulator, which samples an audio signal for one particular channel during the record mode, and the decommutator, which separates individual channels from the composite signal during playback.

When no sampling pulses are present, diodes D_1 and D_2 are forward biased and the junction of R_{13} and R_{11} is at -12 volts. A sampling pulse from the Schmitt turns off both diodes. The voltage at the junction is determined by their voltage-division ratio, the voltage at the emitter of Q_5 and the -85 -volt supply. When no audio signal is present the level-adjust potentiometer is adjusted to give -23 volts at junction of R_{13} and R_{11} . A fully modulated audio signal causes this voltage to swing from -13 volts to -33.5 volts. Thus a 30-Kc train of negative pulses, whose envelope can vary up to 20 volts peak-to-peak, is coupled into an emitter follower whose output drives a channel combiner.

This device was developed as part of a training equipment for the U. S. Naval Training Device Center, Port Washington, Long Island.



The diode matrix is mounted between two circuit plates to form a connected matrix. The completed matrix is then placed on a header and encapsulated into a finished package. It can then be treated as a single component

Diode Matrix Shrinks Decimal Counter

By **ROGER W. WOLFE**
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DEVELOPMENT of efficient methods of packaging components has provided many areas of circuit development. One such case may be found in the circuit concept for a decimal counter, made possible by a compact package containing many diodes connected in a matrix. Such a package, commercially known as a Bipco diode matrix, enables the circuit designer to use large quantities of diodes—in this case 90—without regard to the problems of connecting so many diodes while at the same time obtaining the diodes at an economical price. While the counter could easily be made using conventional components, it would not be attractive because of the relatively large volume occupied by the components and the attendant costs both of these components and of suitable assembly.

The diode matrix is made by diffusing a junction over the entire area of a slice of silicon typically 1 in. in diameter and 0.010-0.015 in. thick. After the silicon slice has been diffused, individual diodes are machined from it in a geometrical pattern that represents the pattern desired in the finished matrix. While each finished diode is still held in position, the diodes are mounted between two circuit plates to form a connected diode matrix, as shown in the photograph. As can be seen from this photograph, diodes can be located at any intersections where required. It is relatively unimportant whether only a few diodes or a large number of diodes are in the matrix although this method of fabrication is most useful when large numbers of diodes are required.

The completed matrix is placed on a header so that it can be more conveniently handled, and then is encapsulated into a finished pack-

age. It may now be treated as a single component to which only a few connections are required.

While the uses of diode matrices in encoders, decoders and other logical devices are many and varied, one unique application is their use in a decimal counter. Such counters are used in a variety of digital applications, such as frequency meters, events-per-unit-time indicators, digital voltmeters and preset counters.

Figure 1A is the schematic of a diode matrix required to make a counter, while Fig. 1B shows the schematic of the diode matrix required to make a 10-state register. This 10-state register is essentially the same as the counter, but has no means to advance from position to position. The register may be conveniently used as a 10-state memory wherever it is desired to store a decimal number.

Figure 2 is a partial schematic of the register. The transistor amp-

Miniature 90-diode matrix eliminates feedback and reduces number of transistors required to make a decimal counter. Completely packaged counter is 1.15 by 1.35 by 1.25 inches

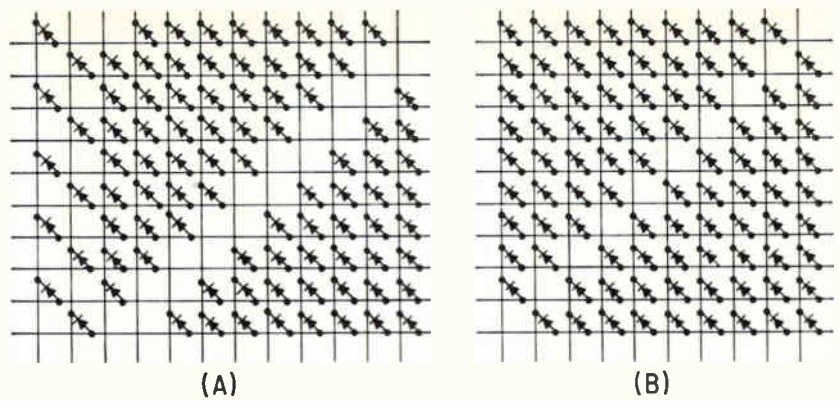


FIG. 1—Diode matrix register (A) with diode matrix counter (B)

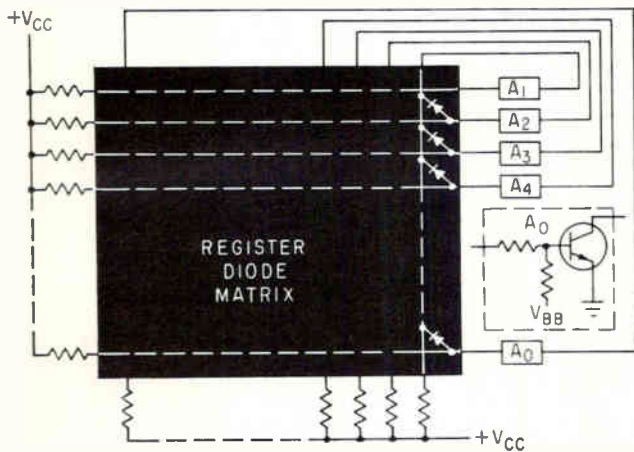


FIG. 2—Partial schematic of complete register. All amplifiers are similar to that shown in inset

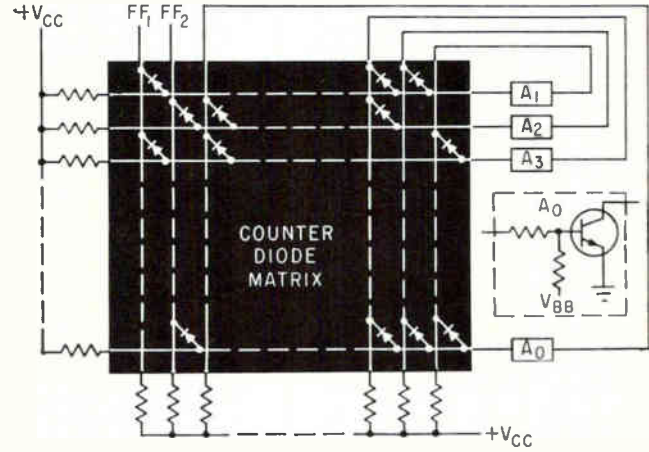


FIG. 3—Simplified schematic of counter. Negative voltage to transistor base is not required for silicon transistors

lifiers are shown as blocks, and only parts essential to the operation of one stage of the register are shown. All the amplifiers are similar to A₀ which is shown separately in detail.

In Fig. 2 the base of the transistor is fed from one row of the matrix, while the collector feeds back into one column of the diode matrix. The matrix connections are such that the feedback column does not contain a diode to connect the collector of the transistor with its own base. With the potentials applied to the circuit as indicated, the base of the transistor will be positive with respect to its emitter, and the transistor will be turned ON. This action will lower the collector to near ground potential and, through the diode matrix, also will lower the potential of the other nine rows to near ground potential. Since these other nine rows are normally connected to the bases of their transistor amplifiers, these ampli-

fiers will be turned off and their collectors will be at virtually the collector supply voltage. No feedback will occur in the other nine columns of the matrix, since in each of these columns, the diodes connecting the rows and columns together have been reverse biased by the on transistor. Thus, only one of the transistors will be on at any one time, and the other nine transistors will be off.

Since any one of the ten transistors may be turned on by applying a momentary positive potential to its base, and will remain on while the other nine transistors will be turned off, the circuit shown is capable of remaining in any one of ten stable states for an indefinite period of time. This action provides a register capable of storing a decimal digit.

To convert the register into a complete decimal counter, it is necessary to provide means for turning on each of the transistors

in turn, while at the same time turning off the one that previously was on. This may be accomplished by the circuit shown in Fig. 3. The basic change made is the use of the diode matrix of Fig. 1A with two more columns controlled by an external flip-flop added to the matrix. One other change is the removal of a second diode in each row and the replacement of it with one controlled by the flip-flop.

With reference to Fig. 3, assume that transistor A₁ is conducting, and that column FF₂ is held at ground potential by the flip-flop. In that event, the other nine transistors are held off through the matrix. Transistors A₂ through A₁₀ are held off by the lowered collector voltage of transistor A₁. Transistor A₂ is held off by the low voltage on column FF₂. To advance the count, it is necessary to put a pulse into the flip-flop, causing it to change state. This will lower the voltage on column FF₁ and raise

the voltage on column FF_2 . As this happens, the diode between column FF_2 and the base of transistor A_2 can no longer keep the base of A_2 at ground potential. Therefore, the potential on the base of transistor A_2 rises, and the transistor turns on. The other transistors are held off, either by the low voltage on the collector of transistor A_2 or by the low voltage on column FF_1 .

Each time a pulse is coupled into the flip-flop the counter will advance one position by a similar action. Since there are ten positions in the counter, the result is a decimal counter.

In the actual counter shown in Fig. 4, resistor R_1 limits base current, and resistor R_2 connects the base to a source of negative voltage, to insure that the transistor is cut off when the row feeding its base is at a low potential. This negative supply voltage is not required if silicon transistors are used.

In most counters, it is desired that a method of zero-setting be provided. This is also shown in Fig. 4. A positive pulse may be coupled to the base of the zero transistor through the external reset circuit. This positive pulse will turn the zero transistor ON and the other transistors OFF. It is necessary also to insure that the flip-flop is set to the state corresponding to the zero state of the counter. This is done by feeding the collector voltage from the zero transistor into

the base of the associated flip-flop transistor through D_1 and C_1 .

A means of readout is also desirable in most decimal counters. In Fig. 4, a glow discharge indicator tube has been connected to the collectors of each of the transistor amplifiers. The glow tube operates when a suitable negative potential is applied to one of its ten cathodes, thus ionizing the neon gas in the tube and causing a neon discharge glow to form around the cathode that has been lowered in potential. This provides a simple method of indicating the state of the counter.

The counter offers many advantages over presently available devices. It is a true 10-state device and provides 10 usable, fairly-high current outputs. These outputs may be used to operate indicator tubes or printers. If a preset counter is desired, adequate current is available to operate the AND gate usually associated with such a counter.

Previous techniques of providing this versatility have usually consisted of using 18 transistors, with 8 used to form four flip-flops and 10 additional transistors to convert the binary output of these flip-flops into a decimal output, either through a diode matrix or a resistive matrix.

In addition, the circuit is readily adaptable to either high- or low-voltage outputs. Thus, it may be used to operate high-voltage devices such as indicator tubes or low-

voltage devices such as incandescent lamps.

The fact that no feedback is required, such as is found in the binary counter chain that has been modified for a 10 count, means that high speeds are easily obtained and the output waveforms are uniform. As an example, speeds of well over 100 Kc are obtainable with the circuit and with faster transistors operating at lower voltages, speeds of over 1 Mc may be obtained.

A complete counter called the BIP-8000 has been built. The finished unit is 1.150×1.350 and is 1.250 in. high. It was made on three stacked printed circuit boards, with the top board holding the diode matrix, the middle board containing the 10 transistor amplifiers, and the lower board holding the flip-flop driver.

The counter operates from 170 v to run a glow discharge tube, and a series dropping resistor is used to supply the collector voltages for the transistors. It operates on a current of 26 ma, and may be operated over a voltage range from 160-190 v. At voltages much below 170 v the glow discharge tube has insufficient voltage to ionize, and therefore no visual indication is obtained.

The author is indebted to Robert E. Benn and others at Burroughs Research Center, Paoli, Penn., for many original concepts that led to this counter design.

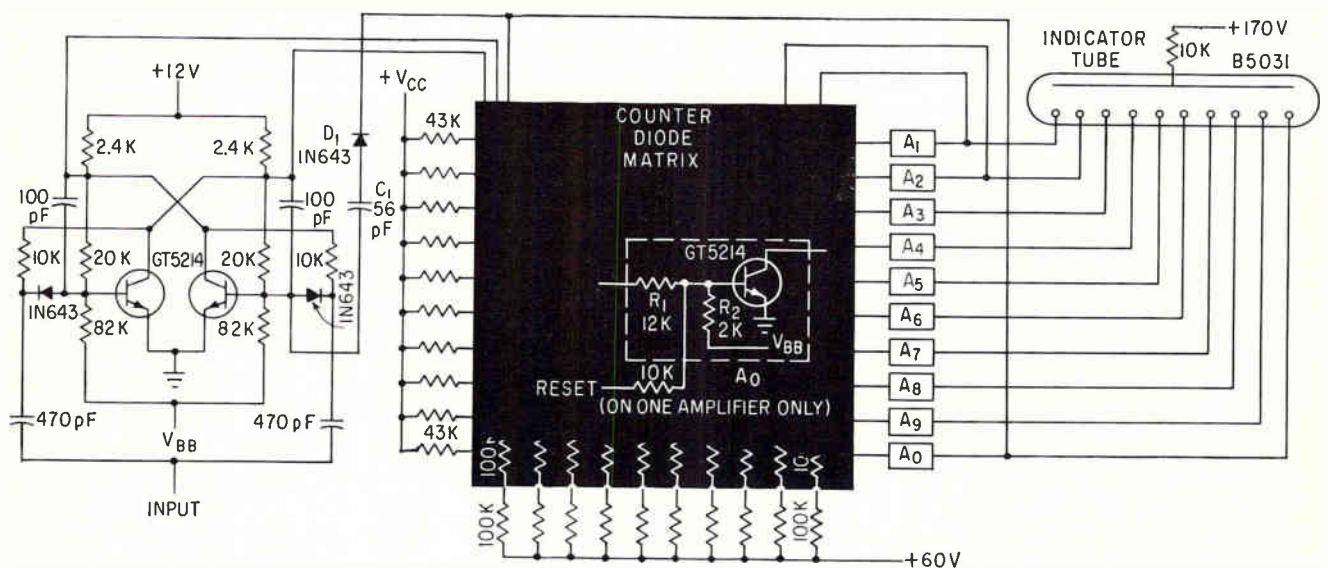


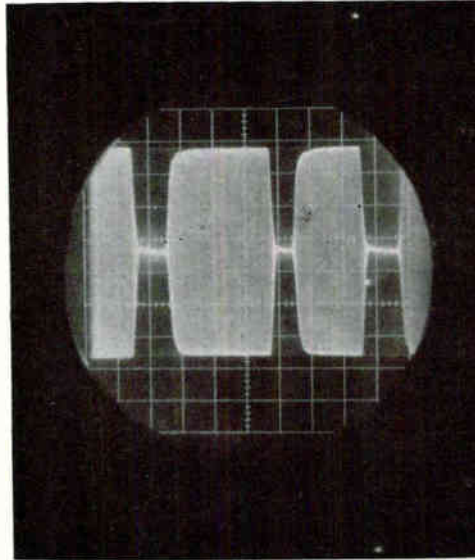
FIG. 4—In actual counter, a positive pulse is applied to the zero transistor for zero setting. A glow counter tube can be connected to the collectors of each transistor amplifier to provide visual indication of the state of the counter

Noise-Free Keying Circuit

Photocell biasing permits transient-free switching of audio signals with a rise and decay time of approximately 100 ms for a 60-db change of output signal level

By A. MARTENS

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Example of switched signal

MANY audio applications call for smooth signal interruption and restoration without interfering noise and transients. The commonly used balanced modulator works well, but is relatively expensive and complex. The circuit shown will satisfy all usual requirements and permit a good degree of variation in decay and rise times.

The purpose of the circuit is to cutoff amplifier tube V_1 by gradual

increase of negative grid bias and simultaneous decrease in input-signal amplitude. This arrangement prevents signal clipping, which would occur if the amplitude remained unchanged during keying. Use of photoresistors makes it possible to isolate the control function from the signal path and thus avoid switching transients.

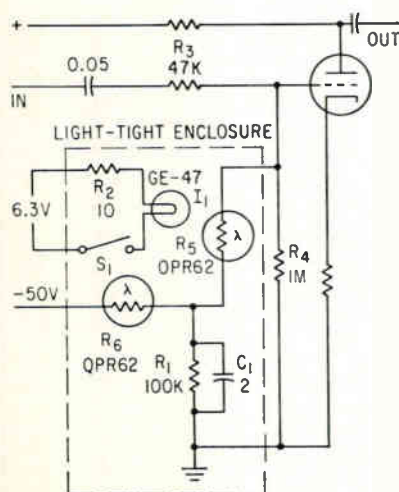
Assume that the system is initially conducting. Photocells R_5 and R_6 , which are in a light-tight enclosure with lamp I_1 , are not illuminated; since their dark resistance is well above 50 megohms, they do not interfere with signal conduction. Capacitor C_1 is discharged through resistor R_1 . Closing switch S , lights the lamp. The time for reaching the maximum brightness is controlled by resistor R_2 . If R_2 were not used, the photocell resistance would drop sharply, causing a transient in a signal as the light is turned on. Capacitor C_1 charges to a value determined by bias-supply voltage and the values of associated voltage divider components.

The grid of V_1 is gradually biased

off through R_6 , whose resistance decreases at the same rate as R_5 . This causes the amplitude of the signal applied to the grid of V_1 to decrease as the negative bias increases through the action of the voltage divider R_5 , R_6 and C_1 .

By making R_2 variable, both rise and delay times may be varied infinitely, in which case S is not required. If the characteristics of keying are to be maintained for each cycle, the fixed values of R_1 , C_1 , R_5 , R_6 and bias voltage control the decay time and C_1R_1 together with turn-off properties of R_5 and R_6 control the rise time. For the values used, both rise and decay were about 100 msec. for better than 60 db change of output level.

Switch S , may be replaced with an automatic pulsing circuit, and the waveform of modulation varied by varying the value of components in the keying circuit. The circuit is equally well applicable to transistor equipment. The combination of bias cutoff and input signal variation allows a far greater range of control and smoother operation compared to circuits using either bias or variable input impedance alone.



Light-sensitive components should be in a light-tight box

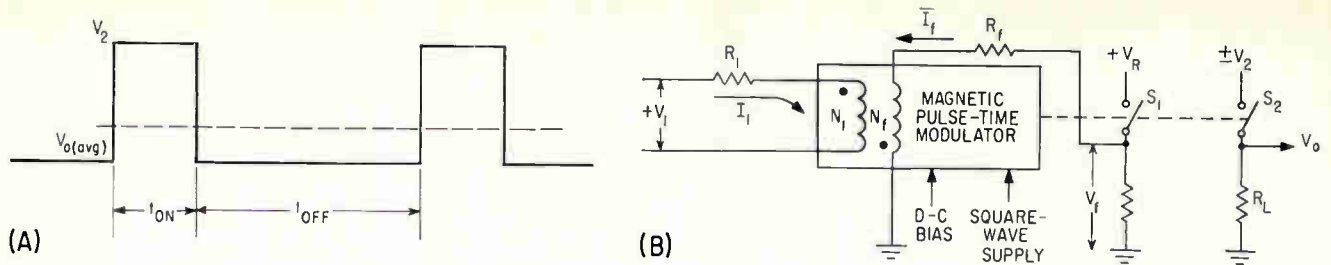


FIG. 1—Value of $V_{o(avg)}$ in (A) is found by using Eq. 1, 2 and 3. Diagram (B) shows how pulse-time multiplier works

Technique for performing accurate analog multiplication uses a magnetic pulse-time modulator and transistors with a special feedback circuit

Accurate Analog Computation

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MULTIPLICATION and division of variables in analog computers are usually mechanized by using servo-driven potentiometers. These potentiometers, being electromechanical, have limited the reliability of airborne equipment operating under severe military conditions.

The increasing need for higher reliability on future airborne systems and space vehicles has led to interest in methods of performing computation and control functions with static devices. A number of papers^{1, 2, 3} have been published on analog computation using pulse-time principles.

A method for performing analog multiplication is the pulse-time rectangle multiplier. One variable establishes the time duration, and a second variable establishes the magnitude of an output pulse. The product of the two variables is proportional to the area of the pulse. Figure 1A illustrates the fundamental process.

With transistors providing nearly ideal switches, the most critical problem is the accuracy of conversion from input voltage to the pulse-time ratio.

A technique for performing accurate analog multiplication is shown in Fig. 1B. Feedback makes it possible to convert an input voltage to a pulse-time ratio with an accuracy of 0.1 percent of full-scale.

In Fig. 1B, the magnetic pulse-time modulator consists of a self-saturating magnetic amplifier and transistor switch driver. The pulse-time modulator drives switches S_1 and S_2 , controlling the relative on-time and off-time of the two switches. The modulator is biased to turn the switches off with zero signal input.

Input voltage V_1 causes a current I_1 to flow into signal winding N_i , with the proper polarity to increase the on-time of the modulator. Reference voltage V_R applied to S_1 produces feedback voltage V_f , which has the wave-shape shown in Fig. 1A.

Feedback voltage V_f is applied in series with R_f through feedback winding N_f on the pulse-time modulator. The polarity is such that the feedback ampere-turns, $I_f N_f$, oppose signal ampere-turns, $I_1 N_i$. With a high internal loop gain, the average value of $I_f N_f$ will be directly proportional to $I_1 N_i$; and the average value of V_f will be proportional to V_1 .

Assuming a perfect switch, and

a fixed reference voltage V_R , the average value of V_f will be proportional to $t_{on}/(t_{on} + t_{off})$. Therefore, the time ratio of the pulse-time modulator is forced by feedback to be directly proportional to the input voltage, V_1 .

Switch S_2 , the multiplying switch, is driven in parallel with S_1 . The second input voltage variable V_2 is applied to S_2 . Then the average value of output voltage V_o is

$$V_{o(avg)} = V_2 \left(\frac{t_{on}}{t_{on} + t_{off}} \right) \quad (1)$$

and since, by the use of feedback

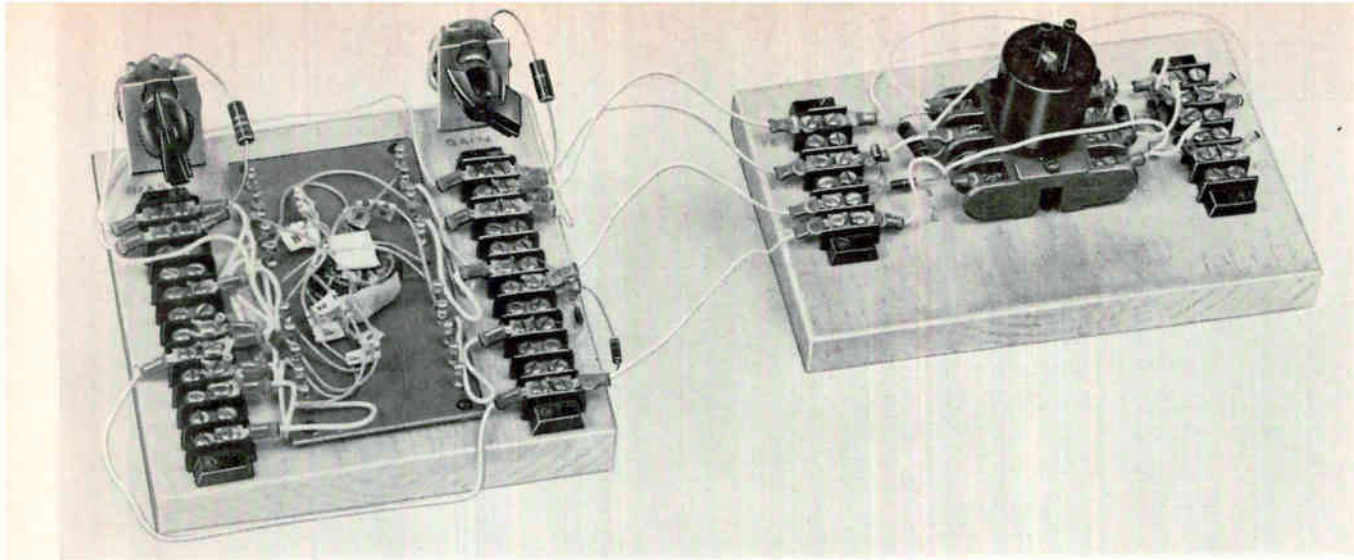
$$\frac{t_{on}}{t_{on} + t_{off}} = K V_1 \quad (2)$$

where K is a scale factor

$$V_{o(avg)} = K V_1 V_2 \quad (3)$$

Thus, the multiplier output is directly proportional to the product of V_1 and V_2 .

The new technique is used in the two-quadrant multiplier circuit shown in Fig. 2. Further refinements are discussed later. The pulse-time modulator consists of full-wave magnetic amplifier Zener diode D_1 and driver transistor Q_1 . Zener diode D_1 allows the presaturation magnetizing current of the magnetic amplifier to flow in resistor R_1 without affecting Q_1 . When the magnetic amplifier does satu-



Breadboard setup of multiplier shows magnetic amplifier at the left and the feedback amplifier and switch at the right

With Pulse-Time Modulation

rate, the voltage across R_1 rises rapidly to the point at which D_1 breaks down. Current then flows in R_2 , switching on Q_1 . When Q_1 is switched on, Q_2 is switched off.

The reference voltage is obtained from zener diode, D_2 . Turning Q_1 on and Q_2 off, provides a pulse of reference voltage, V_R , (fixed by D_2) across feedback resistor R_2 and feedback winding F_3-F_6 .

Transistors Q_3 and Q_4 are the bipolarity switch S_2 . The output voltage is developed across R_{12} . With a bipolarity switch both plus and minus values of voltage V_2 can be switched, so the circuit can be used as a two-quadrant multiplier.

Several switches similar to S_2 could be driven from one driver transistor (Q_1) so that one variable V_1 could be multiplied by several other variables using only one pulse-time modulator. This is similar to the use of ganged potentiometers in electromechanical computing.

The pulse-time modulator is a full-wave, single-ended, self-saturating magnetic amplifier. It is operated from a square-wave supply and drives switching transistor Q_1 . The magnetic amplifier reactor (Table) is as small as possible, consistent with the requirement of a large space required for a large

number of signal and feedback turns. A special requirement of the design is that the ratio of signal winding resistance to total signal circuit resistance should be the same as the ratio of the feedback winding resistance to the total feedback circuit resistance. This compensates for changes in the copper winding resistance with self-heating and ambient temperature changes. Depending on the design, the signal winding resistance and feedback winding resistance may be 5 to 10 percent of the total circuit resistance, so it is important that the ratios be nearly the same.

The magnetic amplifier is designed for approximately two-thirds of normal excitation voltage. That is, with a given supply voltage and frequency, the number of load winding turns is calculated so that the magnetic amplifier operates

over only two-thirds of the total B-H loop. This improves the linearity of the magnetic amplifier characteristic. Figure 3A shows the significant difference in linearity of the magnetic pulse-time modulator (without feedback) operated at normal excitation, and at two-thirds of normal excitation. By operating at reduced excitation, the nonlinearity at the lower end of the characteristic is reduced. With the negative feedback circuit closed, the curve is nearly a straight line, but the nonlinearity is decreased with the lower excitation voltage. Since the amount of negative feedback that can be effectively used is limited by other circuit considerations, this improvement in the magnetic pulse-time modulator characteristic, with reduced excitation, is significant.

Data was taken on the pulse-time modulator with feedback (as shown in Fig. 2) using a digital voltmeter to measure both the input voltage V_1 and the voltage V_7 across Q_2 . To obtain a reading which represents the actual switching time-ratio, the voltage developed across Q_2 with the switch turned on must be subtracted from the total reading. This amounts to a linear correction factor directly proportional to the time the transistor is turned on

REACTOR DESIGN DETAILS

Core: HYMU 80 No. 51002-2D

Winding	Turns	Wire Size (Awg. No.)
A_1-A_2	2,000	42
B_1-B_2	2,000	42
F_1-F_2	3,000	42
F_3-F_4	1,500	39 (Not Used)
F_5-F_6	1,500	39
F_7-F_8	100	39

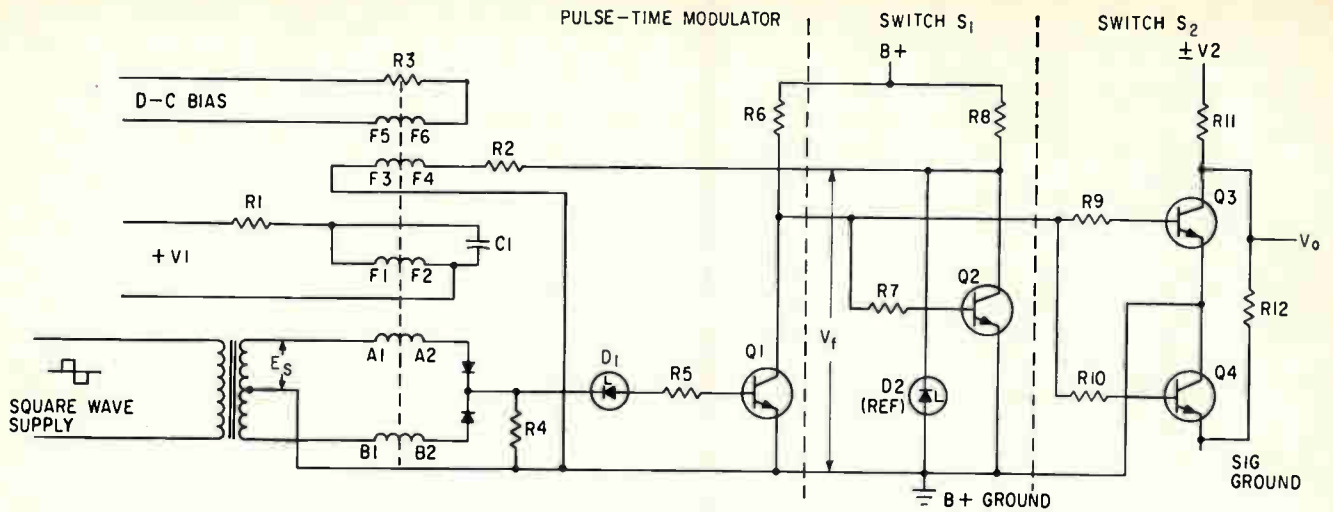


FIG. 2—Two-quadrant multiplier using two transistors to act as switch S_2 .

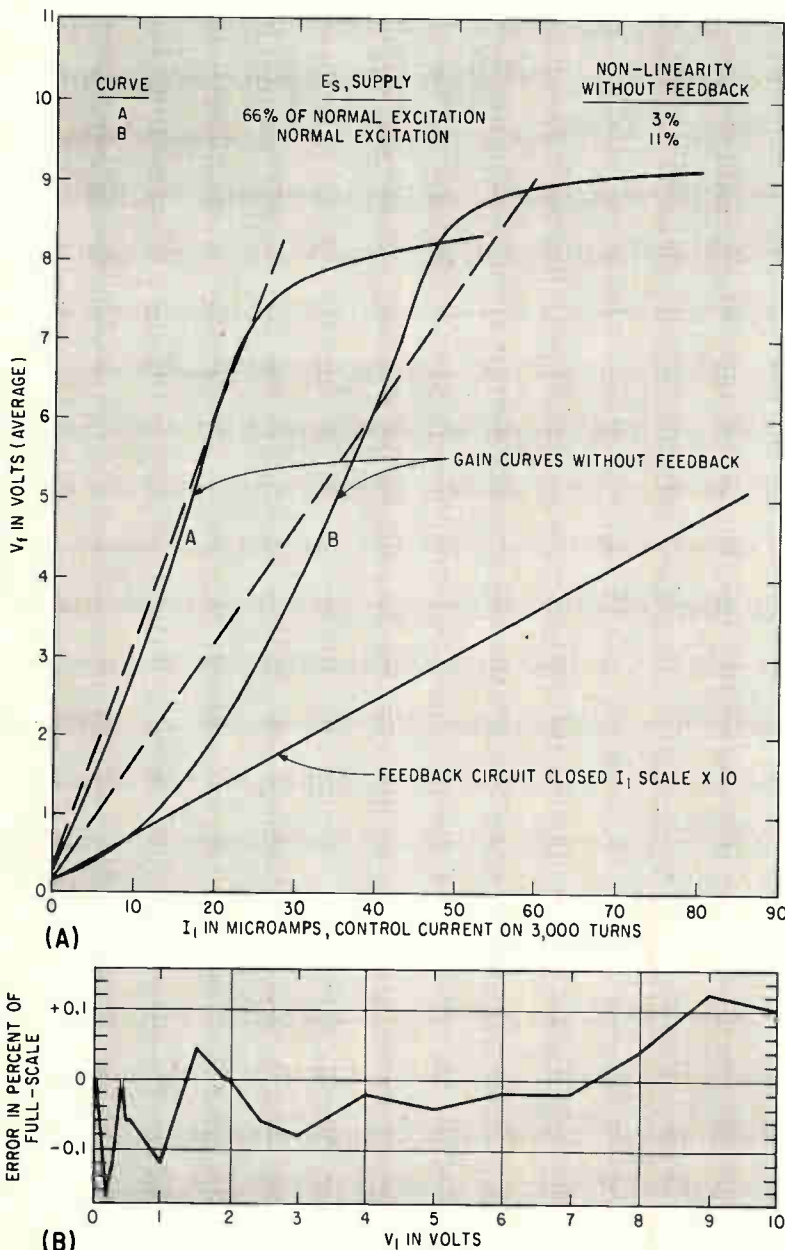


FIG. 3—Gain curves (A) and plot of nonlinearity error (B) indicate performance of magnetic pulse-time modulator circuit

and to the on-voltage-drop of Q_2 .

Figure 3B is a plot of the error in corrected output voltage from an ideal straight-line relationship. The maximum error for this 100 to 1 range in input variable is 0.17 percent of full-scale output. Neglecting the first point, the maximum error is 0.12 percent of full-scale for a 50 to 1 range in input variable. A 0.5 switching time-ratio is used as full-scale output.

A revised circuit for a two-quadrant multiplier is shown in Fig. 4. The main difference in this circuit and the earlier circuit is in the output multiplying switch S_2 .

Output transistor Q_3 is now a single transistor operated as a series switch, with a drive obtained from Q_2 . To provide for positive turn-off of Q_3 , the emitter-to-base junction of Q_3 is back biased at 5 volts. This is accomplished by Zener diode D_3 , which places the emitter of Q_3 above the B supply ground.

When Q_3 is turned on by base-to-emitter current, a collector-to-emitter voltage of the order of 30 millivolts is generated. This voltage is compensated for by the circuit consisting of the R_{11} , R_{12} and potentiometer R_{14} .

Data was taken for both positive and negative values of voltage V_2 with the input voltage V_1 set at 2.5 volts, and at 10 volts. Plots of the data show maximum errors of 4 millivolts, 0.17 percent of full scale. However, the shape of the error curve indicates that a better adjustment R_{14} would bring this error below 0.1 percent of full-scale.

The linearity with respect to

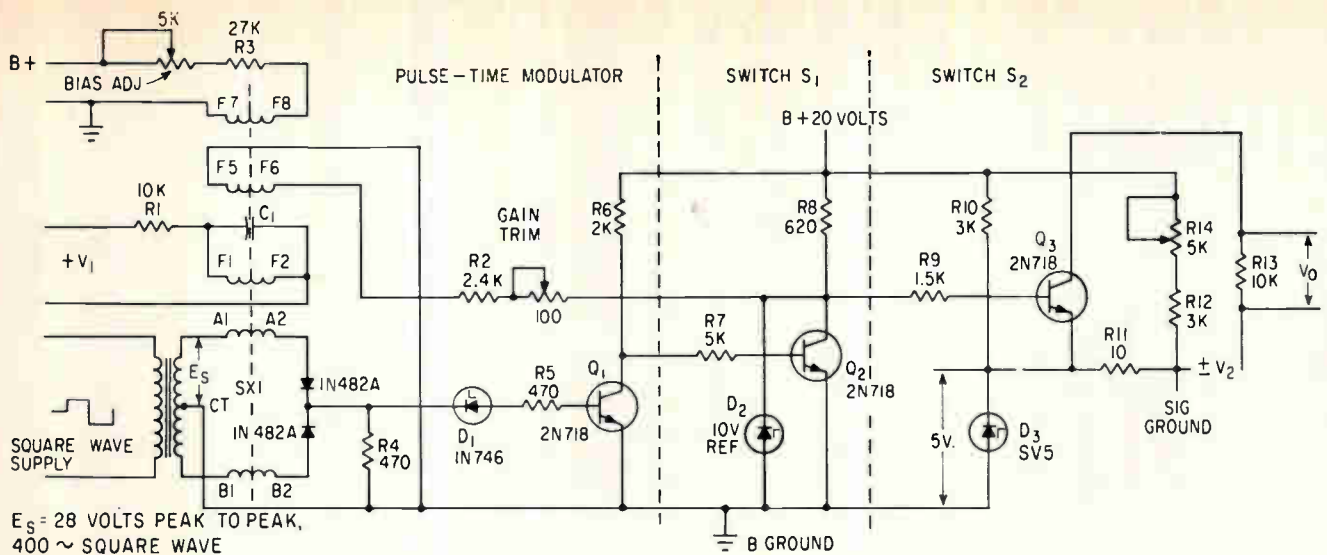


FIG. 4—Revised multiplier uses single transistor as series switch S_1 .

variation in input voltage V_1 was also checked using a constant reference voltage for V_2 . The error is less than 4 millivolts with a range of 50 to 1 in input voltage V_1 .

A pair of two-quadrant multipliers, with signal windings connected in series or parallel, can be used for four-quadrant multiplication. The polarity of the signal windings is arranged so that only one of the pulse-time modulators is turned-on in the positive direction at one time.

There is an additional problem in four-quadrant operation. With a large negative ampere-turn signal applied to the pulse-time modulator which is turned-off, this pulse-time modulator begins to turn-on again. With the two-quadrant multiplier shown in Fig. 4, this point is reached when a negative voltage of approximately 2.5 volts is applied to V_1 . This is only one-fourth of the voltage input magnitude required for full-scale linear output. Thus when negative signals are applied, which are greater than one-fourth of full-scale input, the two-quadrant multiplier will produce an erroneous output. This effect can be eliminated by using diode limit circuits on the signal circuit, or a polarity detector to gate the output circuit.

Another method to overcome this difficulty on a four-quadrant multiplier is to use an additional feedback winding on each pulse-time modulator connected to the output of the other pulse-time modulator. The polarity of these feedback windings is arranged so that a sig-

nal that turns on one pulse-time modulator produces enough positive ampere-turns on the other modulator to keep it from giving an erroneous output.

A four-quadrant multiplier has been evaluated in the laboratory. Errors were of the same order of magnitude as those tabulated on the two-quadrant multiplier circuit.

A useful application of multipliers is in function generation from power series expansions. For instance, the expansion for the sine function

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \dots \quad (4)$$

can be approximated as

$$\sin x \cong x - \frac{x^3}{6.77} \quad (5)$$

This approximation is accurate to 1 percent for values of x from 0 to 1.57 radians (90 degrees).

To generate the sine function, two multipliers are cascaded. Output of the first multiplier gives a term proportional to the square of x . This output is fed into a second multiplier, where it is multiplied by the original input, to give an output proportional to the cube of x . The cubic term is then subtracted from the linear term by mixing the two currents, with the scale factors, in a meter to give the approximate expression for the sine of x . The experimental readings for sine of x shows a maximum error of 1.4 percent from the true value for the sine function over the complete range from 0 to 90 degrees. This result is reasonable when compared

to the theoretical error of 1 percent for the approximate expression.

In function generation and other applications of cascaded multipliers, there is a significant advantage gained from the isolated signal windings of the magnetic pulse-time modulator. The output of one multiplier can be fed directly into a second multiplier without intermediate buffer amplifiers. Interaction between the second stage and the first stage multiplier output switch, may cause additional nonlinearity errors of the order of 1 percent in cascaded multipliers. These nonlinearities are repeatable and can usually be compensated for in the final result. Further analytical and experimental work on applications of cascaded multipliers is now in progress.

The effect of voltage and frequency variations of the square-wave supply for the pulse-time modulator has only a second-order effect on multiplier accuracy. The voltage and frequency of the supply do cause a bias shift in the single-ended characteristic of the magnetic amplifier used in the pulse-time modulator, but the large amount of negative feedback reduces the percentage effect of this variation.

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- (2) H. W. Abbot and V. P. Mathis, Elapsed Time Computation, Proceedings of the National Electronics Conference, 15, 1959, pp. 195.
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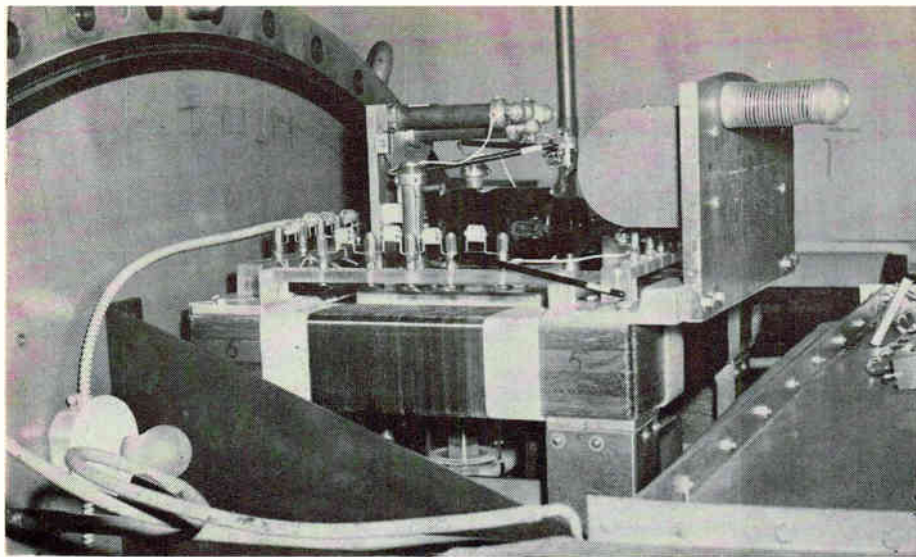


FIG. 1—The three adjustable spark gaps lie horizontally above their adjusting motor; lower down is the 3-henry choke with one air gap visible at its corner. Just below the choke a section of the 100-Kv pulse transformer is visible

High voltage terminal and supporting column (right) are withdrawn from their pressure tank; rings around the support column equalize potential gradient. Shield of high-voltage terminal is partially removed (far right), while inside the pressure tank the liner that receives the high voltage pulses is just visible

Van de Graaff Proton Source

Accelerator injects protons into Cosmotron orbit at 5-minute intervals. During proton injection the Van de Graaff terminal capacitance discharges reducing terminal voltage, hence reducing initial proton energy. An auxiliary boost circuit counteracts voltage loss and matches proton energy to Cosmotron magnetic field

By E. J. ROGERS

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Upton, New York

BROOKHAVEN NATIONAL LABORATORY uses a 70-foot diameter proton synchrotron, called the Cosmotron, to produce high-energy protons for a variety of nuclear experiments. The initial source of these protons is a Van de Graaff accelerator, which is at the periphery of the Cosmotron doughnut. The protons are injected into the Cosmotron orbit with an initial energy of 3.6 Mev'. After several million circuits of the Cosmotron the r-f accelerating field increases proton energy to 3 Bev.

The beam of protons injected into the Cosmotron from the Van de Graaff accelerator causes a current drain of 25.5 ma from the high-voltage terminal during the injection pulse. Since the Van de Graaff belt can supply only a few microamperes, current must be

supplied by the capacitance of the high voltage terminals. However, discharge of the terminal capacitance produces a linear decay in terminal voltage, hence also in the initial energy of the protons.

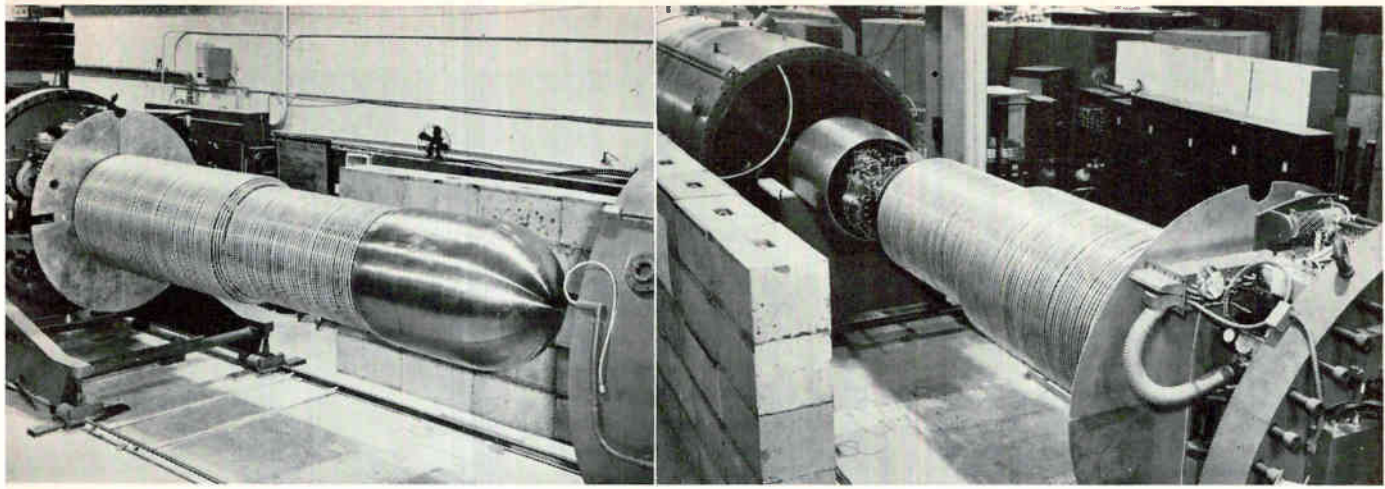
The terminal capacitance is 150 pf. The potential of the high-voltage terminal, and consequently the energy of the injected protons, decays at a rate given by $dv/dt = i/c = 25.5 \times 10^{-9}/150 \times 10^{-12}$, or 170 volts per microsecond. This energy decay is undesirable because the beam is injected into a rising magnetic field. By modulating the Van de Graaff energy upwards during the injection pulse, rather than allowing this decrease to take place, the useful injection time is increased from 50 to 210 microseconds.

The modulation voltage is applied to the high voltage terminal (which is 3.6 Mv above ground) by capacitive coupling from a pulsed liner placed inside the Van

de Graaff tank (see illustrations). Calculation shows that the Van de Graaff voltage should rise 360 v per microsecond during the 210 microsecond injection pulse. Without the pulsed liner it falls 170 v per μ sec, so the induced voltage should rise at 530 v per μ sec for the duration of the injection pulse. For a 210 μ sec injection pulse a total induced voltage of 110,000 volts is required. The capacitance ratio between terminal-to-liner, and terminal-to-tank, is 3 to 1, yielding a capacitive coupling coefficient of 3/4 between the liner and the high voltage terminal.

A total voltage swing of $4/3 \times 111$ Kv or 148 Kv is therefore required on the liner. A system capable of delivering up to 220 Kv was designed and constructed, Fig. 1, allowing for possible future increases in beam intensity.

The liner pulsing circuit is shown in Fig. 2. Between proton injections at 5-second intervals the 1,500 pf liner-to-tank capacitance is charged to -120 Kv by the high-voltage power supply, Fig. 3. This voltage is divided between two equal sections of the spark gap, each of whose breakdown voltage is somewhat higher than 60 Kv. At the beginning of the injection pulse the trigger pulse generator, Fig. 2, delivers a sharp 1,500 v pulse to the pulse transformer. The 100 Kv secondary pulse fires the gap, connect-



Receives 110 Kilovolt Boosts

ing the liner to ground through the 3-henry inductor and the 5,000-ohm damping resistor, R_1 . The circuit begins to oscillate, starting at the negative peak amplitude of -120 Kv. At the end of the first half-period of oscillation the voltage on the liner will be at a positive peak of $+100$ Kv.

The 3-henry inductor resonates with the liner capacitance at 2.38 Kc to give a half-period of $210 \mu\text{sec}$.

The circuit continues to oscillate for a few cycles until the energy is dissipated in R_1 . The spark then goes out and the liner begins charging toward the supply voltage through R_2 . At the next injection pulse, the liner voltage is equal to supply voltage, and the circuit is ready to be fired again.

All the high-voltage liner pulsing components are within the Van de Graaff tank. The high-voltage power supply, spark gap and inductor are mounted on a shelf on the inside of the faceplate.

C. M. Turner supervised construction and installation of the liner and the electrical components of the pulsing system. The work was performed under the auspices of the U. S. Atomic Energy Commission.

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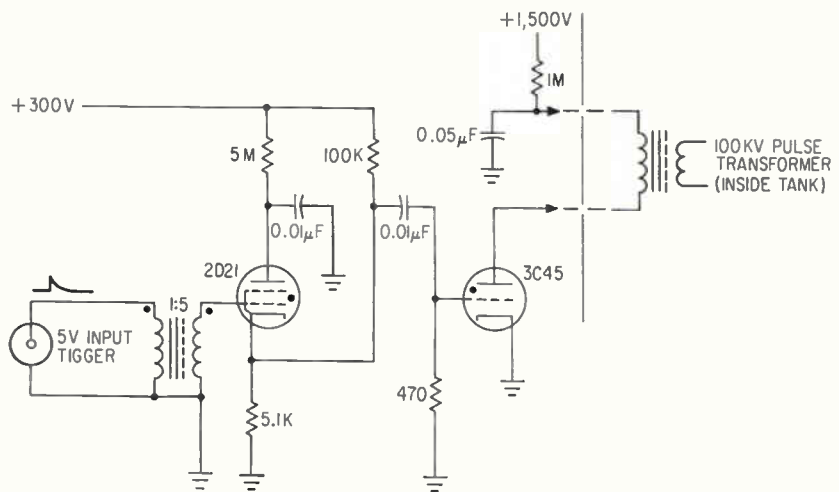


FIG. 2—Trigger pulse is amplified by two thyatrons before passing on to the modulator unit, where it is stepped up to about 100 Kv by the pulse transformer

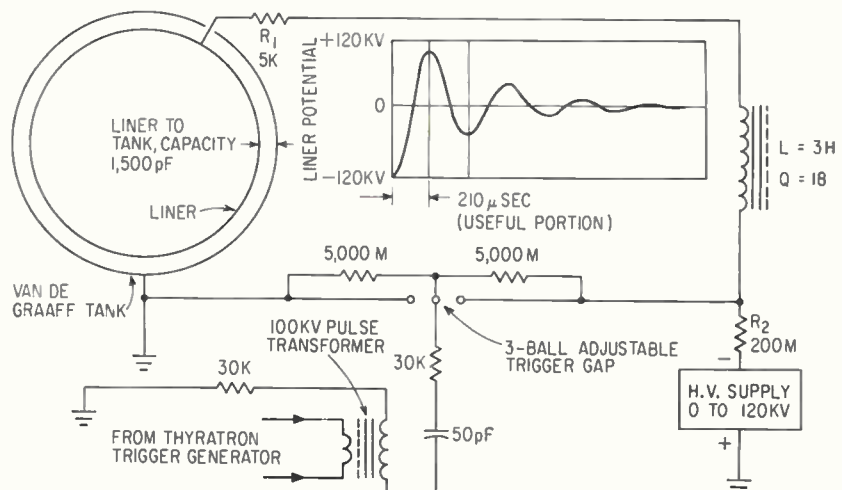
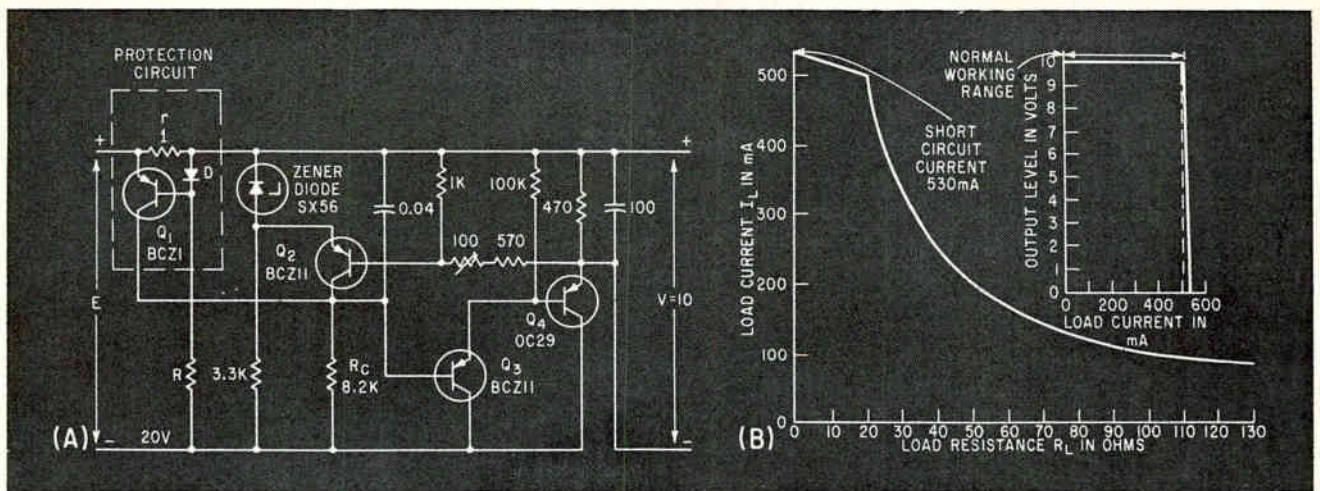


FIG. 3—Secondary output of pulse transformer breaks down modulator argap and initiates the 110 Kv boost pulse that the Van de Graaff liner couples to the proton source



During overload Q_1 turns on and draws current through Q_3 , load resistor R_c , thereby reducing the drive potential to Q_2 base (A); characteristic curves (B) show that output current is limited to 530 ma during short circuit while voltage remains constant at 10 volts in normal operation

OVERLOAD PROTECTION CIRCUIT

USES LOW-POWER TRANSISTOR

Protection circuit detects excessive current then reduces output voltage proportionately—inoperative until preadjusted current level is attained

By C. YARKER

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THE STABILIZER shown in Fig. A enables low output impedance to be obtained with good stabilization ratio. The collector of the protection transistor Q_1 is connected to the collector of Q_2 so that, with increasing load current in the output circuit, Q_1 conducts at a value depending upon r and the potential across R_c increases, eventually causing Q_2 to bottom. As Q_2 bottoms, the output V falls.

By making the resistor r variable the maximum current requirement may be adjusted to suit the load

circuit. Although load current flows through r the resistance is low (about 1 ohm) and no appreciable power is dissipated. The current needed to drop the full voltage E across R_c is a few milliamps, so transistor Q_1 need be only a low-power type.

The main disadvantage of the circuit without using diode D is its temperature dependence. As the temperature rises the V_{ce} drop of transistor falls, and so the current required to trip the circuit falls too—in many cases this might be considered an advantage.

The introduction of diode D in the protection circuit causes no appreciable change in the triggering level at higher temperature. Re-

sistor R maintains the diode in a state of conduction and although the V_{ce} drop of the transistor and the diode drop decrease, a steady triggering level is maintained across r .

A more complicated stabilizer variety was checked at 25 C and 55 C without the diode compensating circuit. The trip current at 25 C was set by r to 0.4 amps and this fell to 0.36 amps at 55 C.

With the diode in circuit no appreciable change was observed in the triggering current.

The stabilizer used had a slower response time than the trip circuit owing to the presence of a capacitor to prevent circuit oscillation.

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

With the hp 297A Sweep Drive, the hp 302A is converted to a sweep oscillator-tuned voltmeter for automatic frequency response measurements, even in noisy systems. The 297A motor accessory permits sweeping the entire frequency range of the 302A, 20 cps to 50 KC; provides fast sweep for covering the spectrum rapidly, slow sweep for high resolution plot. The Sweep Drive with an X-Y recorder permits automatic plots of harmonics or intermodulation products. Model 297A attaches to the 302A panel, or may be bench mounted on an adjustable stand.

SPECIFICATIONS

hp 302A Wave Analyzer

Frequency Range:	20 cps to 50 KC
Frequency Calibration:	Linear graduation 1 division/10 cps. Accuracy $\pm (1\% + 5 \text{ cps})$
Voltage Range:	30 μv to 300 v, full scale, 15 ranges
Warm-up Time:	None
Voltage Accuracy:	$\pm 5\%$ of full scale
Residual Modulation Products & Hum Voltage:	Greater than 75 db down
IF Rejection:	Intermediate frequency in input signal rejected by at least 75 db down
Selectivity:	$\pm 3\frac{1}{2}$ cycle b.w. — at least 3 db down ± 25 cycle b.w. — at least 50 db down ± 70 cycle b.w. — at least 80 db down Beyond ± 70 cycle b.w. — at least 80 db down
Input Impedance:	Determined by setting of input attenuator: 100,000 ohms on 4 most sensitive ranges, 1 megohm on other ranges.
Dimensions:	20 $\frac{3}{4}$ " x 12 $\frac{1}{2}$ " x 14 $\frac{1}{2}$ " (cabinet), 19" x 10 $\frac{1}{2}$ " x 13 $\frac{1}{2}$ " (rack mount)
Weight:	43 lbs. (cabinet), 35 lbs. (rack mount)
Price:	hp 302A (cabinet), \$1,800.00 hp 302AR (rack mount), \$1,785.00

hp 297A Sweep Drive

Sweep Range:	50 revolutions
Sweep Limits:	Any interval from 50 revolutions to 5 degrees
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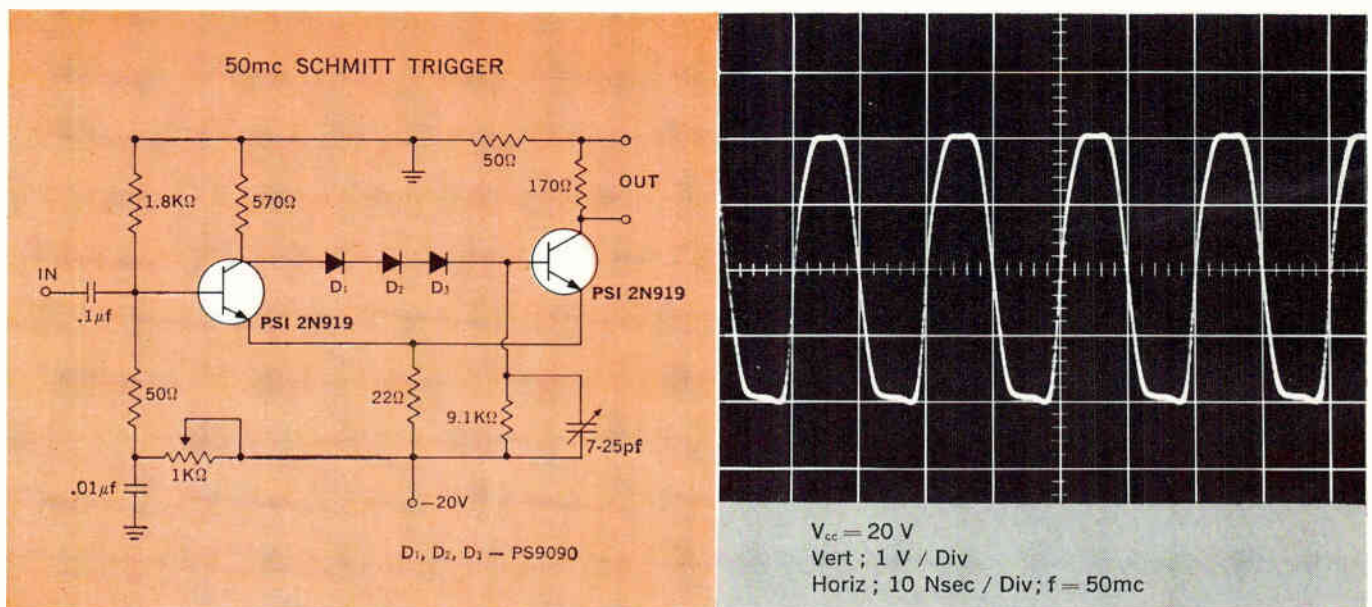
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- Low Leakage and $V_{CE(SAT)}$

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2N919	1.2	25	20	5	20-60	400	0.20	TO-18
2N920	1.2	25	20	5	40-120	400	0.20	TO-18
2N921	1.2	50	30	5	20-60	400	0.30	TO-18
2N922	1.2	50	30	5	40-120	400	0.30	TO-18



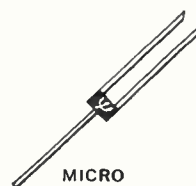
TO-5



TO-18



TO-46



MICRO



PICO

(ACTUAL SIZE)

PLANAR TRANSISTORS

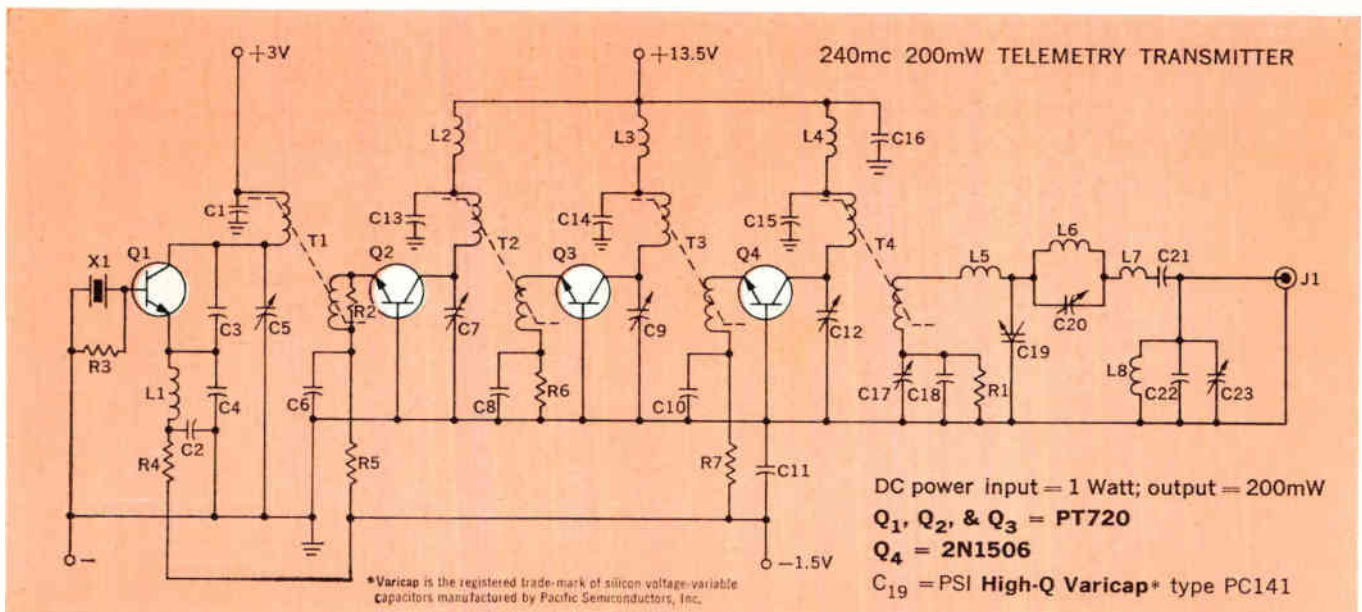
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VERY HIGH FREQUENCY TRANSISTORS								
Type	Total Power @25°C Case Watts	V _{CEO} Min	V _{CEB} Min	V _{ESD} Min	Power Gain @ f = 30mc Typical	Power Gain @ f = 70mc Typical	Power Gain @ f = 100mc Typical	Pkg
PT720	1.2	25	15	5	—	—	15db P _o = 0.2W	TO-18
2N707	1.0	56	28	4	—	—	6db P _o = 0.2W	TO-18
2N1338	2.8	80	50	3	18db P _o = 0.35W	10.5db P _o = 0.35W	7db P _o = 0.35W	TO-5
2N1342	2.8	150	125	5	—	13db P _o = 0.4W	10db P _o = 0.3W	TO-5
2N1505	3.0	50	40	3	10db P _o = 1.8W	8db P _o = 1.2W	6 db P _o = 1W	TO-5
2N1506	3.0	60	40	4	12db P _o = 1.8W	10db P _o = 1.2W	8.5db P _o = 1W	TO-5



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Recording Physiological Data in Digital Form

HUMAN REACTIONS to psychological stimuli can be recorded directly in a form that enables the data to be studied by digital computer. All repetitive manual computation can be eliminated, and the steps needed for statistical analysis can be minimized. One reel of magnetic tape records a day's measurements. An operator is required only for initial equipment checkout, selecting film-strip stimuli and attaching transducers to subjects.

The technique was developed by the National Bureau of Standards. The equipment accepts simultaneously rapidly occurring psychophysiological measurements in analog form, converts them to digital form and records them on magnetic tape. Circuits to drive and interconnect a standard analog-to-digital converter and recorder were designed for the Air Force Office of Scientific Research.

Although the equipment was intended to record the responses of subjects in a continuing psychological investigation, it can be used in many biological studies that yield rapidly changing analog data. Examples include studies of psychological conditioning, reactions to drugs and autonomic responses to emotions and situations.

In studying autonomic responses, the subject may be unable to describe or time stimuli or to appraise his responses objectively, some of which he may not even perceive. Transducers are available to measure autonomic conditions of the human body. However, recording several simultaneously occurring and sometimes rapidly changing reactions has been a technical problem.

Polygraph Limitations

The polygraph has filled the recording need in some cases. It inks measurements of body responses to a series of questions put to the subject directly on a moving roll of graph paper. Although it is ideal for easy inspection of the responses of individual subjects, the

raw data supplied by the transducers would have to be in digital form for computer use.

The converter-recorder method was developed to record the reactions of subjects to visual stimuli given at 30-second intervals. The psychological data acquired on a production-line basis is later treated statistically. The equipment scans the transducers at a 0.1-second repetition rate. Since successive converted readings of any analog channel change little, they are effectively continuous. The record for each stimulus consists of measurements during a 10-second prestimulus period, which provides a baseline. Measurements of the same conditions during a 20-second post-stimulus period are recorded and can be compared with the prestimulus data.

Converter-Recorder Capacity

The converter-recorder can handle eight analog channels and two channels of pulse-coded session and time identification data. The physiological conditions measured are skin resistance, chest and diaphragm respiratory movements, integrated muscle action potential, time interval between electrocardiogram R-spikes, pulse amplitude, skin temperature and integrated shifts of body weight.

The analog from each channel is amplified by a preamplifier designed for signals having the characteristics of the particular measurement. Six analog signals are also presented continuously on a

strip chart recorder for on-the-spot observation and initial equipment adjustments.

Both analog data and the digital session and time data are scanned by the converter at a rate of 10 msec per channel, converting each analog to an 11-bit binary signal. The 11 bits of digital information for each analog channel could, for example, accommodate integral numbers from -1024 to $+1024$ for a zero-centered range. The digital signals are buffered and again converted but to a maximum of five words of 36 binary digits each, and this information is supplied to a diode selector matrix.

Matrix Operation

The matrix connects successive groups of six digital lines to six parallel heads that record the digital signals on magnetic tape. The matrix has a format of five six-character words of six bits each. It is scanned at a character rate of 300 cps.

The six information channels plus one channel for parity check are recorded at 1.5 ips on half-inch tape. The tape transport accommodates 10-inch reels for recording 12 half-hour sessions.

The system can be used for a variety of projects for recording several simultaneous channels of continuous analog data or of mixed continuous and discretely quantized information (analog and digital) if the reading rate is compatible with the greatest rate of variable change.

Ball Control Aids Radar Tracking

FINGERTIP MOVEMENT of a smooth nylon ball enables faster and more precise tracking of airborne radar targets. The electromechanical ball tracking control permits smooth, continuous movement in two directions including all angles between the normal vertical and horizontal directions.

The ball tracker, developed by Hughes Aircraft Company, is used to control the movement of the radar antenna. To track an airborne target by radar, the operator is usually required to place a tracking pip on the radar screen over the target pip. A variety of manual controls have been provided to

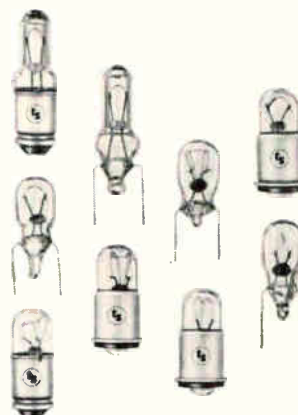
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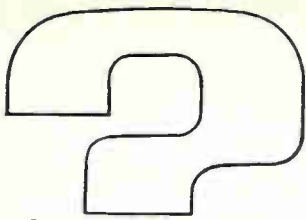
The Tung-Sol line of subminiature lamps is engineered and manufactured to meet the design requirements—Light, Life and Shock—of the most advanced electrical/electronic equipment. The four base types are supplied in varying voltages ranging from 1.38v. to 28v. Tung-Sol subminiature lamps are designed for indicator and readout applications, with life ratings from 350 hours to indefinite. Designers can be completely confident of both uniformity and reliability—even under environmental extremes.

Write for bulletin A14 containing complete specifications. Special design requirements invited. Tung-Sol Electric Inc., Newark 4, N. J. TWX:NK193

Actual size



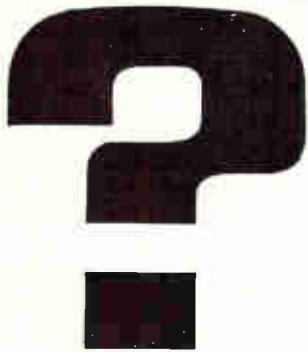
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What do you need to know about



PURE FERRIC OXIDES MAGNETIC IRON OXIDES



Since the final quality of your production of ferrites and magnetic recording media depends on the proper use of specialized iron oxides—you'll find it mighty helpful to have the latest, authoritative technical data describing the physical and chemical characteristics of these materials. This information is available to you just for the asking. Meanwhile, here are the highlights.

PURE FERRIC OXIDES—For the production of ferrites, both hard and soft, we manufacture a complete range of iron oxides having the required chemical and physical properties. They are produced in both the spheroidal and acicular shapes with average particle diameters from 0.2 to 0.8 microns. Impurities such as soluble salts, silica, alumina and calcium are at a minimum while Fe_2O_3 assay is 99.5+%. A Tech Report tabulating complete chemical analysis, particle shape, particle size distribution, surface area, etc., of several types of ferric oxides, hydrated ferric oxide, and ferroso-ferric oxide is available.

MAGNETIC IRON OXIDES—For magnetic recording—audio, video, computer, and instrumentation tapes; memory drums; cinema film striping; magnetic inks; carbon transfers; etc.—we produce special magnetic iron oxides with a range of controlled magnetic properties. Both the black ferroso-ferric and brown gamma ferric oxides are described in a Data Sheet listing magnetic properties of six grades.

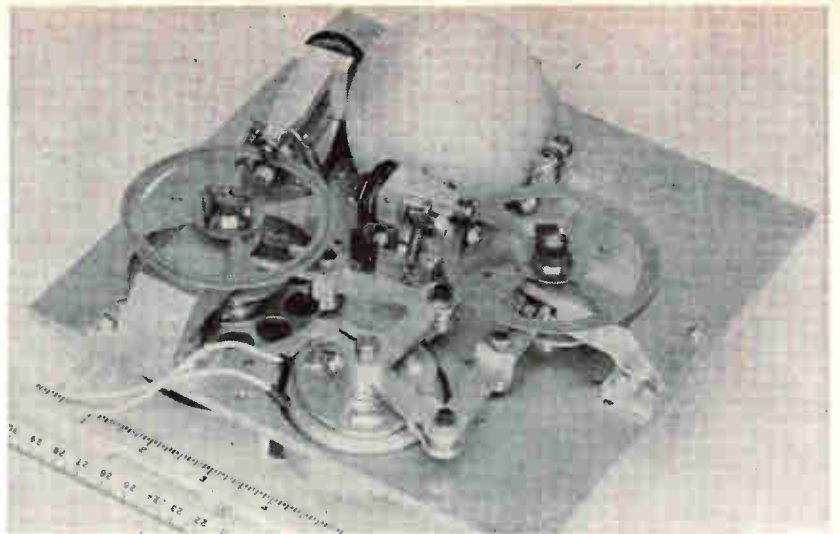
If you have problems involving any of these materials, please let us go to work for you. We maintain fully equipped laboratories for the development of new and better inorganic materials. Write, stating your problem, to C.K. Williams & Co., Dept. 25, 640 N. 13th St., Easton, Pa.

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Movement of ball is transmitted to potentiometers that govern position of tracking pip on radar screen

enable an operator to position the antenna about two axes through servo systems, with antenna position indicated by the tracking pip.

Handwheels, cranks, joysticks and similar devices usually rotate gimbals through separate gear trains and mechanical linkages for two directions of movement. Backlash in such mechanisms make smooth movement difficult, particularly between the two directions.

An accepted test of such controls, tracing a figure 8 on the radar display, is said to be readily performed with the ball tracker. The control is basically a single input device with divided output, which permits movements in an infinite number of directions be-

tween vertical and horizontal.

No gears are used in the ball tracking control shown internally in the photograph. The ball is mounted in a bed of $\frac{1}{8}$ -inch ball bearings. Mechanisms are provided that transmit movement of the ball from two rubber-tire wheels to disks. The disks are each attached by a hub and a clamp to a potentiometer shaft. The potentiometers convert motion of the ball into electrical signals that govern the position of the tracking pip.

The rotary solenoid in the center foreground activates two beveled forks that lift the potentiometer shafts, allowing two heart-shaped cams to engage the potentiometers for rapid centering.

Lighter Riometer Consumes Less Power

LOW-WEIGHT transistor riometer indicates perturbations in the ionosphere caused by either natural or man-made phenomena. The Mark II riometer (relative ionospheric opacity meter) measures changes in ionospheric absorption by determining and recording the level of extraterrestrial cosmic radio noise in the h-f region.

The instrument, developed by Air Force Cambridge Research Laboratories, achieves long-term stability by continuous comparison with a standard noise diode source. The Mark II riometer is currently being manufactured by Aerospace Research Inc.

The transistor riometer is only about 25 percent of the size of conventional riometers and consumes only 20 watts, compared to 180 watts for electron-tube models. It is based on the same principles as the IGY vacuum-tube riometer, but features have been added to ensure long service under field conditions with minimum maintenance and calibration needs.

The 26-pound instrument has been operating at the AFCRL Radio Astronomy Field Site at Sagamore Hill, Hamilton, Mass. It is also being used to collect ionospheric absorption data by the Antarctic expedition in the Kerguelen Islands.

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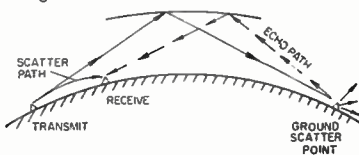
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DEW LINE COMMUNICATIONS PROBLEMS SOLVED BY RIXON



The Problem:

Important digital communications to and from the Distant Early Warning System installed in Northern Canada several years ago were provided by Ionospheric Scatter Circuits operating in the 30 to 40 Mc range. During certain portions of the sun spot cycle, strong signals were reflected to the earth by the intense 'F' layer ionization. A portion of this signal energy was again reflected by the earth and the ionosphere to arrive at the receiving station in the form of a delayed echo of the original information.



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The Solution:

Rixon provided a solution to the problem by developing equipment to simultaneously step the transmitter and receiver frequencies a few cycles after each mark or space signal interval. Thus, the receiver properly detected the primary signal but was tuned to an echo free adjacent frequency when the interfering echo arrived. By appropriate cycling over a limited number of closely spaced frequencies the system was programmed to avoid the damaging echoes and provide error free communications.

The significant hardware consisted of automatic equipment to determine the data rate and program the synchronous frequency stepping at the transmitter and receiver terminals plus the frequency stepping equipment for each terminal. Equipment was usually desperately needed by the time it was approved for purchase so Rixon deliveries were always on a crash basis.



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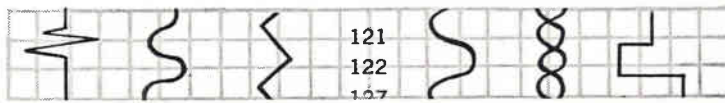
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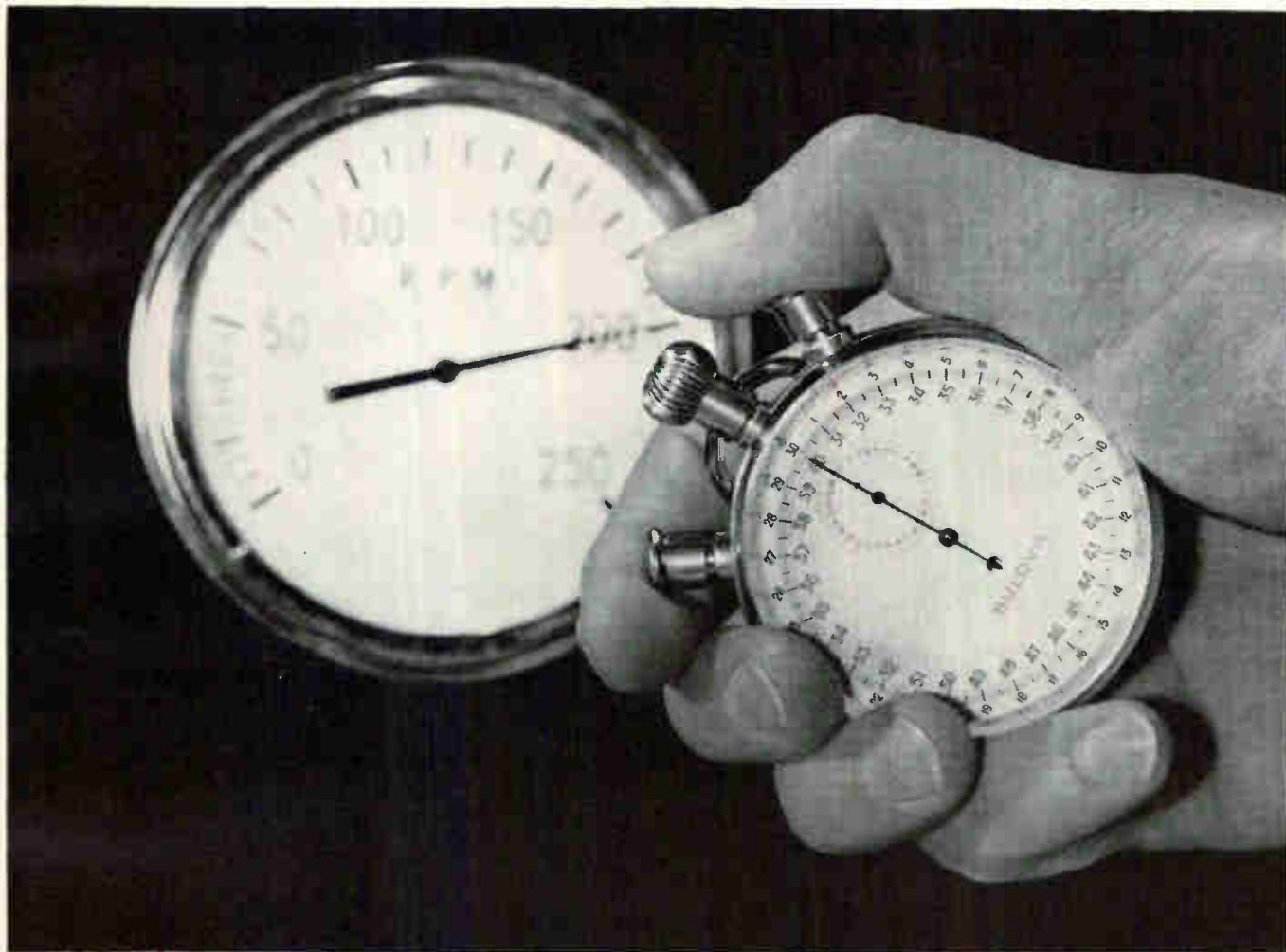


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Q.

Who has the facts about accelerating a torque motor load from zero to 200 rpm in one millisecond?

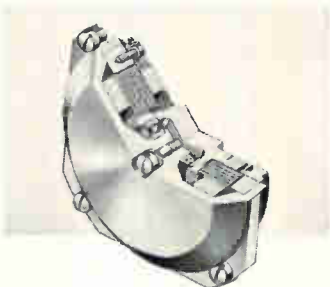


A.

The Engineers who create Inland Gearless Torquers*

They'll tell you, for instance, that acceleration of a 70 gr-cm² load from zero to 200 rpm in a millisecond is possible only with a direct-drive torquer having a torque-to-inertia ratio of 20,000 radians per second squared . . . at least 10 times the value of an equivalent gear-train servo motor.

You'll also learn that Inland d-c torquers, ranging from 0.1 to 3,000 pound-feet, are now supplying fast, high resolution servo positioning to stabilization and tracking

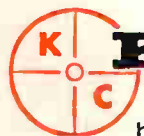


systems in airborne, shipboard and ground installations.

What is your question? If it is in the area of remote viewing, aligning, testing, inspecting, measuring or controlling, the answer may be among the growing number of optical/ electronic/ mechanical devices, instruments and systems engineered by Kollmorgen and its subsidiaries.

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may already have the answer to your next question in optics or electromechanics.

Multiple Beam Klystron For Superpower

THE DEVELOPMENT of a multiple electron beam klystron now provides a tested design format for construction of improved multi-megawatt tubes at microwave frequencies.

Advantages of the multiple beam klystron (MBK) over single beam units of comparable power output include: much lower operating voltages and thus less hv break-

down and x-ray hazard, easier cooling, smaller physical size, low harmonic content in output, broader mechanical tolerances in manufacture, and higher reliability.

A factory built model of the new klystron tube, which employs ten electron beams, is now under test. The multiple beams are contained in a single vacuum envelope and are phase locked. Combined output

of all beams is obtained through a single, circular waveguide window transparent at microwave frequencies.

The developmental model of the MBK now under test provides sustained output of 32 kilowatts at X band. The tube is 32 percent efficient and has a gain of 46 db at 12 kilovolts input. The tube's beam transmission is over 99 percent efficient.

Original research on the MBK was sponsored by the U. S. Army Signal Research and Development Laboratory at Fort Monmouth, N. J. over three years ago; and performed by General Electric Company's Power Tube Department. After the original contract ran out, General Electric funded continuing research and development on the tube for the past one and a half years, leading to the present prototype.

Both pulsed and CW multiple beam klystrons can be built. Any number of beams can be included, with a maximum of between 40 to 100 considered possible. Use of many more beams will allow construction of MBK tubes of up to 100 times greater power handling ability than present microwave designs.

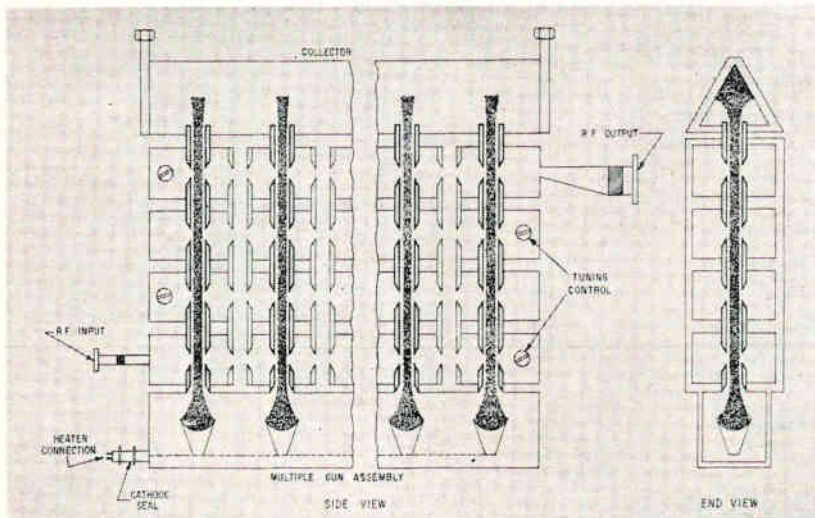
In the ten beam MBK, a low level signal (see sketch) is supplied to the tube's input cavity. In design, it is analogous to a periodic waveguide circuit physically extended in one direction, compared to an ordinary klystron which employs a single cavity.

The signal interacts with all of the ten beams, with the entire system operating in a phase locked condition. Additional intermediate cavities are employed to increase gain and efficiency. Each of the intermediate cavities is designed on the extended periodic waveguide format.

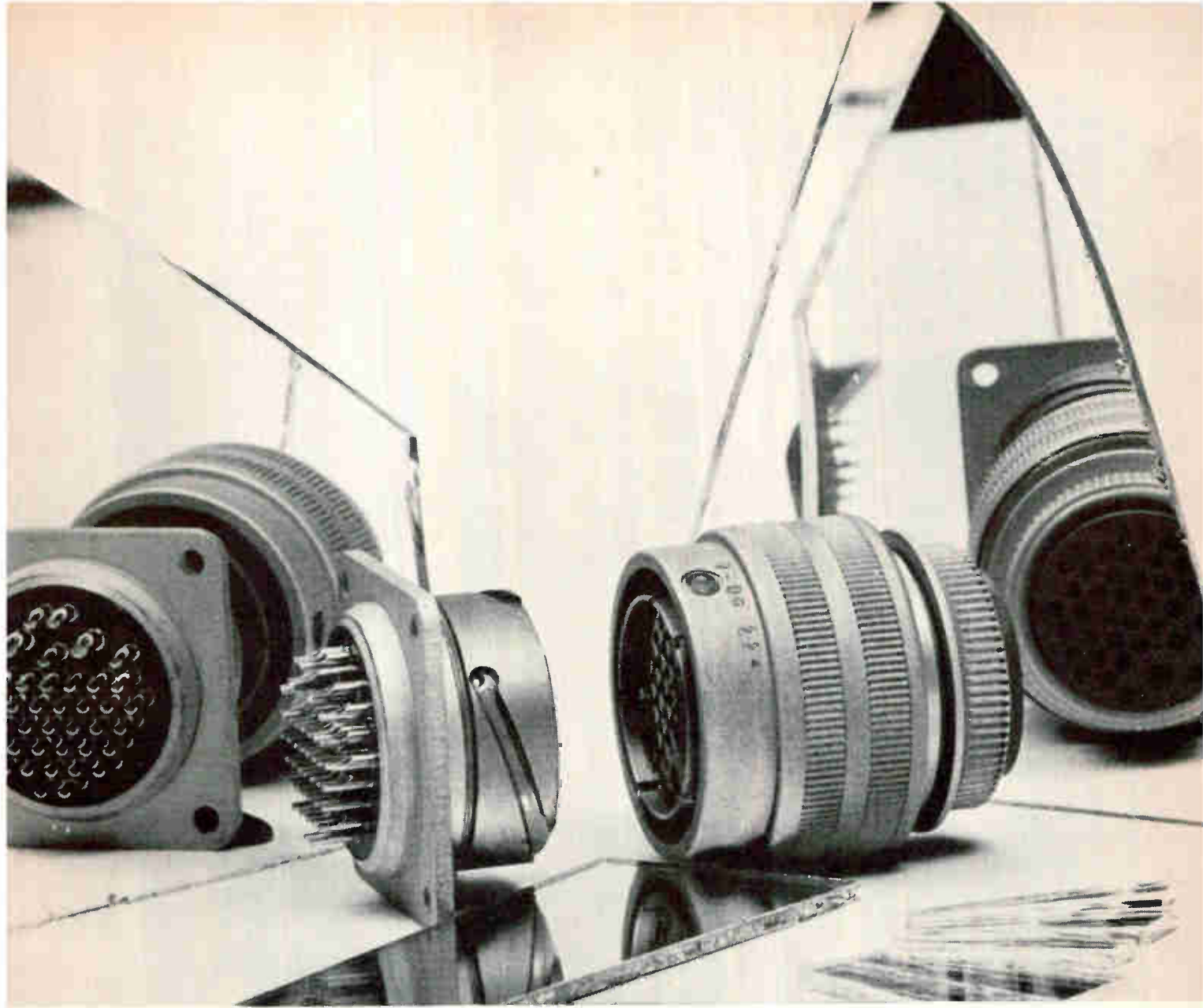
The sum of the powers of each individual beam is combined in an extended output cavity. Output in the ten beam model is taken through a single waveguide win-



Multiple beam klystron by General Electric has single vacuum envelope, employs ten electron beams. Developmental model (above) operates at X band, produces C-W output of 32 kilowatts. Engineer holds multiple beam interaction section of tube



Simplified sketch reveals format of ten-beam klystron. Extended cavities are coupled to each of the electron beams. Output of phase locked beams is obtained through waveguide window



Showoff

The Amphenol Minni E[®] connector does more than conform to MIL-C-5015. On the really important points, it far exceeds requirements.

For example, during and after a twenty-day moisture resistance test, Minni E insulation resistance is 1,000 megohms minimum. 100 megohms is plenty to meet the specifications. Minni E's withstand 2,000 cycles of vibration testing at 20 g's. MIL-C-5015 specifies 500 cycles. And, after three cycles of grueling altitude-immersion testing, Minni E's have an in-

sulation resistance of 1,000 megohms. MIL-C-5015 doesn't even contain an altitude-immersion test requirement.

It's tough enough just meeting specs. Why deliberately design connectors to exceed them?

Dependability is why.

Amphenol engineers use specs as a starting point—not the last word. If their experience in connectors (how to design them for what they'll have to do) tells them added performance is needed—

added performance is added.

That's the only way we can be certain of getting the highest possible dependability built into connectors.

A wealth of technical information on Amphenol Minni E connectors is yours for the asking. Just write Dick Hall, Vice-President, Marketing, Amphenol Connector Division, 1830 S. 54th Avenue, Chicago 50, Illinois. Or, if you prefer, contact an Amphenol Sales Engineer or Amphenol Industrial Distributor. He'll be happy to "show off" the Amphenol Minni E.

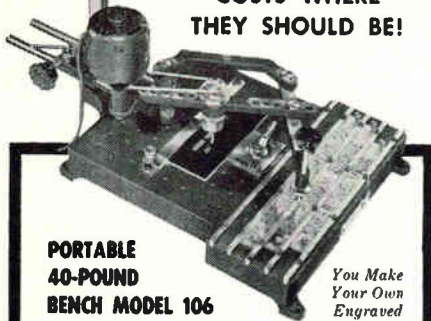


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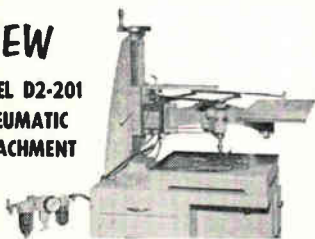
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dow. In a superpower model of the MBK, if the power output of the tube exceeds the window material's power rating, several windows may be used. All of the outputs would still be obtained in phase.

In attempting to obtain superpower by paralleling pairs of microwave tubes, power combiners dummy loads and phase control devices are used. Delicate adjustment is required. In the MBK phase locking of the output of each beam is inherent due to cavity design and spacing of the beams.

Operation of MBK at one-third or less of the voltage required for single beam designs is possible. Proper selection of the number of beams for a given power level is made during design to achieve maximum power. In addition to high voltage hazard reduction, modulation of the beam is simplified.

Tests have been made to determine performance deterioration of total power output with the failure of a single beam. Power drops in roughly direct proportion to the number of beams lost. In a multiple tube system, where the outputs are combined externally loss of power with failure of a single source is

greater due to the mismatches created.

Tuning of the MBK is achieved by moving the sidewalls with a single set of adjustments which tunes all cavities at once.

Gain and bandwidth are equivalent to that of a single beam klystron. The multiple beam format can be applied to existing single beam tube designs, either hollow, cylindrical or sheet beam.

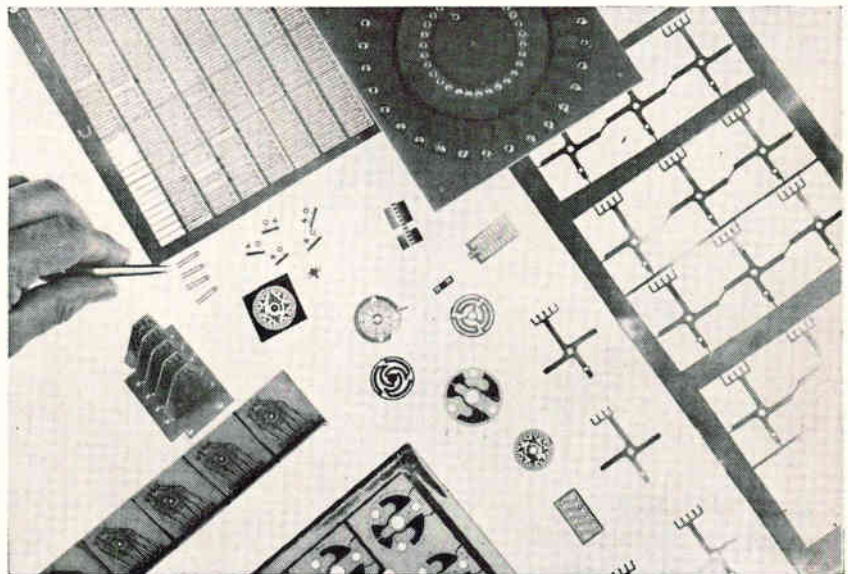
Cancellation of harmonics between beams is achieved in the MBK, resulting in a lower harmonic output than for single beam tubes.

Applications of the multiple beam klystron include tracking systems for ICBM's and satellites, high power space communications, electronic counter measures, and industrial devices.

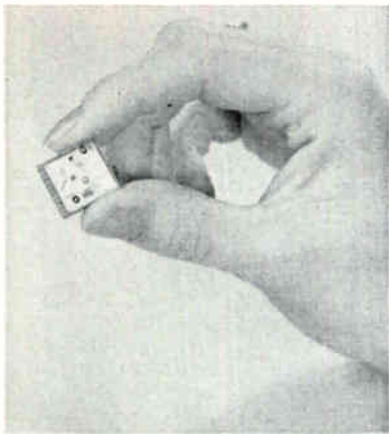
Thin Film Circuits Now in Production

CIRCUITS with deposited conductors, resistors and capacitors are now available in production quantities. Varo, Inc., of Garland Texas has firm orders for 1,700 thin film circuits, these orders will run through July. Potential orders from March

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Employing techniques used by photoengravers, Industrial Electronic Engineers Inc., North Hollywood, California, is producing small, complicated parts, shown above, from any ferrous or non-ferrous material in any thickness down to 1/10 mil with hole or line tolerances as close as ± 0.0002 in. Applications requiring close tolerance parts, such as miniature transformer laminations, printed circuit coils, flush-type commutators, switches, magnetic head laminations, etc. are ideally suited to photoetching



through July total 17,800. Devices are being delivered at "prices competitive across-the-board with welded assemblies", according to company spokesman. Any existing circuit can be converted to thin film in about 30 days, company can go into full production within 60 days. Company's latest thin film conversion (photo above) operates in vhf region, is designed for a classified project.

Domestic Source For Ultra Pure Fused Quartz

UP TO NOW all silicon-dioxide used for fused quartz production had to be imported, the only known sources of reliable quality being Brazil and Madagascar. General Electric has spent eight years in perfecting a new process for purifying raw silicon dioxide, and fabrication of the new quartz into tubing and rod is now underway by the company's Lamp Glass Department. With the new process, GE is now producing fused quartz which has a higher degree of purity than ever before possible, and this has been accomplished at a cost comparable to that obtained when imported material is used.

The semiconductor industry will benefit from a much lower content of alumina and boron, previously a major problem in the manufacture of transistors.

The new material deforms at less than one-half the rate of the former quartz when subjected to temperatures of 1,200 deg C and higher. In addition, tubing and rod produced from the domestic source will devitrify much more slowly, and remain more transparent, at the high temperatures.

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Frequency range.....	10 cps to 1 Mc		3%, 100 cps to 100 kc
Accuracy above 300 μ V		Input impedance. 2 megohms shunted by	15 pf or 25 pf
	2%, 10 cps to 700 kc		
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V_{g2}	150	V
I_a	10	mA
I_{g2}	3.3	mA
g_m	12	mA/V
r_a	>350	k Ω
μ_{g1-g2}	70	
V_{g1}	-1.2	V
R_{eq}	1.0	k Ω

Triode Section

V_a	100	V
I_a	14	mA
g_m	5.5	mA/V
μ	7	
V_g	-3.0	V

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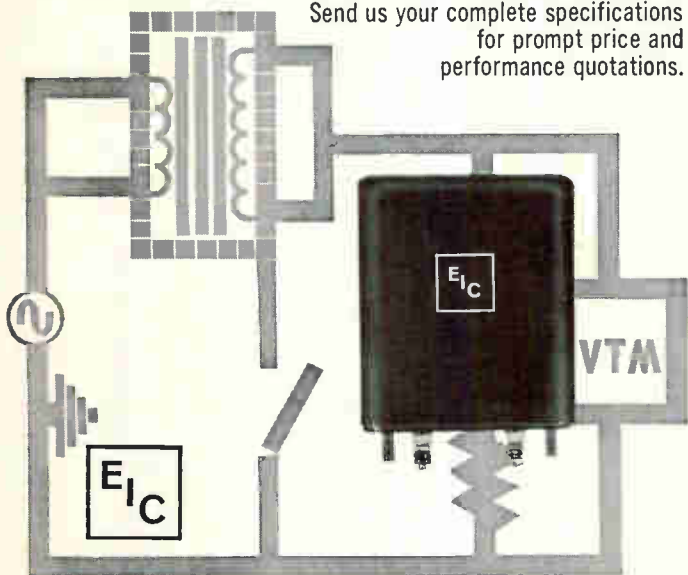
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←CIRCLE 76 ON READER SERVICE CARD

■ ■ ■ ■ ■ exciting things are happening at Eimac. Who's the world's foremost developer and manufacturer of electron power tubes? Eimac—with a long line of firsts in the field. The first modern beam magnetic optics. The first practical matrix cathode. The first metal-ceramic tubes. The first modulating anode.

Eimac tubes have powered the first satellite bounce communication. The longest command-response achieved by man. The first radar contact with the moon. Venus. And the sun.

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You can make this exciting future your future. Each of our development laboratories has openings for microwave tube or power grid tube development engineers. If your forte is developing new higher power, higher frequency tubes, or cavities or test equipment. Or if you have a flair for solving tube production problems and advancing production techniques and equipment, there are exciting challenges to investigate at Eimac. You'll work in an area renowned for its concentration of electronics industry, sunny weather, fine schools and pleasant living conditions. If you can qualify, write: Mr. C. F. Gieseler, Department B, Eitel-McCullough, Inc., San Carlos, California. An equal opportunity employer.

KEEP YOUR EYE ON



Mechanized Fixtures Speed Pot Tests



Linear drive mechanism tests potentiometers against 0.01 percent rotary master

TO TEST THEIR EXTENSIVE line of conductive-plastic precision potentiometers, Markite Corp., N. Y., N. Y., have developed several special machines. The machines are used to speed up the tests, to make them more uniform from operator to operator, and to increase accuracy and repeatability.

In the photograph below is a special table with a manually operated spiral cam with adjustable hardened steel pin insets, which is used to make various tests on rectilinear motion potentiometers. When the cam is rotated, an air cylinder, using 20 psi air, moves the table until it butts up against one of the pins in the cam. Thus the table is moved a carefully controlled distance— 0.1 ± 0.0001 inch from pin to pin—that is easily repeatable. Attached to the moveable part of the table is the body of the potentiometer being tested. Since the wiper arm of the potentiometer is fixed at its free end, each motion of the table produces a displacement of the pick-up arm and the potentiometer element.

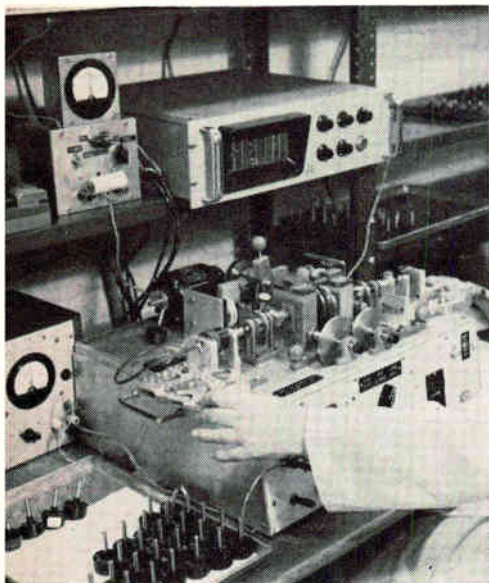
For each 0.1 inch displacement, the operator records a voltage ratio output reading, which is later compared to a set of calculated nominal values of the specific output desired of the potentiometer. The equipment is also used to measure independent linearity and terminal linearity of rectilinear potentiometers.

Potentiometers with strokes up to 2.8 inches, in increments of 0.1 inch, can be tested, with a typical saving in time over older testing methods of 50 percent.

The photograph at left shows another special piece of test equipment that is used to make other tests on rectilinear potentiometers. Parameters that can be tested include linearity, conformity, noise, functional length and terminal voltage loss.

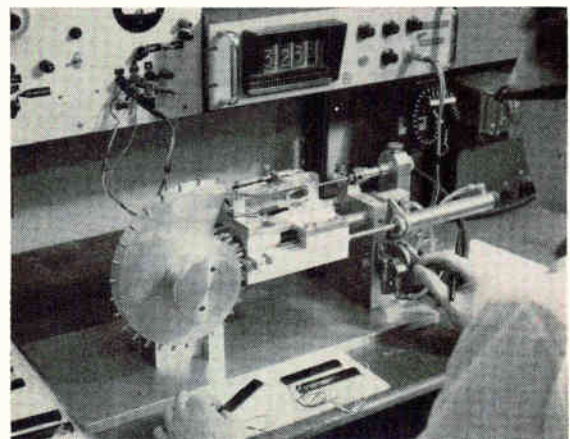
The operator places the potentiometer to be tested on the moveable platform, which rides on two guide rods. To test for linearity error, for example, the operator turns a selector switch to the "linearity" position and then moves the platform manually to one end. An end resistance adjustment is made until the oscilloscope spot is centered vertically and in line with a special mark at the left side of the face of the scope; the platform is then moved to the other end of its travel and another adjustment of end-resistance is made until the scope spot is at a special mark at the right side of the scope. When these two adjustments are set, the end zero-error voltage points are attained and no further operator adjustments are required.

The operator then engages the drive motor and a lead screw drives the platform from one end of its travel to the other. The potentiometer



Precision rotary potentiometers are tested on production line basis

Spiral cam provides high position accuracy needed to test relatively long stroke linear motion potentiometers



400 VCE



IT'S HERE! A SILICON POWER TRANSISTOR WITH V_{CE0}, V_{CB0} AND V_{CEs} OF 400 VOLTS

DELCO RADIO'S ACHIEVEMENT PERMITS DRAMATIC SIMPLIFICATION OF CIRCUIT DESIGN

IDEAL FOR MILITARY USE WHERE HIGH TEMPERATURE & VOLTAGE TRANSIENTS ARE ENCOUNTERED

VIRTUALLY IMMUNE TO FAILURE IN 24VDC AND 28VDC SWITCHING AND REGULATOR CIRCUITS

PERMITS OPERATION FROM 110 AND 220 AC LINE SOURCES FOR POWER CONTROL APPLICATIONS

SAMPLES AVAILABLE. CALL OR WRITE:

Collector diode voltage V _{CB0} 400 Volts		Base current (continuous) 1 Amp.			
Emitter diode voltage V _{EB0} 5 Volts		Maximum junction temperature 150°C			
Emitter current (continuous) 5 Amps.		Minimum junction temperature -65°C			
PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
I _{CB0}	V _{CE0} = 400V , T = 125°C	—	—	10	ma
I _{CE0}	V _{CE0} = 400V	—	—	10	ma
I _{CEs}	V _{CEs} = 400V	—	—	10	ma
R _{Sat}	I _C = 5 amp, I _B = 1 amp	—	0.15	0.25	ohm
h _{FE}	V _{CE} = 5V, I _{CE} = 5A	10	—	—	
R _{th}		—	0.5	—	°C/watt

Electrical characteristics @ T_c = 25°C unless otherwise noted.

Union, New Jersey
324 Chestnut Street
MURdock 7-3770

Detroit, Michigan
57 Harper Avenue
TRinity 3-6560

Santa Monica, California
726 Santa Monica Blvd.
UPTon 0-8807

Syracuse, New York
1054 James Street
GRanite 2-2668

Chicago, Illinois
5750 West 51st Street
PORtsmouth 7-3500

General Sales Office: 700 E. Firmin, Kokomo, Indiana, GLadstone 2-8211—Ext. 500

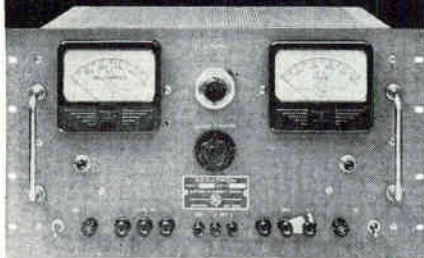
Division of General Motors



ELECTRONIC MEASUREMENTS

high-precision

POWER SUPPLIES



the power supplies demanded by the laboratory

There are a lot of reasons why E/M's high-precision power supplies are in such demand by R & D laboratories. Ten-turn main DC control and vernier provide high resolution of output voltage from just a few millivolts to 1000 V DC, depending on model. Regulation is at least 0.02%. And full current output is available at any voltage... even at less than one volt. Various models cover current ratings up to 1.5 A. Some models feature a -150 V bias output. Others include a modulation input. All models have a 6.3 V AC CT output. And there are still more features... fully described in Catalog VR 1962.



ELECTRONIC MEASUREMENTS COMPANY
INCORPORATED
SATONTOWN - NEW JERSEY

eter being tested is measured against a Markite conductive-plastic rotary master (linearity of ± 0.01 percent), which is set into the rear of the machine and is driven through precision, anti-backlash gearing. The error signal that is developed is fed to a recorder and the oscilloscope, so that a permanent record is available for the customer while important variations are immediately shown on the scope. Other tests possible with the equipment are made in a similar fashion.

The third photograph shows a fixture for taking voltage gradient readings of rotary potentiometers. The machine is an automatic, two-station device, so that while one potentiometer is being tested in one station, the other station is being loaded with the next potentiometer.

To operate, the potentiometer is

placed in one of the fixtures of the machine and then a lever is manipulated; the lever acts to clamp the potentiometer firmly in the fixture and to make electrical connections. The potentiometer shaft is ready to be connected to the drive mechanism but is still free to rotate at this stage; the operator adjusts the potentiometer shaft until it is at electrical center, as determined by ratiometer reading.

When the drive mechanism is engaged, it begins testing the readied potentiometer, indexing it 4 degrees ± 0.01 degree at a step, and taking a maximum of 30 readings on each side of electrical center. At each point, the voltage ratio is automatically read and printed. The equipment can make 60 readings in three minutes, which is ample for the operator to remove a tested unit and prepare the next.

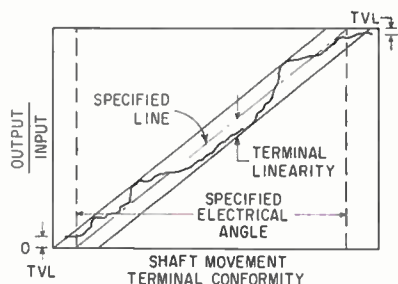
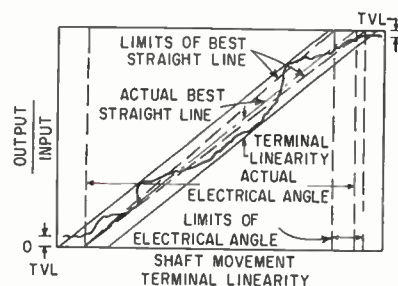
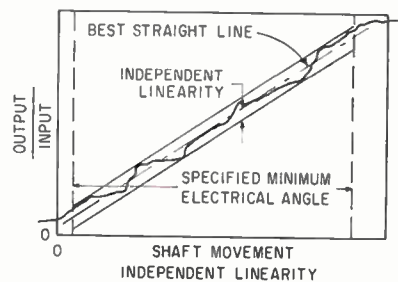
DEFINITIONS OF POTENTIOMETER PARAMETERS

(1) *Independent Linearity:* the maximum deviation of the electrical output from the best straight line drawn through the electrical output versus mechanical displacement diagram. It is expressed as a percentage of the applied voltage, and measured over the minimum specified electrical angle or length.

(2) *Terminal Linearity:* the maximum deviation of the electrical output from the best straight line drawn through the electrical output versus mechanical displacement diagram which goes from 0 to 100 percent of the input voltage within the specified electrical angle or length range. It is expressed as a percentage of the applied voltage and measured over the actual electrical angle or length, within the specified range.

(3) *Linear conformity:* the maximum deviation of the electrical output from a specified line or curve relating electrical output to mechanical displacement. It is measured over the specified electrical angle, and expressed as a percentage of applied voltage.

(4) *Function conformity:* the maximum deviation of the electrical output from a specified line or curve relating electrical output to



The Oak Approach!



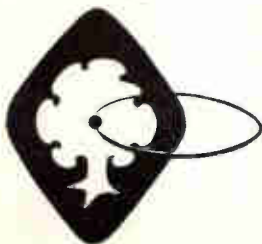
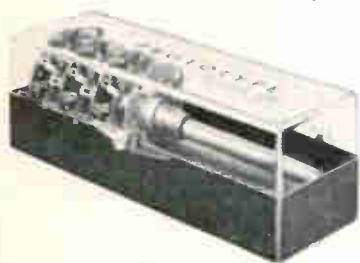
Jack be quick! Your prototype switch in just 3 days

No surprise! OAK has the fastest delivery cycle in the industry for prototype rotary switches. How speedy? It's sketch to switch in just 72 hours after receipt of your drawings.

Your switch arrives in time because we rush it to the airport as soon as it's completed. But OAK speed begins as soon as we receive your order. It's spotted and routed through a special prototype department — hand-tended from applications engineering through final shipping. And your switch arrives safe-

ly — thanks to the same Oakote protected packaging that is used on regular OAK shipments. Inside, your prototype is attractively boxed in the "plasticase" shown at the left.

We make your sketching easier too! Special layout sheets are now available at no cost to help in diagraming your switch. For further information on "Jack be quick" prototype service, products or production scheduling, get in touch with us or the OAK Representative nearest you.



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Subsidiaries: OAK ELECTRONICS CORPORATION
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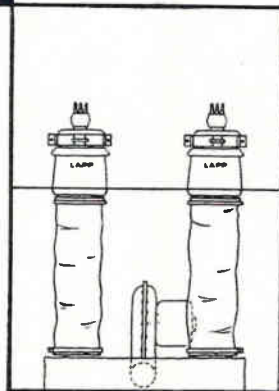
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AND VENDING CONTROLS • ROTARY SOLENOIDS • CHOPPERS • CONTROL ASSEMBLIES

Lapp

TUBE SUPPORTS for air-cooled power tubes



Since forced-air-cooled tubes were first introduced, equipment manufacturers have been designing their own supports, many of which

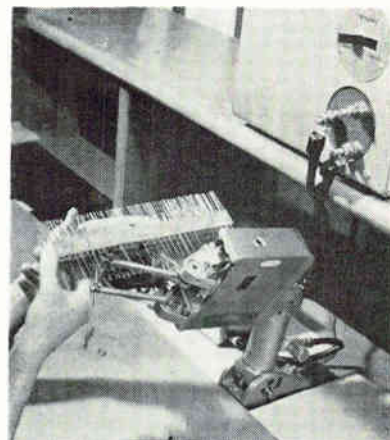
have been produced by Lapp. To standardize the great variety of tube support designs, Lapp set out to design a complete line which is now available and offers the equipment manufacturer a valuable service by way of more economical production, interchangeability and availability of replacement units. Lapp Tube Supports are compact, efficient and attractive in appearance. Their duty is threefold . . . they support the tubes, insulate, and furnish an air duct which channels air over tube fins for maximum cooling. Write for Bulletin 301, with complete description and specification data. Lapp Insulator Co., Inc., Radio Specialties Division, 190 Sumner Street, LeRoy, New York.

Lapp

mechanical displacement. It is measured over the specified electrical angle, and expressed as a percentage of applied voltage.

(5) Zero based linearity: the maximum deviation of the electrical output from the best straight line drawn through the electrical output versus mechanical displacement diagram, which passes through the zero percent input voltage point. It is expressed as a percentage of the applied voltage and measured over the minimum specified electrical angle or length.

Welding Heads Rotate, Tip, Tilt



O-SERIES resistance welding heads, by Raytheon Co., Lexington 73, Mass., are compact precision units for accurate, high speed production welding of small parts, sub-assemblies, micromodules, etc. Heads swivel, tip and tilt and can even be used upside-down. The electrode arms rotate and swing to provide optimum electrode position.

Three heads are included in the series. All will deliver up to 100 watt-seconds of stored energy (d-c), or up to 2 Kva (a-c); all have two ranges of adjustable forging force, 0.5 to 10 lb., and 2 to 20 lb., and fire at the preset force setting.

The heads have a 4 inch throat and adjustable travel up to $\frac{3}{4}$ inch, but with special electrode holding arms the effective throat opening can be from 1 to 7 inches. The heads are operated by foot treadle but one version is supplied with an air cylinder for power-assist operation.

\$1500*

\$1285*

\$845*

\$630*

\$250*

\$35*

077-GE

*APPROX. PRICE OF COMPETITIVE DEVICES

Detailed value-analysis chart shows how cost, size, and performance advantages can be yours. Clip coupon, or circle reader service number, for free copy.

Why pay as much as \$1500 for a microwave device if a \$16 G-E ceramic tube will do the job? In many UHF applications up to 10 KMC (power amplifiers, oscillators, or frequency multipliers) high-gain, low-noise ceramic tubes can often replace TWT's, klystrons, magnetrons or pencil tubes and provide better over-all performance. Oftentimes, ceramic tubes can effect component cost reductions of 5 or 10 to 1, and reductions of 50 to 1 are possible.

Value analysis will show you that G-E ceramic tubes can mean even greater over-all savings. Most common reasons: simplified system design, fewer components, reduced power requirements, and elimination of cooling equipment. Microminiature ceramic tubes increase system resistance to radiation, provide extreme high-temperature tolerance (400°C., max.), and are up to 40 times smaller and 20 times lighter than many other UHF devices.

Most G-E ceramic tubes are on approved MIL-spec lists and are available "off-the-shelf" from your local G-E receiving tube sales representative. Send, today, for your free value-analysis chart which lists all the cost, size, and performance advantages that can be yours with G-E ceramic tubes.

NEW
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CERAMIC TUBES
REDUCE
MICROWAVE
COMPONENT COSTS
DOWN TO
\$16.00
OR LESS

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 General Electric Receiving Tube Dept.
 Room 1718
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**CERAMIC
 TUBE
 VALUE
 ANALYSIS
 DATA**

Name _____ Title _____
 Company _____ Address _____
 City _____ Zone _____ State _____

Progress Is Our Most Important Product

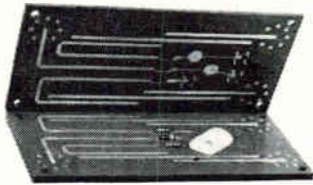
GENERAL  ELECTRIC

This means you can design microwave circuits with freedom . . . breadboard and test quickly and accurately . . . reduce package weight and volume . . . get MIL-Spec reliability . . . at lower cost. What the concept of strip transmission line promised, TRI-PLATE techniques deliver — they've made the concept a practical reality! To Bread-

board and Test new circuit ideas quickly and easily — no matter how advanced or daring — a complete line of over 600 TRI-PLATE Modules is available. To help you create new directions in electronics more than 150 TRI-PLATE Mounts for standard and advanced semiconductor devices are offered. In just minutes, you can have complex

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Tri-Plate®



Stacked Circuit with internally mounted Semi-Conductors



**products
make**

**strip transmission
a practical reality!**

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Line. Microwave Packages that heretofore have been thought impractical or impossible to build because of their bulk and complexity, are successfully produced in TRI-PLATE Line. For they match the performance of coaxial and waveguide circuits yet have a volume less than one-half, weigh less than one-fourth, and cost substantially less. What's more, TRI-PLATE Strip Transmission Line circuits have a packaging versatility to solve the most difficult problems. Reliability

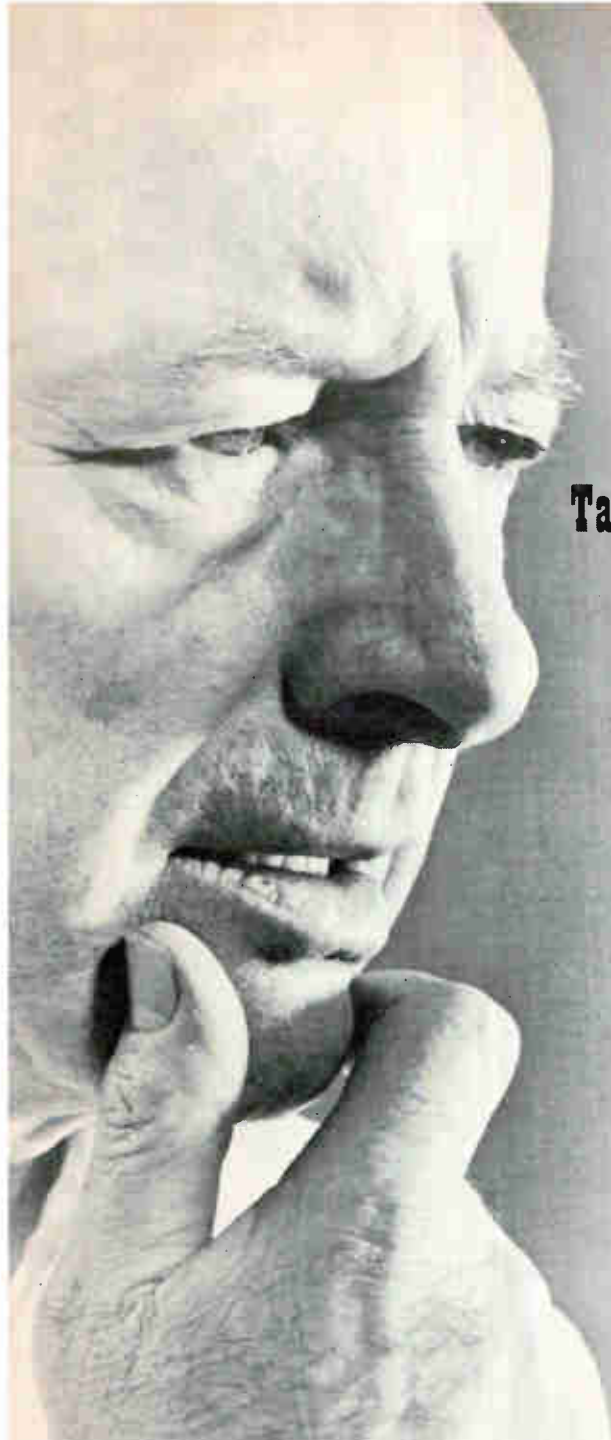
at Low Cost in TRI-PLATE Strip Transmission Line is a reality. Simplicity in construction, sound engineering techniques and automated production methods let you go from design to prototype to production with known characteristics. The advanced photo-etching process used in TRI-PLATE Strip Transmission Line provides a simple, fast and econom-

ical method of exact reproduction. 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

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SANDERS TRI-PLATE® STRIP TRANSMISSION LINE



Take an engineer's critical look at



MERCURY-WETTED CONTACT RELAYS

☆☆☆ by **P & B** ☆☆☆

Your product demands a *superior* relay? Can't tolerate contact bounce, welding or pitting? Must have billions of operations? Need fast switching . . . complete stability and reliability? Our JM Series mercury-wetted contact relays meet all these requirements. No other type relay gives you the combination of all these features:

LONG LIFE BILLIONS OF OPERATIONS

 **NO BOUNCE**

HIGH (100 cps) **SPEED**

SUPERIOR RELIABILITY

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JM Relays are now available at your local electronic parts distributor.



ENGINEERING SPECIFICATIONS

Speed: SPDT Operate: 3 milliseconds (approx.) at 2 watts. Release: 3.2 milliseconds (approx.).

Contact Rating: 5 amperes maximum, 500 volt maximum, 250 volt-amp max. (with required contact protection).

Contact Configuration: Each capsule SPDT., combination of capsules in one enclosure can form DPDT, 3PDT, 4PDT. (All Form D.)

Terminals: Octal type plugs, 8 and 11-pin; Solder lugs; 14 or 20-pin miniature; AN connectors.

Coil Resistance: 2 to 58,000 ohms.

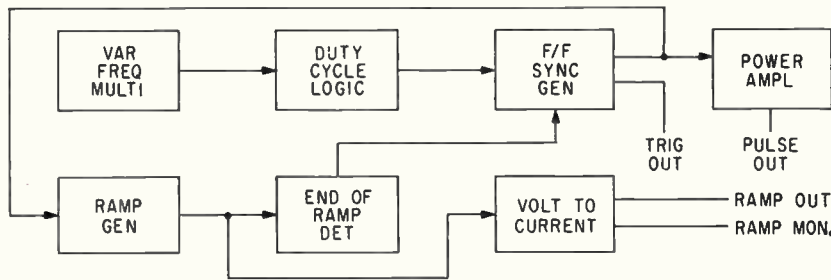
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IN CANADA: POTTER & BRUMFIELD, DIVISION OF AMF CANADA LIMITED, GUELPH, ONTARIO

DESIGN AND APPLICATION



Ramp-Pulse Generator

MEASURES PULSE TRANSFORMER INDUCTANCE

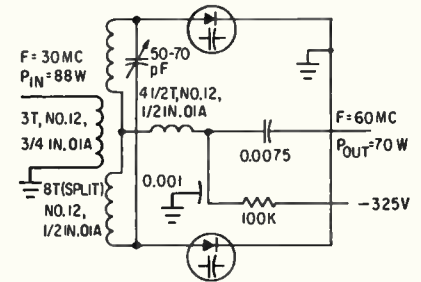
RECENTLY announced by Pulse Engineering, Inc., 560 Robert Ave., Santa Clara, Cal., is the model 210 ramp generator that generates current ramps up to 0.3 ampere and 0.6 to 1,000 μ sec duration. Internal impedance of pulse output is approximately 1 ohm with a fast rise time thus producing virtually droopless voltage pulses. The device applies a known current ramp to the unknown coil with resulting peak induced voltage. Peak pulse inductance is related to peak voltage amplitude. Onset of core saturation can be observed and this method also eliminates parasitic oscillations that often occur on current ramp during magnetizing cur-

rent measurements. The sketch shows operation of the device. The variable-frequency multivibrator establishes the primary prf, and drives the duty cycle logic which automatically limits maximum duty cycle to 0.1. The pulse then complements a control flip-flop which drives a pulse amplifier and the ramp generator. The pulse amplifier delivers a current limited, low-impedance pulse to the output. The ramp generator produces a ramp which is delivered to the output as a current ramp. The trailing edge of the pulse or ramp is determined by the end-of-ramp circuit which resets the control flip-flop.

CIRCLE 301 ON READER SERVICE CARD

control winding on the magnetic amplifier which in turn controls the scr regulator.

CIRCLE 302 ON READER SERVICE CARD

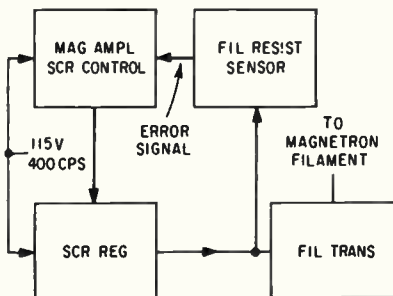


Parametric Multipliers

QUADRUPLES TO 120 MC

RECENTLY announced by General Electronic Labs., Inc., 18 Ames Street, Cambridge, Mass., are a series of parametric frequency doublers with output frequencies in the 30 and 430 Mc ranges and a quadrupler with an output center frequency of 120 Mc. Overall half-power bandwidths are 2 percent for the 30 and 120 Mc units and 10 percent for the 430 Mc unit. Efficiency is up to 75 percent, and indefinitely long life is reported for unit operating under specifications. When specified, minor circuit modifications permit cascading units for higher orders of multiplication.

CIRCLE 303 ON READER SERVICE CARD

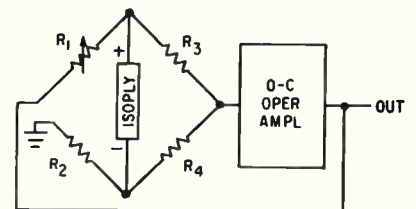


Filament Regulator

PROTECTS MAGNETRONS

MANUFACTURED by Crydom Laboratories, Inc., 12850 Western Ave., Garden Grove, California, the filament regulator is a solid state device that is capable of maintaining magnetron filament temperature

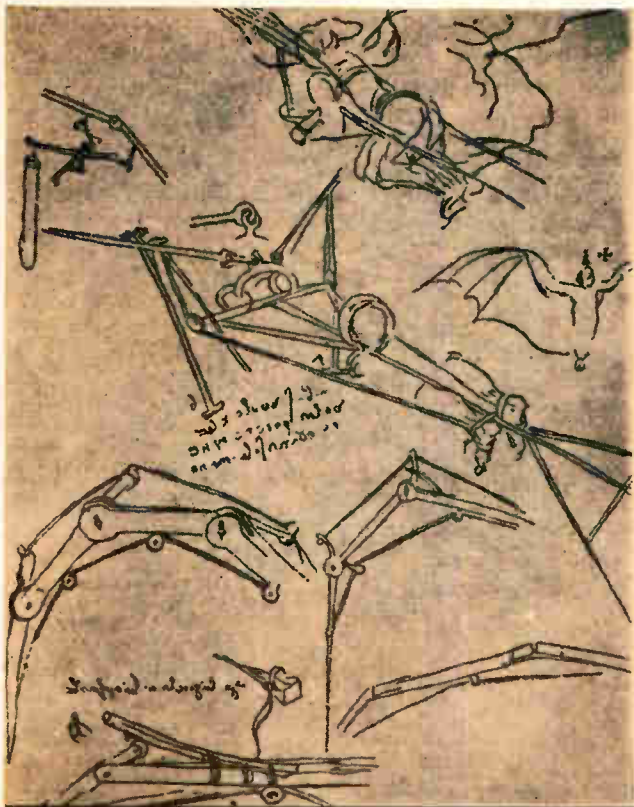
within ± 3 percent after initial warmup over ambient temperature ranges from -55 C to $+85$ C with up to 75-percent backheat and ± 10 -percent variations in line voltage. Resistance of a magnetron filament is a function of temperature. This unit senses filament resistance, therefore temperature by measuring the filament transformer primary voltage and current. Under zero anode power conditions, the silicon controlled rectifier regulator (see sketch) supplies recommended filament voltage. As backheat is applied to the filament, its resistance change distorts the E/I ratio producing an error signal from the filament resistance sensor. This signal is fed to a con-



Isolated Power Supply

10¹² OHM LEAKAGE

ANNOUNCED by Elcor Inc., 1225 W. Broad St., Falls Church, Va., is the Isoply series of isolated power supplies. Low interwinding capaci-



"There shall be wings!" said da Vinci. "If the accomplishment be not for me, 'tis for some other. The spirit cannot lie; and man, who shall know all and shall have wings, shall indeed be as a god." Leonardo's originality is evident in the many sketches and plans for both flying machines and parachutes in his notebooks. Though he was never satisfied with his designs and died before he could bring his work to fruition, his sketchbooks indicate a thorough study of the mechanics of bird flight and his attempts at simulating it. The remarkable da Vinci even designed a helicopter, which indicates that his grasp of aerodynamics extended well beyond bird simulation to concepts of flight we employ today.

The facsimile page presented herewith is from his original book of sketches and observations. Flying Machine models, constructed in exact accordance with Leonardo da Vinci's specifications, are on exhibition in the National Museum.

LEONARDO'S FLYING MACHINE DESIGN—1490

ORIGINAL



Daystrom originated the square design for a trimming potentiometer. Since we introduced the Squaretrim® several years ago, it has established an enviable growth curve, and is being specified on more designs every day. The original space-saving square shape, plus the high reliability that results from our wire-in-the-groove resistance element winding technique (another original) sets the Squaretrim in a class by itself. Further, we offer immediate delivery and the widest selection of standard models. Send for catalog.

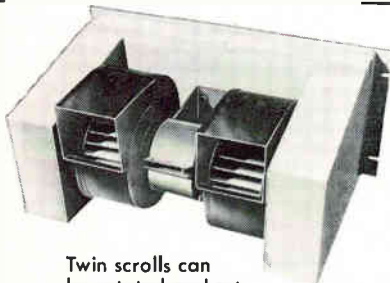
THE SQUARETRIM® SUBMINIATURE POTENTIOMETER

DAYSTROM, INCORPORATED
 POTENTIOMETER DIVISION
 ARCHBALD, PENNSYLVANIA • LOS ANGELES, CALIFORNIA

Versatility TO SAVE YOU MONEY

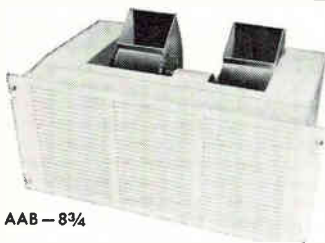
PANEL MOUNTING ALL-ANGLE BLOWERS

One multi-purpose model in stock will eliminate procurement of several single-purpose units to satisfy variable requirements. Large cooling capacity.



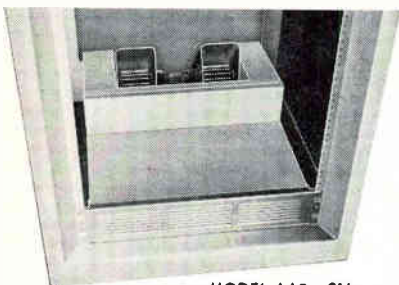
Twin scrolls can be rotated and set to angle of choice through 230° for accurate air flow control.

Use for supply or exhaust—or one port for supply, the other exhaust.



MODEL AAB-8¾

Mount as standard 8¾", 7" or 3½" panels. Blower unit of 3½" model is recessed to allow extra usable chassis or storage space.



MODEL AAB-3½

- MIL quality heavy duty construction and finish or finish to Customer specs
- Easy maintenance without removal from cabinet
- Cushion mounted for quiet operation
- Cleanable filter
- Motor bearings permanently lubricated

Ask for complete data—our Bulletin D-1000

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for VENTILATED RELAY RACK CABINETS,
CONTROL CONSOLES, BLOWERS, CHASSIS,
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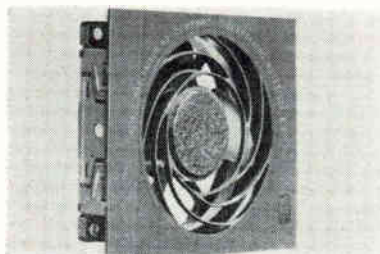
ORegon 8-7827

WESTERN DEVICES, INC.

600 W. FLORENCE AVE., INGLEWOOD 1, CALIF.

tance prevents transfer of hum and noise energy to load circuit. Low distributed shunt capacitance (typical 20 pF) permits use in high-speed circuits. As opposed to batteries, output voltage can be changed in fine increments and they are available in constant voltage or current types. Typical use is shown in sketch (p. 86). Leakage resistance between secondary and ground is approximately 10^{12} ohms. At quiescence, R_2 is equal to R_1 , and R_3 and R_4 are equal. Output of operational amplifier is out of phase with input so that any change in input signal causes amplifier to supply, at very low impedance, output of opposite polarity which when coupled back to input through bridge, restores input to zero condition. Action of circuit keeps current through R_1 and R_2 constant. Value of current is determined by R_2 since its potential is same as R_1 at bridge balance. Any change in potential across R_2 produces an error signal. Resulting balance restores original potential across R_2 thus keeping current constant. Value of R_1 may be varied to near zero ohms and up to some value limited by linear output voltage.

CIRCLE 304 ON READER SERVICE CARD



Super-Quiet Fan

COMPACT UNIT

ROTRON MFG. CO., INC., Woodstock, N. Y. The Whisper Fan delivers 60 cfm and operates at 1,800 rpm on 115 v a-c, 60 cps, single phase. It measures 1½ in. deep and 4¼ in. sq. Completely ready for mounting, the fan weighs only 1.2 lb. Speech interference level, -18 db.

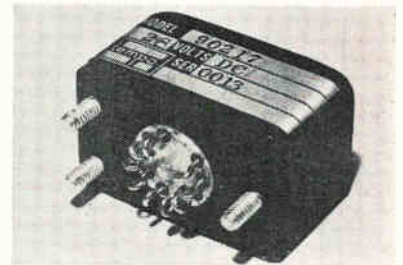
CIRCLE 305 ON READER SERVICE CARD

Voltage Regulator

SOLA ELECTRIC CO., Elk Grove Village, Ill. New Solartron line voltage regulator combines a regulating

transformer that is a static magnetic device plus a sensing circuit that senses the variations in output voltage that result from changes in line voltage, changes in load and changes in frequency.

CIRCLE 306 ON READER SERVICE CARD



Solid State Timer

FOR CRYOGENIC USES

TEMPO INSTRUMENT, INC., Technical Industrial Park, Plainview, N. Y., announces a solid-state electronic timer for applications where temperatures might range from -196 to +55 C. It provides time intervals from 0.05 to 1 sec. is adjustable by means of an external timing resistor, and operates from 20 to 31 v d-c. Unit incorporates a static output switch capable of delivering up to 500 ma to an external load.

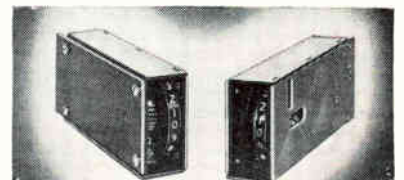
CIRCLE 307 ON READER SERVICE CARD

Quartz Crystal

GLASS MOUNTED

BLILEY ELECTRIC CO., Union Station Building, Erie, Pa. In primary standards, this glass mounted, optically polished, gold-plated fifth overtone quartz crystal at 2.5 Mc provides a stability of 1 part in 10^9 with aging of only 5 parts in 10^{10} . Known as type BG11AH-5, the average Q is 4,500,000.

CIRCLE 308 ON READER SERVICE CARD



Stepping Switches

HIGH-SPEED

HILLBURN ELECTRONICS CORP., 55 Greenpoint Ave., Brooklyn 22, N. Y. High-speed stepping switches fea-

ture both digital and visual readouts. They are suited for use in computers, counters and test equipment for signal initiation, programming and visual display. A digital readout wheel actuated by a high-speed stepping relay provides direct visual readout, auto-homing to "0" and "carry" at "9". Relay will auto-home at 50 pps and follow a square wave pulse of 25 millisecc.

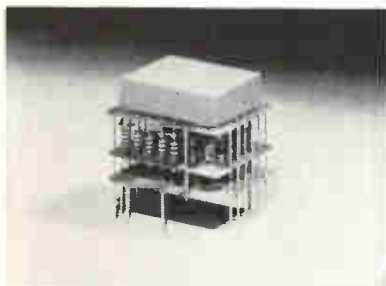
CIRCLE 309 ON READER SERVICE CARD

A-D Converter

ALL SOLID STATE

TEXAS INSTRUMENTS INC., 3609 Buffalo Speedway, Houston, Texas. Model 834 features high speed and high accuracy. Designed for data acquisition systems, process control or data processing systems, it can be modified for many digital data handling applications. It features high speed: 1.5 μ sec per bit, built in sample and hold, high accuracy: ± 0.05 percent of full scale and automatic zero stabilization.

CIRCLE 310 ON READER SERVICE CARD



Decimal Micro-Counter

ALL SOLID STATE

BURROUGHS CORP., Plainfield, N. J. Decade Counter BIP-8000 has 90 diodes, 12 transistors and associated components in a package 1.2 \times 1.2 \times 1.4 in. Frequency capability is 110 Kc and readout can be Nixie tubes, printers or other circuit functions. Price is \$95 in single quantities and unit is available from stock.

CIRCLE 311 ON READER SERVICE CARD

Stable Oscillators

TRANSISTORIZED

LABORATORY FOR ELECTRONICS, INC., 1079 Commonwealth Ave., Boston 15, Mass. Series 816 stable micro-

March 30, 1962

have you tried BIRD?

READ RF WATTS DIRECTLY

Today everyone who measures RF power in coaxial systems wants the answer in watts. The BIRD, Model 43 THRULINE reads watts!

Connect the Model 43 between transmitter and antenna or load. The meter reads RF power directly. Measure forward or reflected power instantly.

No calibration charts. No adjustments. No calculations. No auxiliary power.

Plug-in elements are used to cover 2 to 1000 mc, and powers to 1000 watts.

BIRD Quick-Change (QC) Connectors eliminate adapters. Any standard series of coaxial line fittings may be accommodated.

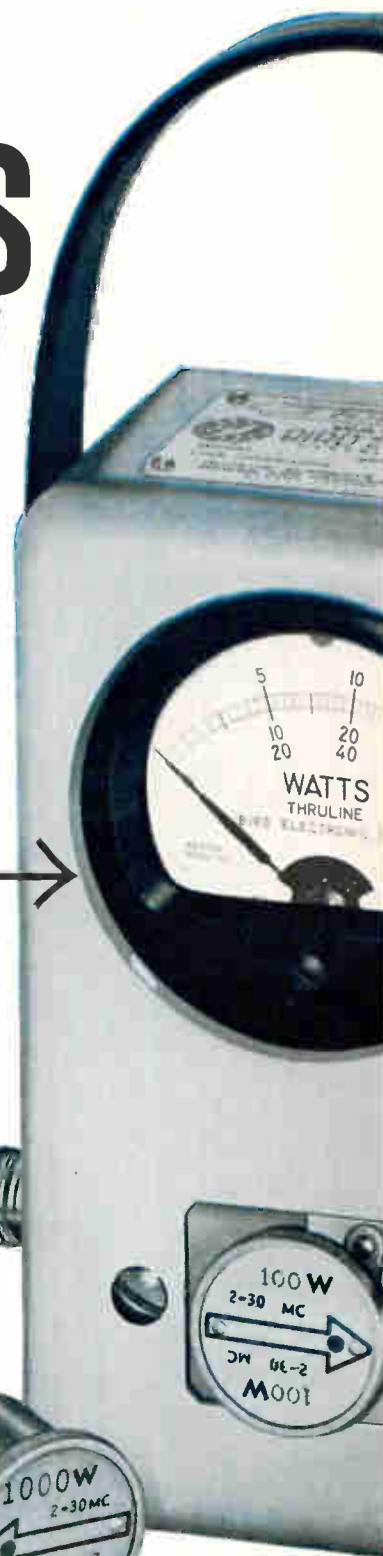
Write, TWX or call us for complete specifications on the Model 43 and other BIRD products.

Price:

Instrument only \$95.00 each

Plug-in elements \$30.00 each

F.O.B., Factory



**BIRD Model 43
Thruline Wattmeter**



BIRD

ELECTRONIC CORPORATION

30303 Aurora Rd., Cleveland 39 (Solon), Ohio

Churchill 8-1200

TWX CGN F5 679

Western Representative:

VAN GROOS COMPANY, Woodland Hills, Calif.

CIRCLE 89 ON READER SERVICE CARD

89

ask

MARKEM

to show you

how to

identify

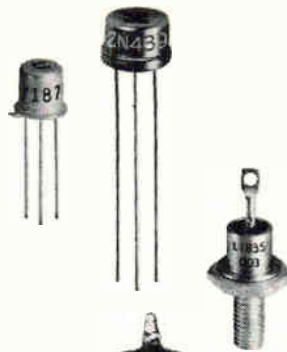
your products

completely

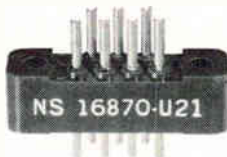
— at

least

cost

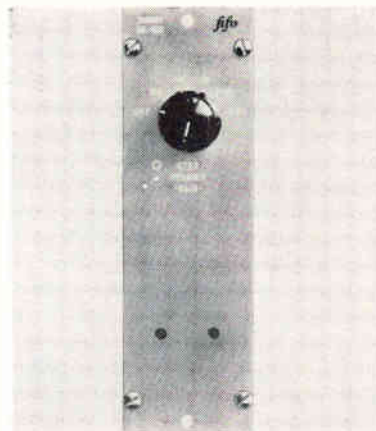


#A-104660
4000 OHMS
C. P. CLARE & CO
CHICAGO, ILL.



wave oscillators, with short-term stability of 5 parts in 10⁶ peak deviation and long-term stability of 1 part in 10⁶, reduce phase instability in high resolution and MTI radars operating at L- and S-bands. Series is made up of 18 different models, each covering a specific 200 Mc increment between 1 Gc and 3 Gc.

CIRCLE 312 ON READER SERVICE CARD



D-C Amplifier

10 KC BANDWIDTH

SANBORN CO., 175 Wyman St., Waltham 54, Mass. The FIFO (floating-input, floating-output), a miniature d-c amplifier, is designed for extracting low-level transducer signals from a high noise level, features one-millisecond recovery time after a 14-v overload.

CIRCLE 313 ON READER SERVICE CARD

Whether your electrical and electronic products range from subminiature and microminiature components to large panels and "packages", you can identify them *all* completely and clearly, at production speeds, with economical Markem methods engineered to your particular requirements. For example: methods to mark odd shapes, sizes and surfaces with your complete, detailed legend, using quick-change type flexibility and ink to meet military specifications and withstand unusual environmental conditions—and above all, with savings in time and money—are offered by Markem, one responsible source for the entire process.

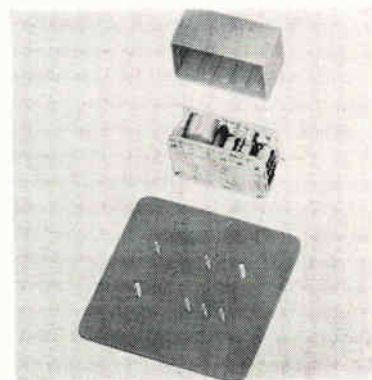
For a complete in-plant analysis of all your product identification processes—or a practical answer to a specific problem—call in your local Markem Technical Representative. Markem Machine Co., Electronics Division, Keene 5, N. H.

12-page catalog on request. Please use inquiry card.



MARKEM

HELPS YOUR PRODUCT SPEAK FOR ITSELF



Micromodule

RELIABLE CONTACTS

ELCO CORP., M St. below Erie, Philadelphia 24, Pa. Advance-design micromodule, called Modu-Con, offers reliability of the company's Varicon contacts. Unit is pluggable; contacts are recessed; and there are no

exposed parts. Modu-Con permits repair of components without disturbance to circuit or assembly; and offers vibration lock. Modules are available from stock in 3 standard sizes and consist of Mylar wafer; plastic header; Varicon contacts and potting shell.

CIRCLE 314 ON READER SERVICE CARD

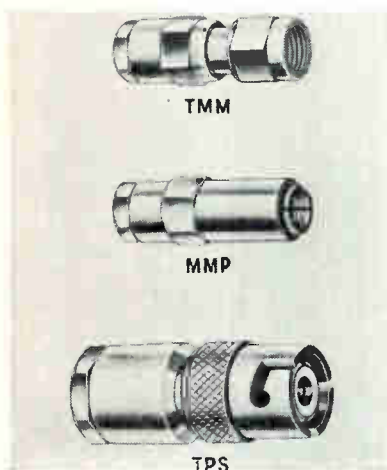


Low-Noise Choppers

SOLID-STATE

AIRPAX ELECTRONICS, INC., Cambridge, Md., announces type 7001, an spst chopper, and type 7005, an spdt unit. Both have a typical noise level of only $35\mu\text{v}$ rms at 400 cps working into a 10,000 ohm load. The choppers have an input signal rating of ± 15 v and operate in temperatures from -30 C to $+100$ C. Price is \$98.20 each in quantities with delivery in 15 days.

CIRCLE 315 ON READER SERVICE CARD



Connectors

MICROMINIATURE

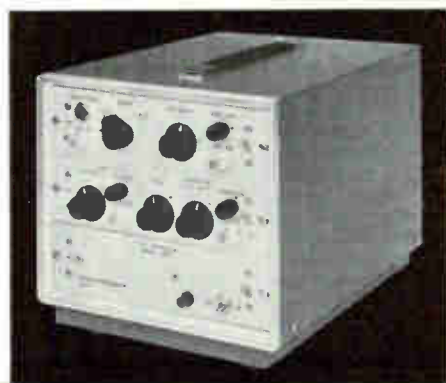
AUTOMATIC METAL PRODUCTS CORP., 315 Berry St., Brooklyn 11, N. Y., announces five series of microminiature connectors: TMM (threaded), 50 and 75 ohm; MMP (push on), 50 and 75 ohm; and TPS (bayonet), 50 ohm. They are recommended for the most severe applications at frequencies up to X band. Standard cable

March 30, 1962

100,000,000

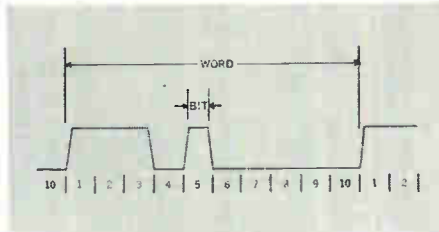
Pulses/Sec

from TI



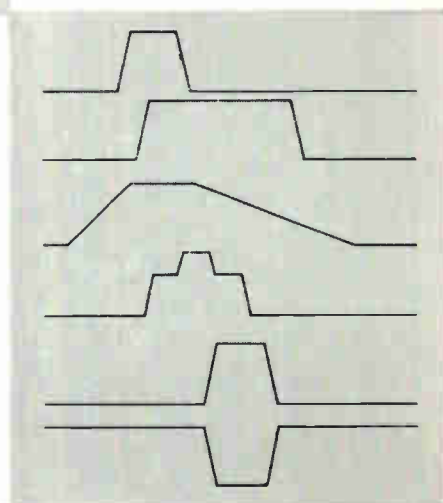
PROGRAMMED PULSE GENERATORS

- Bit Rates up to 25 MC
- 10 Bit Programmable Words



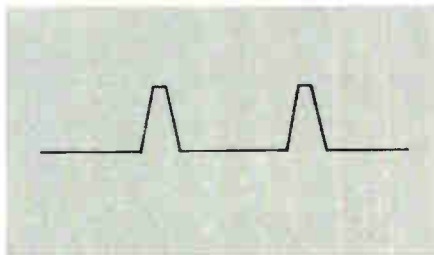
GENERAL PURPOSE PULSE GENERATORS

- PRF 100 cps to 25 MC
- Variable Pulse Width and Delay
- Variable Rise and Fall Times
- Pulse Mixing
- Plus and Minus Outputs



CLOCK PULSE GENERATORS

- PRF 100 cps to 100 MC
- Rise and Fall Times—
Less Than 4 nanoseconds
- Pulse Width—
Less Than 8 nanoseconds



Texas Instruments complete line of pulse instrumentation features compact design and high reliability through use of all solid state circuitry. Versatile modular construction permits custom combination of desired performance characteristics.

Write for complete information



TEXAS INSTRUMENTS

INCORPORATED
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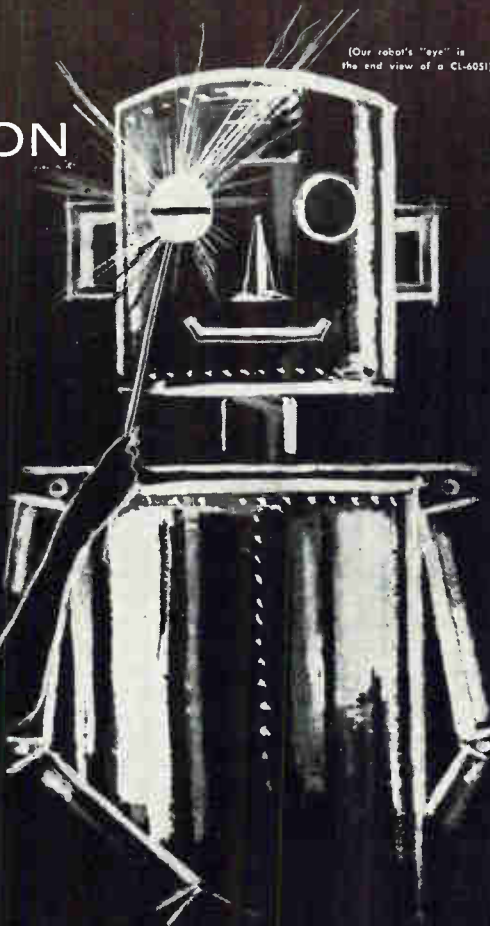
501

CIRCLE 91 ON READER SERVICE CARD

91

THE *light* TOUCH

IN AUTOMATION AND CONTROL



Clairex Photoconductive Cells, like the human eye, are "windows to the world" of control system design. Our continually expanding line now includes the 5-1 series of hermetically sealed Cadmium Sulphide cells, employing a sensitive material formulation that matches the spectral sensitivity of the human eye! These are the first real "electronic eyes" and thus are particularly useful in applications involving human vision . . . such as Daylight Switches, Photography, and Automatic Brightness Control in Television Receivers.

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CORPORATION

and New Facilities . . . to meet Growing Needs
8 WEST 30 STREET, NEW YORK 1, N. Y. • MU 4-0940

clamping in all is wedge-lock/captive contact. All connectors have Teflon insulation.

CIRCLE 316 ON READER SERVICE CARD



Time Delay Switch

PUSHBUTTON TYPE

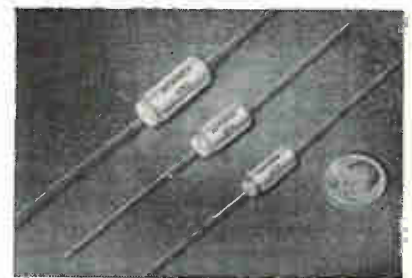
AGASTAT TIMING INSTRUMENTS, Elastic Stop Nut Corp. of America, Elizabeth, N. J. Completely independent of electrical effects, this switch in the hermetically sealed version meets all applicable MIL specs, and offers timing-on-push or-release action. Switching options include 1, 2, 3 or 4 pole models, double throw, with capacities to 10 amp at 28 v d-c resistive, or 5 amp at 115 v a-c resistive. Five timing ranges cover a span from 0.03 to 180 sec, with ambient temperature operation between -67 and 185 F.

CIRCLE 317 ON READER SERVICE CARD

Test Equipment

TRIO LABORATORIES, INC., Dupont Drive, Plainview, L. I., N. Y. Tri/Lim digitally-programmable go/no go test instrumentation system features 0.1 accuracy, handles over 95 percent of all industrial tests with 8 plug-in modules.

CIRCLE 318 ON READER SERVICE CARD



Capacitor

ELECTROLYTIC

AEROVOX CORP., New Bedford, Mass., announces ultraminiature tubular electrolytic capacitors. All internal

connections are welded, thus eliminating the danger of open circuits with the passage of time in service. Type QRE capacitors have a useful life expectancy of more than 10 years when operated within ratings. Operating temperature range: -40 C to +85 C. Voltage ratings: 1, 3, 5, 6, 10, 12, 15, 25, 50, 100 and 150 v d-c.

CIRCLE 319 ON READER SERVICE CARD



Miniature Choppers SPDT UNITS

COLLINS ELECTRONICS, Stevensville, Md. The Mini-Chop is available in any specified frequency rating from 1,000 cps down. Case size is 1/4 in. by 3/8 in., by 3/8 in.; and 1 1/2 in. gold-plated wire leads are provided. Three standard models of the hermetically sealed units are available—for 60 cps, 400 cps and 1,000 cps.

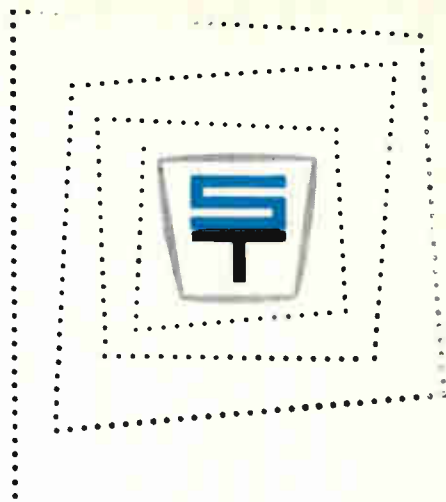
CIRCLE 320 ON READER SERVICE CARD



H-F D-C Preamp TRANSISTORIZED

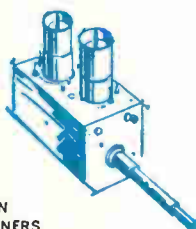
BULOVA WATCH CO., INC., 40-01 61st St., Woodside 77, N. Y. Fully potted summing buffer amplifier, designed for airborne or missile applications, weighs 1 oz and occupies 1 cu in. Model AMP meets or exceeds MIL-E-5272, MIL-E-5400. D-C power required is 28 v d-c at 10 ma max. Frequency response (at 3 db) is 10 to 10,000 cps. Gain

PRACTICAL INGENUITY IN ELECTRONICS

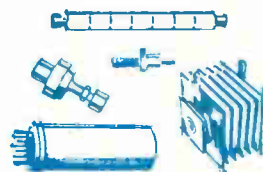


What is it? You might call it a philosophy... an idea... a principle.

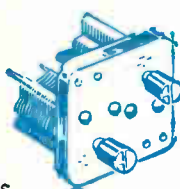
What does it mean? Technical excellence, reliability, performance—combined with sensible pricing. On this philosophy rests the enviable Tarzian reputation for customer satisfaction. Too, it has earned for Sarkes Tarzian, Inc. recognition as the producer of "the world's finest tuner for the world's finest sets". You'll also find this same practical ingenuity in all of these electronic products from Tarzian:



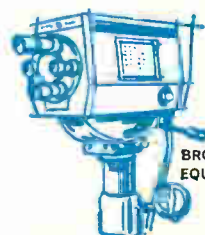
TELEVISION
and FM TUNERS



SEMICONDUCTOR DEVICES



AIR
TRIMMERS



BROADCAST
EQUIPMENT



MAGNETIC TAPE



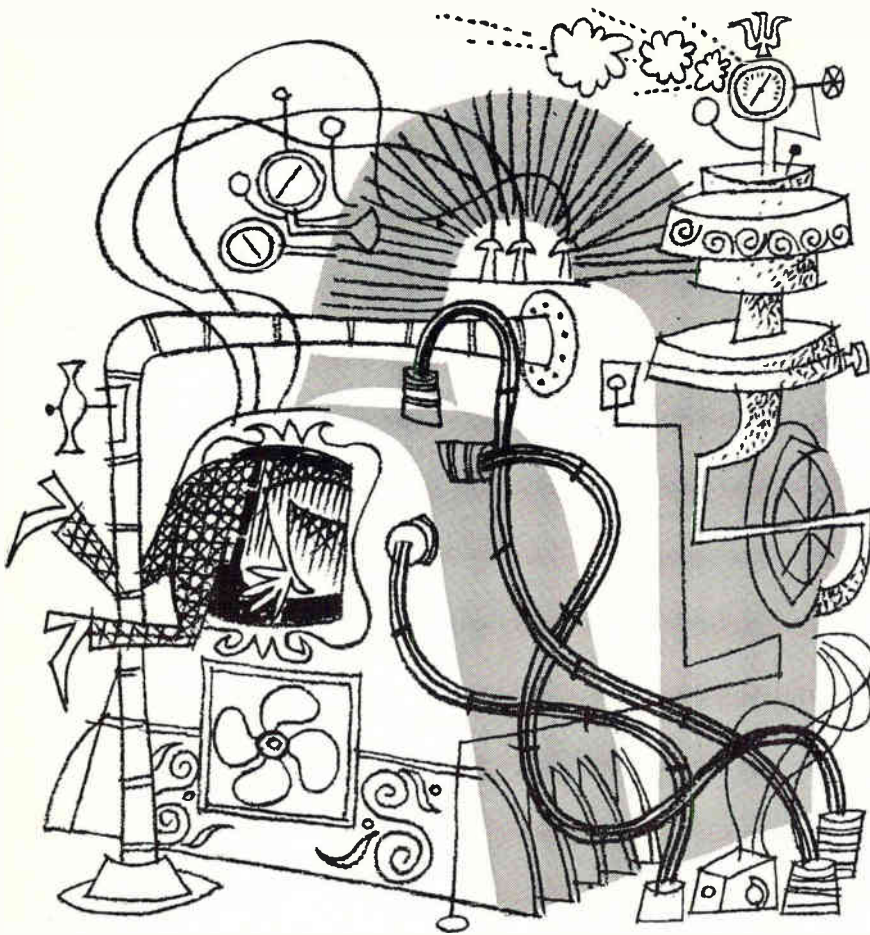
FM RADIOS and
AM/FM RADIOS

Electronic Products of Tomorrow... TODAY



SARKES TARZIAN INC

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SOMETHING HAPPENED TO GEORGE'S VACUUM

Friend of ours had his vacuum system fired up.
Something happened. We shudder to tell you about it.

George had his pressure down to 5×10^{-5} mm Hg. Everything was going well.

Then a thoughtless rogue employed by the electric power company cut the master switch.

No power. No vacuum. Grit teeth.

Smile tightly. Start all over again, George.

There are ways, our vacuum specialists tell us, to prevent more such tragedies. Complain to power company. Complain to management. Better still, use VacIon® all-electronic vacuum pumps, which are guaranteed to be fail-safe. Your vacuums can't be compromised in event of power failure. Just wait till the juice goes back on, and continue what you were doing.

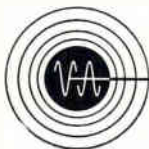
There are other advantages which accrue to the fortunate users of VacIon getter pumps and systems. Pressures guaranteed below 1×10^{-6} mm Hg. Ultra-clean vacuums, free from organic

contaminants which usually creep into vacuums produced by oil diffusion systems.

More advantages? VacIon pumps come in many handy sizes, all the way from miniscule 0.2 litres/second appendage pumps to impressive 10,000 litres/second pumps ideal for evacuating hyperaltitude simulation chambers. If you expect a constant speed of, say, 40 litres/second, that's exactly what you get. And here's more frabjous information. We're so proud of what our VacIon Pumps can do that we'll guarantee to replace a pump or refund your money if the pump you buy doesn't perform exactly to specifications. Of course, we expect that you'll set up your vacuum system in the way our high-powered coterie of vacuum specialists recommend.

We're ready to process your order. For off-the-shelf delivery, too.

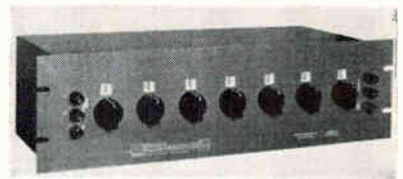
VACUUM
PRODUCTS
DIVISION



VARIAN associates
PALO ALTO 1, CALIFORNIA

stability is ± 0.5 db in a temperature range of -55 to 125 C. Maximum linear output voltage is 1 v rms.

CIRCLE 321 ON READER SERVICE CARD



Voltage Divider

7-DECADE UNIT

ELECTRO SCIENTIFIC INDUSTRIES, 7524 S. W. Macadam Ave., Portland, Ore. The TV-722 Dekavider is a precision, 7-decade, resistive voltage divider using the Kelvin-Varley circuit. Resolution is 10,000,000 divisions in 0.1 ppm steps. Input resistance is 100 kilohms ± 0.005 percent. Terminal linearity is 1 ppm. Output voltage does not differ from the input voltage times the divider setting by more than one 1/1,000,000 of the input voltage.

CIRCLE 322 ON READER SERVICE CARD



Crystal Case Relay

HALF-HEIGHT

UNION SWITCH & SIGNAL, div. of Westinghouse Air Brake Co., Swissvale, Pa., offers a 2 pdt half-height crystal case relay that is designed to meet or exceed the rigid requirements of MIL-R-5757D. Its size makes it particularly suited for use on p-c boards.

CIRCLE 323 ON READER SERVICE CARD

P-C Laminate

HOT PEEL STRENGTH

SYNTHANE CORP. Oaks, Pa. Grade G-10R laminate for printed circuits meets or exceeds NEMA and MIL specs for room temperature peel strength, and delivers 2 to 4 lb peel strength per in. of width at 500 F. Material provides solution to many

INTEGRATE

ANY SERVO RECORDER SIGNAL

Automatically
... Precisely

All-Electronic ATTEN-U-MATIC INTEGRATOR PX 593

BUILT-IN ATTENUATOR
KEEPS ALL SIGNALS ON-SCALE

New Atten-U-Matic Integrator PX 593 insures accurate quantitative measurement of almost any recorded curve requiring integration: Gas chromatograms . . . spectroscopic-spectrographic data . . . thickness, pressure, or force vs. time curves . . . flow and power data.

This unique, completely-electronic integrating instrument has been designed for easy use with nearly all standard servo-drive recorders. It records both variable and integral with one pen—and automatically attenuates and integrates signals that normally would exceed full scale. Attenuator range is 1024 to one.

At maximum sensitivity operation, the PX 593 gives full scale integral of full scale signal in 0.14 seconds — *the equivalent of*



420,000 counts per minute. Other features include: Automatic cycle of read, reset, and integrate whenever signal goes below a pre-selected threshold setting. Manual operation at any time desired.

For full details on the PX 593—or for assistance in devising complete integrating systems to meet your special requirements—phone or write . . .



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INSTRUMENT GROUP**

a Schlumberger division
Ridgefield 5, Conn. Idlewood 8-6571
Chicago Office: 747 Deerfield Road,
Deerfield, Ill., Windsor 5-2992
CIRCLE 204 ON READER SERVICE CARD



Gamewell made
this special
completely from
scratch.

Every part of this rotary switch was newly designed by Your Engineered Specials service to meet a customer's special requirements. The unit provides bi-directional operation at 160 rpm max. It is rated at 28 VDC, 60 ma . . . has high vibration and shock resistance . . . and -55° to +150°C. temperature range.

Although this design called for only six poles and 11 switching segments, many more could have been provided.

Gamewell's YES service has developed answers to hundreds of special "pot" problems. Interested? Write for the full story.

*your
Engineered
Specials service

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1402 CHESTNUT STREET, NEWTON UPPER FALLS 64,
MASS. A SUBSIDIARY OF E. W. BLISS COMPANY.

CIRCLE 95 ON READER SERVICE CARD 95

electronics

Editorial Opportunity

IT DOESN'T HAPPEN OFTEN, but electronics, "bible of the industry" and a McGraw-Hill publication, has an opening for an Assistant Editor.

Ideally, the man we are looking for and to whom a post on our New York staff could be a long-term challenge, would have an electrical engineering degree or technical equivalent, practical experience in our field and a demonstrated aptitude for editing, writing, reporting. He probably lives somewhere in the metropolitan area and therefore would have no relocation problem.

Write The Editor, electronics, 330 W. 42nd St., New York 36, stating experience, aspirations and past earnings. Mark the envelope "Confidential" and it will be kept that way.

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■ ELECTROSTATIC PICTURE STORAGE AND RECALL SYSTEMS ■ LOW-LIGHT-LEVEL CAMERA AND DUAL STORAGE TUBE SYSTEMS ■ DOUBLE-ENDED STORAGE TUBE SYSTEMS ■ DATA SUMMATION UNITS ■ COMPUTER OUTPUT STORAGE FOR TELEVISION DISPLAY.

Standard storage tube systems are readily available. A custom-engineered system can be built to meet your special needs.

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NEWTON LOWER FALLS 62,
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WOODWARD 9-8440

CIRCLE 205 ON READER SERVICE CARD



**CAMBION MOLDED
CHOKES, Series 2960, are
available to conform to**

**requirements of MIL-C-15305B,
MS75008-1 thru -20. Series
2950 covers MS91189-1 thru-13.**



**For specifications, ranges and
prices, call, wire or write today
to Cambridge Thermionic**



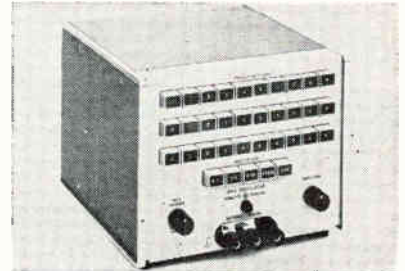
**Corporation, 437 Concord
Avenue, Cambridge 38,
Massachusetts.**



CAMBRIDGE THERMIONIC CORPORATION
CAMBION[®]
The guaranteed electronic components 

wire failures occurring under certain dip soldering techniques in the solder pot at 500 F during the manufacture of printed circuits; especially curved wires which have a tendency to pull off the board during the soldering operation.

CIRCLE 324 ON READER SERVICE CARD

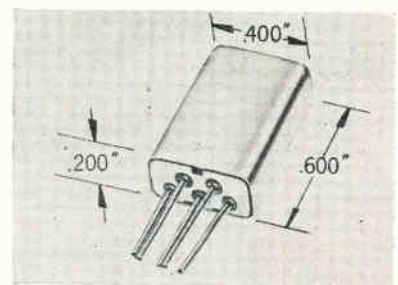


Oscillator

PUSH-BUTTON

HEWLETT-PACKARD CO., 1501 Page Mill Rd., Palo Alto, Calif. A solid-state instrument with a frequency range from 10 cps to 1 Mc, model 241A uses pushbutton selection of control elements to eliminate frequency ambiguity. Three switches, each controlling a single digit, give a choice of 900 base frequencies from 100 to 999, while a fourth selects any decade multiplier from $\times 0.1$ to $\times 1000$. This, combined with 1 percent frequency accuracy, suits the unit for repetitive and production line testing.

CIRCLE 325 ON READER SERVICE CARD



Sensitive Relay

MICRO/MICROMINIATURE

BABCOCK RELAYS, Div. of Babcock Electronics Corp., 1645 Babcock Ave., Costa Mesa, Calif. The BR-5 micro/microminiature relay features outstanding operation in extreme environments and switching of dry circuit to full 1 amp loads at 32 v d-c with high sensitivity. This sensitivity is attained by using a special magnetic circuit enabling

VERSATILE PERFORMER

SANGAMO 470 SERIES MAGNETIC TAPE INSTRUMENTATION

FEATURES ALL NEW
ELECTRONICS MODULES



**THE SANGAMO 470-SERIES
RECORDER/REPRODUCER**

offers new flexibility for general purpose instrumentation through the use of electronic modules that give 4 speeds of both FM and Direct record and reproduce capability in a single module with simple toggle switch selection. A front panel meter and selector switch permit monitoring of FM and Direct input and output signal level as well as head current level. Levels can be easily adjusted by attenuators on the module panel. Test signals may be inserted through front panel jacks which automatically disconnect permanent signal inputs.

The 470-Series is available with either normal bandwidth



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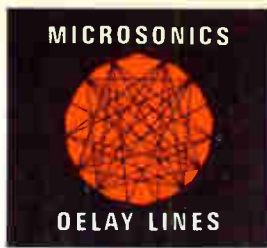
(Model 471) or extended bandwidth (Model 472) frequency response capabilities, and is adaptable to 7 or 14 channels of record/reproduce electronics in a single cabinet, and can be expanded to 28 channels in a second cabinet for growth potential... for Direct, FM, PCM and Digital modes.

Sangamo speed control and tape handling make it possible to achieve magnetic tape instrumentation system accuracies heretofore considered unattainable. The transport offers both reel to reel and continuous loop operation capability without the use of adaptors.

For complete information on this Versatile Performer, write, wire, or phone:



SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS



MICROSONICS

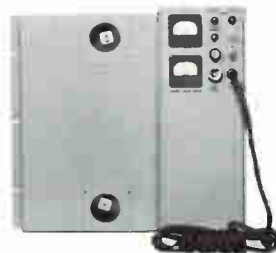
... unexcelled source for **ultrasonic** delay lines

NEW VARIABLE DELAY LINE Microsonics' new ultrasonic variable delay lines are continuously adjustable from 5 to 200 μ sec with longer delays possible. Multiple variable outputs may be adjusted together or separately as well as through an adjacent output, over a limited range. Other characteristics: Frequency—20 to 60 mc; Band width—8 to 20 mc; Spurious—30 to 40 db.



Microsonics has been selected time after time by major system manufacturers to develop and build ultrasonic delay line equipment. Systems using Microsonics delay lines include ASR-2, 3, 4, 5; UPS-1; FPS-30; SPS-38; SPS-6; ARSR; CPN-18; HAWK; APQ-72; MPS-23. Many of these applications have required advancements in the state of the art.

NEW TEMPERATURE CONTROLLED ULTRASONIC DELAY LINES Microsonic temperature-controlled delay lines are for use as recirculating memories in systems where a phase coherent storage loop is a prerequisite. They may be used for IF Cancellors, Long Time Integrators, Delay Line Filters, Time Compression and Real Time Spectral Analysis. These controlled systems provide temperature excursions not greater than .01°C. Short term stability shall not exceed .003°C/minute over a twelve-hour period. Units have been furnished with .007°C stability over two weeks.

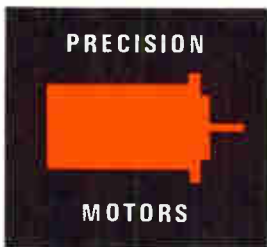


All of Microsonic's ultrasonic delay lines are hermetically sealed and meet the most rigid military environmental tests of shock, vibration, temperature and altitude.

Inquiries should be made directly to:

MICROSONICS INCORPORATED

Hingham Industrial Center, Hingham, Massachusetts



SANGAMO PRECISION MOTORS



NEW—SIZE 5 and SIZE 8 SERVO MOTORS.

A size 5 (0.5" dia.) and size 8 (0.75" dia.) control motor, motor generator and synchronous motor have recently been added to Sangamo's extensive line of Precision Motors. Both units are designed for 400 cps excitation and are manufactured of corrosion resistant stainless steel. The size 8 can be provided with integral gear reducers.



NEW FEATURE ADDED TO SIZE 10 and 11 MOTOR GENERATORS

Sangamo's standard size 10 (.938" dia.) and size 11 (1.062" dia.) servo motor generators are now available with a rear shaft extension to permit mechanical coupling and/or speed checks after the unit is installed. Positive alignment is assured by the use of three ball bearings in each unit.



SYNCHRO



SYNCHRONOUS MOTOR



GEARED MOTOR GENERATOR

We at Sangamo have been designing and producing AC servo motors, Induction Generators, Motor Generators, Drag Cup motors, Synchronous motors, Synchros, and PM Generators for more than 20 years.

We can supply—on short notice—hundreds of designs for both 60 and 400 cycle input sources with frame sizes ranging from size 5 to size 25. The materials, finishes, and performance of these units are tailored to meet applicable military specs. Most of our motors and motor generators are available with integral reduction gear ratios, and selected current designs can be furnished to operate at total temperatures of up to 200°C.

This is sure: whether it's a "stock" motor or a special requirement motor, if it comes from Sangamo it is ultra-reliable, competitively priced, and delivered on time.

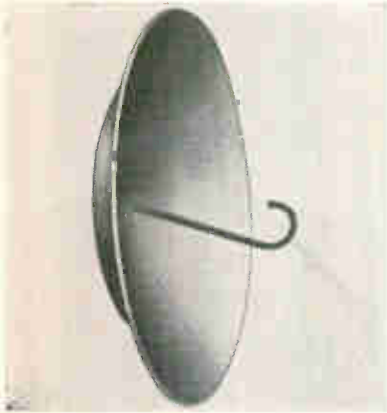
Write for complete information.



SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS

low pull-in power with max contact pressure. Gold plated AgMiNi contacts assure dependable performance over prolonged periods of peak loading.

CIRCLE 326 ON READER SERVICE CARD

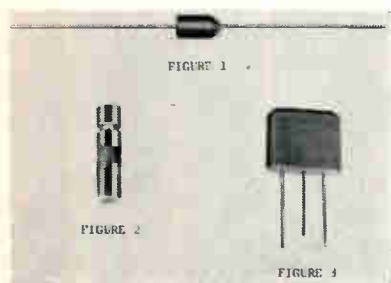


Microwave Line

RECENTLY EXTENDED

TECHNICAL APPLIANCE CORP., Sherburne, N. Y. Line now includes spun surface reflectors from 4 ft to 10 ft, mesh surface reflectors from 4 ft to 12 ft and larger sizes. Microwave feeds are available for the 900 Mc, 2 Gc, 4 Gc, 6-8 Gc and 12 Gc bands. Complete mounting, de-icing and other accessory equipment is also offered.

CIRCLE 327 ON READER SERVICE CARD



Silicon Rectifiers

HIGH-VOLTAGE

SOLITRON DEVICES, INC., 500 Livingston St., Norwood, N. J. Hermetically-sealed, miniature HV series is rated from 1,200 piv to 3,600 piv, at current ratings up to 500 ma. All rectifiers are packaged in a transfer molded case (Fig. 1) measuring 0.200 in. diameter by 0.375 in. long, with solid silver axial leads; or 0.250 in. diameter by 1.0 in. long clip-in ferrule (Fig. 2). The molded assemblies of the two insulated body units can be sup-

← CIRCLE 98 ON READER SERVICE CARD

HOW CHEAP IS "CHEAP"?

"Why should we buy from you when we can get the 'same thing' from other suppliers at a lower price?"

In selecting a supplier of lacing tape (or any component), price and compliance with specifications are not the only criteria. But too often, manufacturers ignore the other factors involved and consequently lose money.

For example, in a \$15,000 piece of equipment there may be only 15 cents worth of Gudebrod lacing tape. It costs \$75 to work this tape. It may be possible to buy the same amount of tape from other suppliers for 2 or 3 cents less . . . it "will meet the specs" according to these suppliers. But one of our customers recently pointed out why he still specifies only Gudebrod lacing tape in such cases.

"We tried buying some cheaper tape that 'met the specs.' Within a few months our production was off by 50% . . . boy, did the production people really scream about that tape. And our labor costs doubled . . . our costing people really flipped!"

"Another thing, why should we risk the possible loss of thousands of dollars when the original material cost difference is only a few cents. Once you put cheaper tape on and something goes wrong after the equipment is finished . . . you've had it. No, thank you! We learned our lesson! We buy Gudebrod lacing tape!"

Whether your firm uses one spool of lacing tape or thousands, there are four advantages in specifying Gudebrod for all your lacing requirements:

1. *Gudebrod lacing tape guarantees increased production!*
2. *Gudebrod lacing tape guarantees reduced labor costs!*
3. *Gudebrod lacing tape guarantees minimal maintenance after installation!*
4. *Gudebrod guarantees quality!* On every spool is a lot number and seal which guarantees that all Gudebrod lacing tape is produced under strict quality control. Our standards are more exacting than those required for compliance with Mil-T.

Our Technical Products Data Book explains in detail the complete line of Gudebrod lacing tapes for both civilian and military use. For your copy write to Mr. F. W. Krupp, Vice President, Electronics Division

GUDEBROD BROS. SILK CO., INC.

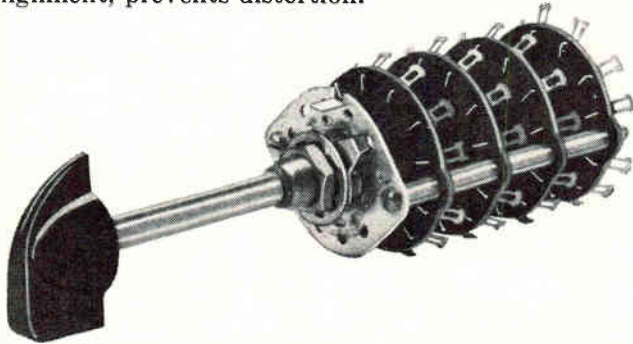
Electronics Division
225 West 34th Street
New York 1, New York

Executive Offices
12 South 12th Street
Philadelphia 7, Pa.

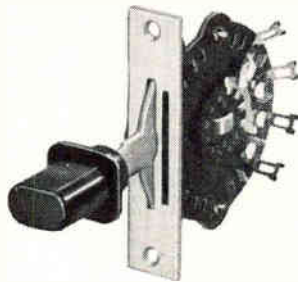
CIRCLE 99 ON READER SERVICE CARD 99

SWITCHES FOR CIRCUIT SHRINKERS

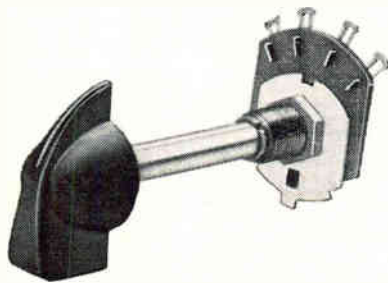
The MALLORY-GRIGSBY line of switches gives you compact size in a variety of rotary and lever action models . . . all with exclusive "Wedglock" terminal construction that assures positive alignment, prevents distortion.



4M series (30° indexing) has 1 3/8" wafer diameter. Meets or exceeds MIL-S-3786A. 12 positions in phenolic wafer and ceramic. Shorting and non-shorting types, up to 6 sections. 60° and 90° indexing styles, with two-piece metal and phenolic shaft, for high RF signal circuits.



6M series, lever action, uses same wafer construction as 4M. Projects only 1 1/4" back of panel. 30° indexing; with or without spring return; 3 position.



5M series is a truly low-cost general purpose rotary switch, in several shaft and circuit configurations.

Available from stock at factory prices from Mallory Industrial Distributors. Write for data and for name of source nearest you.

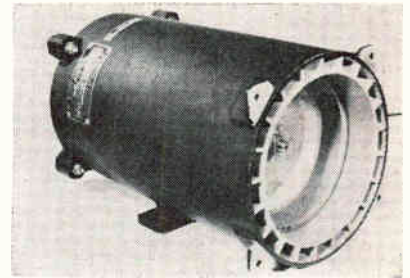
Distributor Division

P.O. Box 1558, Indianapolis 6, Ind.



plied in a package 0.250 by 0.750 by 0.625 in. having a doubler, center tap, or center tap negative configuration (Fig. 3).

CIRCLE 328 ON READER SERVICE CARD

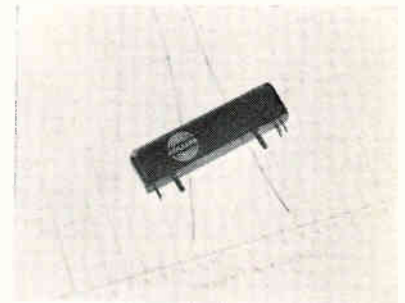


Cooling Blower

FOUR-STAGE

THE TORRINGTON MFG. CO., Torrington, Conn. With four stages, the SVA 540-14375 vane-axial blower unit, which is only 5.6 in. in diameter and 10 in. long, produces 120 cfm against a static pressure of 2.7 in. of water at a speed of 3,450 rpm. It meets applicable requirements of vibration, shock, high and low temperatures, fungus, humidity and endurance in MIL-E-5272C. Motor may be either 400-or 60-cps, 220 v, 3-phase.

CIRCLE 329 ON READER SERVICE CARD



Mechanical Filter

LOW COST

COLLINS RADIO CO., 19700 San Joaquin Road, Newport Beach, Calif., announces a 455 Kc mechanical filter at cost reductions of as much as 35 percent under the standard version. It has steep skirted selectivity with a 6 db bandwidth of 2.1 Kc and a 60 db bandwidth of 5.3 Kc—a shape factor of just over 2.5 to 1. It is expected to find wide application in ssb transmitters and receivers. Filter is suited for circuit board manufacturing techniques involving dip soldering.

CIRCLE 330 ON READER SERVICE CARD

PRODUCT BRIEFS

DIVERSITY CARRIER TELEGRAPH transistorized. Northern Radio Co., Inc., 147 W. 22nd St., New York 11, N. Y. (331)

NUCLEAR COUNTING SYSTEM high speed. Hamner Electronics Co., Inc., Princeton, N. J. (332)

MAGNETRON voltage-tunable. General Electric Co., Schenectady 5, N. Y. (333)

FREE GYRO 4-in. diameter. Giannini Controls Corp., 1600 S. Mountain Ave., Duarte, Calif. (334)

IMPULSE COUNTER automatic reset. Automatic Timing & Controls, Inc., King of Prussia, Pa. (335)

BULKHEAD CONNECTOR glass-sealed. Sealectro Corp., 139 Hoyt St., Mamaroneck, N. Y. (336)

SPECTROMETER electron spin resonance. Alpha Scientific Laboratories, P. O. Box 333, Berkeley 1, Calif. (337)

CONTACTLESS POTENTIOMETER uses fiber optics. Duncan Electronics, Inc., 2865 Fairview Road, Costa Mesa, Calif. (338)

BALUN TRANSFORMER high-power. Granger Associates, 974 Commercial St., Palo Alto, Calif. (339)

FREQUENCY METER film calibrated readout. Lavoie Laboratories, Inc., Morganville, N. J. (340)

H-v SILICON RECTIFIERS hermetically sealed. Solitron Devices, Inc., Norwood, N. J. (341)

SPDT SWITCHES manually-operated. Waveguide, Inc., 851 W. 18th, Costa Mesa, Calif. (342)

POWER SUPPLY adjustable parameter. NJE Corp., 20 Boright Ave., Kenilworth, N. J. (343)

ATTENUATORS cover 40 to 40,000 Mc. Tucor, Inc., 59 Danbury Rd., Wilton, Conn. (344)

UHF TETRODE for frequencies up to 1,000 Mc. Ampere Electronics Corp., 230 Duffy Ave., Hicksville, L. I., N. Y. (345)

RECEIVER-DECODER PACKAGE command-destruct. RS Electronics Corp., P. O. Box 11368, Station A, Palo Alto, Calif. (346)



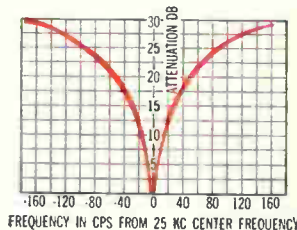
Crystal Filters do Wonderful Things



Needle-sharp filtering in a single jump is a wonderful thing! Itek Crystal Filter 754A is only 10 cycles wide at the 3db points — a bandwidth requiring a "Q" that only crystal can provide. Circuit simplification, ruggedness, temperature and long time stability, and utmost reliability are built-in extras.

Perhaps you don't need a 10 cycle wide crystal filter. But could you use the ingenuity that built one? Could Itek technical leadership help you?

Of course, the world's largest and most complete selection of stock crystal filters is available, too. Choose from more than 3,000 Itek-Hermes designs.



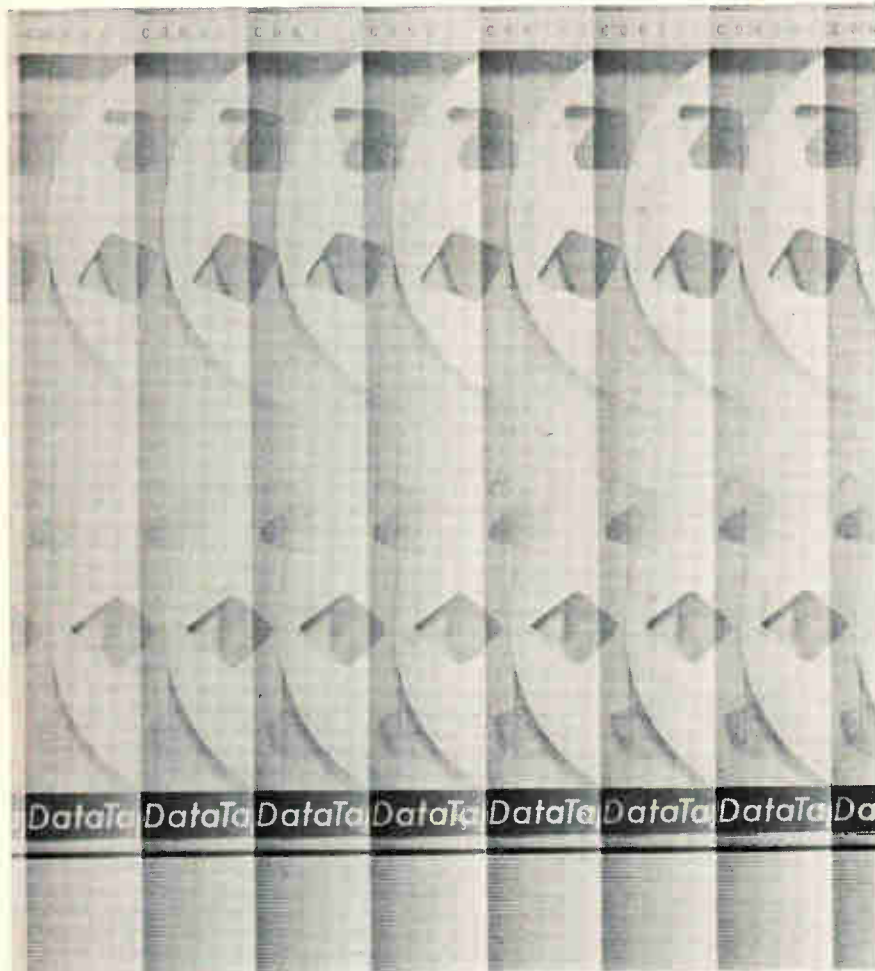
Write for free Brochure "WEEKACFAACP" or, *What Every Engineer Should Know About Crystal Filters At A Cocktail Party. You'll enjoy it.*

Itek Electro-Products Company

75 CAMBRIDGE PARKWAY, CAMBRIDGE 42, MASS. A DIVISION OF



Literature of



High performance.....

Another proof that good things come in small packages: CEC's new, low-cost Type PR-3300 Recorder Reproducer shown on the opposite page. Equally at home in a sub, lab, or missile base, it is a solid-state instrument — matching most of the performance characteristics of larger recording devices on the market. Six standard tape speeds are provided — in pairs from 60 through $1\frac{7}{8}$ ips — with gentle, controlled tape handling. The unique capstan drive system has the flexibility of the open loop head stack arrangement with the high performance characteristics of a closed loop. (And now see the opposite page...)

MINIATURIZED POWER PACKS Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N. J. Ultra low voltage units are covered in catalog sheet 126. (347)

ACCELEROMETERS Electra Scientific Corp., Electra Way, Fullerton, Calif. Technical brochure details series 6000 accelerometers and transistorized amplifiers. (348)

ADHESIVE SEALANT Hysol Corp., Olean, N. Y. Bulletin A-500 describes Epoxi-Patch kit molecular action adhesive sealant. (349)

TRANSISTOR-SIZED RELAY Babcock Relays, a div. of Babcock Electronics Corp., 1645 Babcock Ave., Costa Mesa, Calif. Tenth-ounce relay performance is described in bulletin BR-617. (350)

TOGGLE SWITCHES Electrospace Corp., 12 Morris Ave., Glen Cove, L. I., N. Y. Details of panel sealed toggle switches and a hermetically sealed unit are contained in bulletin 5400. (351)

PANEL INSTRUMENTS Weston Instruments Division, Daystrom, Inc., 614 Frelinghuysen Ave., Newark 14, N. J. Circular Z-69 discusses a complete line of panel meters available as stock items. Prices are included. (352)

PRINTED WIRE HARNESS Sanders Associates, Inc., 95 Canal St., Nashua, N. H., has available an 8-page brochure on Flexprint flexible printed wire harness. (353)

MASERS AND LASERS Trion Instruments, Inc., 1200 N. Main St., Ann Arbor, Mich., has available a bibliography of maser and laser references. (354)

CROSSBARS James Cunningham, Son & Co., Inc., P.O. Box 516, Rochester 2, N. Y. Bulletin 60-301 covers wide band compensated crossbars. (355)

SYNCHROS The Bendix Corp., Montrose Div., South Montrose, Pa., announces availability of its synchro engineering specification catalog. (356)

P-C BOARD CONNECTORS Micon Electronics, Inc., Roosevelt Field, Garden City, L. I., N. Y. Line of 50 ohm printed wiring board con-

the Week

nectors is described in a 10-page catalog. (357)

POWER SUPPLIES Power Sources, Inc., Northwest Industrial Park, Burlington, Mass., has published a 4-page brochure entitled "Solid State Power Supplies". (358)

OSCILLOGRAM PROCESSOR Consolidated ElectroDynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. A 4-page bulletin describes the type 23-109B oscillogram processor. (359)

PROXIMITY DETECTOR Automation Devices Inc., 3125 Brandes St., Erie, Pa. Four-page brochure describes the Proxi-Tron transistorized proximity detector. (360)

CHOPPER Solid State Electronics Co., 15321 Rayen St., Sepulveda, Calif. Two-page bulletin covers model 64 transistorized line driven plug-in chopper. (361)

NUCLEAR BATTERIES Leeson Moos Laboratories, 90-28 Van Wyck Expressway, Jamaica 18, N. Y. Brochure contains information on the company's nuclear batteries and self-powered components. (362)

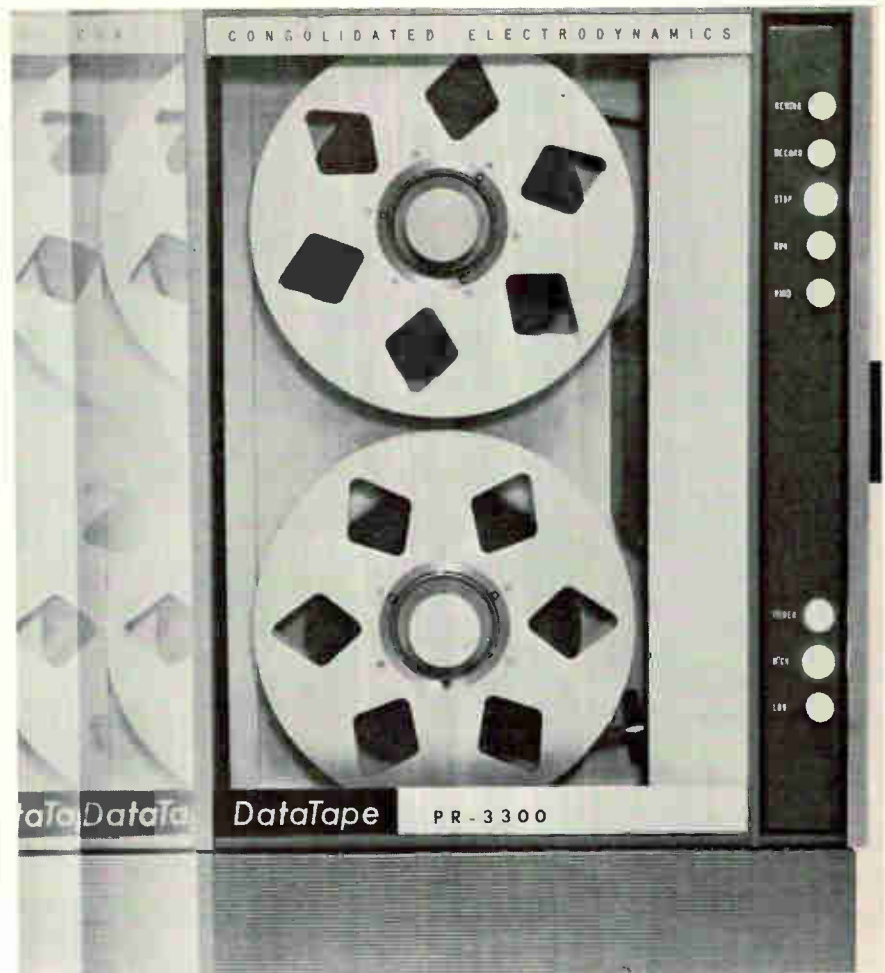
SOLID-STATE PRINTER Beckman Instruments Inc., Berkeley Div., 2200 Wright Ave., Richmond, Calif. Brochure A1453 covers a solid-state 7 to 12 digit printer. (363)

LASER SYSTEM Maser Optics, Inc., 89 Brighton Ave., Boston 34, Mass. Series 100 general purpose laser system is described in a recent bulletin. (364)

WAVE DROPOUT ANALYZER Acoustronics, Inc., 156 Olive St., Huntington Station, N. Y. Catalog sheet describes model 900 wave dropout analyzer for c-w signals. (365)

STANDARD CAPACITORS Arco Electronics, Inc., Community Drive, Great Neck, N. Y., has published a study report, technical bulletin 1-62, on the stability of its type SS standard capacitors. (366)

WIREWOUND RESISTORS Charles T. Gamble Industries, Reeder and Monroe Streets, Riverside, N. J. A 4-page brochure describes a line of precision and power wirewound resistors. (367)



..... and portable

In addition to high performance (see opposite page), the PR-3300 features portability: a single 22 $\frac{5}{8}$ " case houses a complete 14-channel record and reproduce transport. Removed from its case, the unit can be mounted vertically in most standard racks. It's a package well worth looking into: a recorder reproducer outstanding in its class. For full facts, call your nearby CEC office or write for Bulletin CEC 3300-X5.

CEC

Data Recorders Division

CONSOLIDATED ELECTRODYNAMICS
PASADENA, CALIFORNIA • A SUBSIDIARY OF BELL & HOWELL



Herman Fialkov



Arno Nash



Norman Neumann

GI Expands Semiconductor Operations

GENERAL INSTRUMENT CORP., Newark, N. J., has announced a major expansion of its semiconductor operations with formation of a new Semiconductor Products Group; creation of a separate Rectifier Division (within the group) to concentrate exclusively in the rectifier field; construction of an additional new 10,000-sq-ft facility for production of silicon controlled and high-powered rectifiers; and development of semiconductor devices that will substantially broaden the group product lines.

The Semiconductor Products Group will be headed by Herman Fialkov, as group vice president for semiconductor products. Divisional heads will report directly to him. Fialkov previously was president of the GI Semiconductor Division (which now becomes part of the group).

The new group will include:

1) The Rectifier Division, with 150,000 sq ft of plant space at Newark, N. J. and Brooklyn, N. Y. This is headed by Arno Nash as vice president and general manager and will have its headquarters at Newark. Nash formerly was head of the GI Selenium Division (Radio Receptor), which is being combined in the new Rectifier Division with the silicon rectifier operations formerly handled within the Semiconductor Division.

2) The Semiconductor Division,

with 150,000 sq ft of plant space at Woonsocket, R. I., and Hicksville, L. I., N. Y. This division is headed by Norman Neumann as vice president and general manager and will have its headquarters at Woonsocket. Neumann previously had been general manager of the Woonsocket facility. This division will be responsible for all semiconductor products other than rectifiers.

Each of the divisions within the group will have completely separate engineering and field sales forces, Fialkov said.

Now under construction at the Newark Plant, he disclosed, is a new facility for production of scr's and high-power rectifiers, incorporating high-precision, controlled-atmosphere manufacturing techniques. A number of new products in the high power field are in development.

Semiconductor Products Group headquarters will be at the company's main plant in Newark, N. J. Top group personnel will be announced later, Fialkov said.

Augat Appoints Two Key Executives

AUGAT INC., Attleboro, Mass., has announced the appointment of Ralph C. Hoy as vice president in charge of production; and Neil F.

Damon, vice president in charge of engineering.

Hoy has been associated with Augat since 1952 as head of the toolroom department and later as superintendent. Prior to this, he was with Metal Specialties Co.

Damon joined the company in 1958 as chief engineer. He came from the Raytheon Co. where he was employed as a design engineer for 11 years.



Trent Assumes New Post

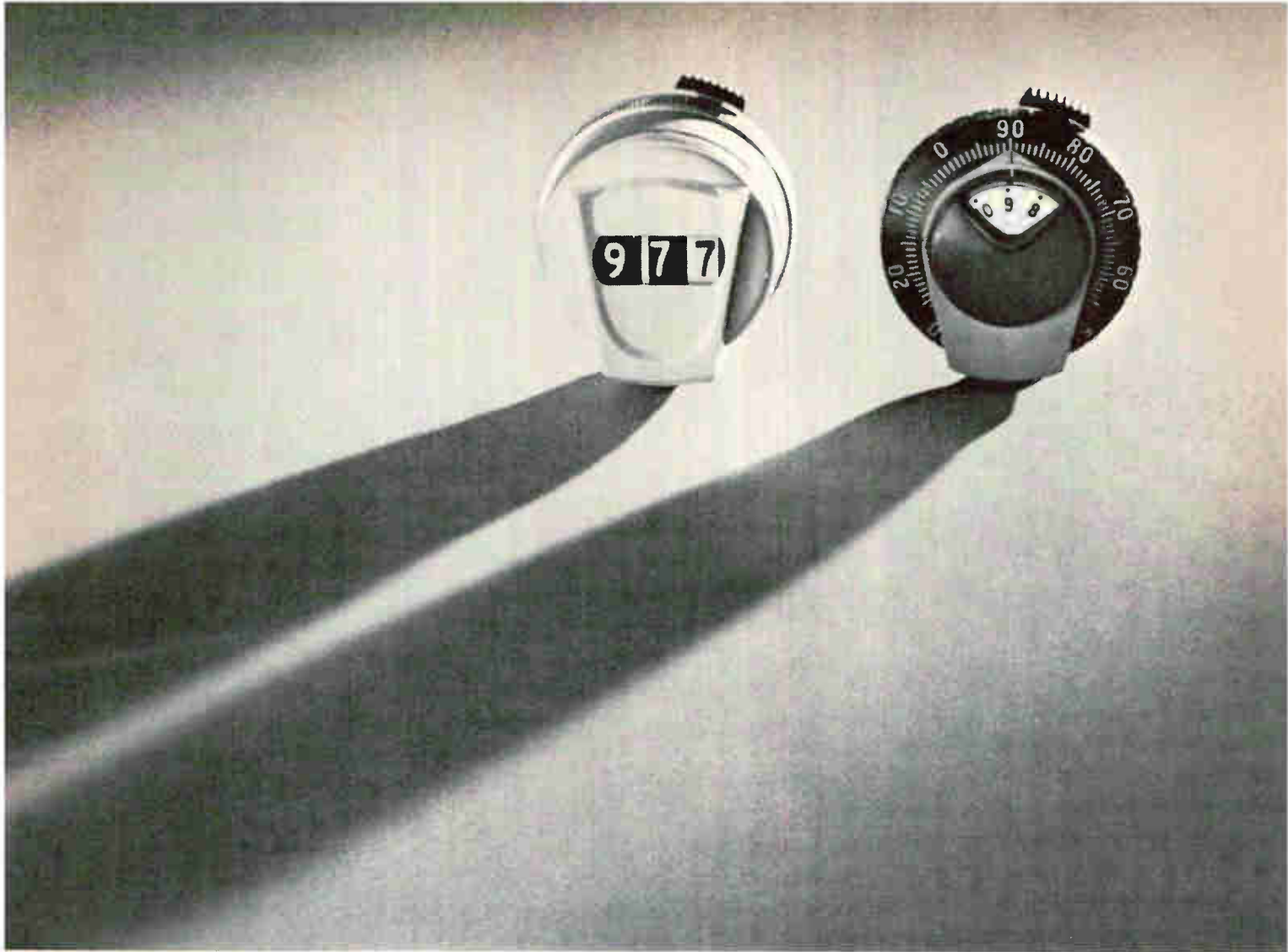
ROBERT L. TRENT has been appointed director of engineering for National Semiconductor Corp., Danbury, Conn.

Prior to joining the company, Trent was technical director for Sperry Semiconductor Div., Sperry Rand. He also served as manager, engineering department, for Fairchild Semiconductor Corp. and manager, development department-germanium devices, Texas Instruments, Inc.



GE Sets Up Defense Program Operation

GENERAL ELECTRIC CO. has formed a Defense Program Operation in its Electronic and Flight Systems Group to provide better service and greater economies for its billion-



How do you prefer your Microdial®: Digital or Concentric Scale?

The Borg Microdial line (broadest in the industry) offers both types—two digital series, and three concentric scale series. Whichever type you like for potentiometer control, remember:

1. Each Borg Microdial features large numerals that are well contrasted to their backgrounds for squint-free readability. 2. Each can be equipped with positive braking to prevent accidental setting changes. 3. Indexing

accuracy is one part in a thousand, suitable to a potentiometer of .1% linearity, thus enabling you to get all the precision you pay for in a precision potentiometer. 4. Rugged design withstands rough handling and "panic" responses or setting changes. 5. Customization of counting wheels and gearing can give you practically any readout configuration you might require.

Most Microdial models come in a

variety of color combinations that contribute to appearance and permit coding for fast identification in panel groupings.

The Borg Microdial line is competitive too, as you can verify by contacting your nearby Borg technical representative or omnipresent Amphenol-Borg Industrial Distributor. Or, you can address specific inquiries to R. K. Johnson, Sales Manager:



BORG EQUIPMENT DIVISION

Amphenol-Borg Electronics Corporation,
Janesville, Wisconsin.





NEW GAS DISCHARGE INDICATION TUBE FOR SMALL SIGNALS

Designed specifically for display indicator use in transistorized electronic equipment, the TG121A glow discharge tube offers important advantages over neon indicators and miniature incandescent lamps. Of prime importance is the fact that it can be switched on and off by an input signal of a few volts and thus can be operated directly by ordinary transistor output voltage without amplification. Since it is a cold cathode device there is no heating problem such as is encountered with miniature lamps, even when many are used. This advantage coupled with its small size (length 18mm, diameter 8mm) makes it ideal for miniaturized equipment. Characteristics are stable and life is practically limitless. Detailed specifications and application information are available from our representatives listed below.



FUJI TSUSHINKI SEIZO K.K.,

TOKYO, JAPAN

Represented by:

■ The Nissho American Corporation □ New York 5, 80 Pine St., WH 3-7840 □ Chicago 3, 140 S. Dearborn St., CE 6-1950 ■ The Nissho Pacific Corporation □ San Francisco 4, 120 Montgomery St., YU 2-7901 □ Los Angeles 14, 649 S. Olive St., MA 7-7691

CIRCLE 106 ON READER SERVICE CARD

Is your advertising selling the same four key buyers your salesmen call on? Competition demands it! Only advertising in electronics reaches and sells the electronics man *wherever* he is: in *Research,*

TODAY YOU MUST SELL ALL FOUR!

Design, Production, and Management. Put your advertising where it works *hardest...*

in **electronics**

dollar-a-year aerospace and defense business.

J. S. Parker, vice president and group executive of the group, said the new operation, to be in Washington, will be headed by Robert J. Brown (picture on p 104), former general manager of the company's Heavy Military Electronics department, Syracuse.



**Power Designs Inc.
Appoints Stein**

IRWIN D. STEIN has been appointed vice president of engineering for Power Designs Inc., Westbury, L. I., N. Y. Company is engaged in the design and manufacture of high-reliability power supplies for defense, industry, and research laboratories.

Prior to joining Power Designs, Stein was associated with Airborne Instruments Laboratory Div., Cutler-Hammer, Inc., as consultant on aerospace systems.



**Mepco Names Klein
Executive V-P**

EDWARD L. KLEIN has been named executive vice president of Mepco, Inc., Morristown, N. J. Company manufactures resistors and allied electronic component products.

Klein is former vice president and director of operations of the

How to design transistor circuits

Covers the physics, technology, and circuit applications of transistors, diodes, and photocells



Here is a comprehensive handbook to help you in designing and applying semiconductor devices. By 18 specialists, it authoritatively covers the entire field. It explains physical principles underlying the operation of semiconductor devices, and surveys current technology used in their fabrication. You are shown methods of circuit design and application, including high and low frequency amplifiers and switching circuits. In addition, a major reference section gives methods of mathematical analysis and semiconductor parameter measurements, and the most thorough bibliography available today. Revised and rewritten—with new material added—this Second Edition brings you abreast of important developments in the semiconductor field.

Just Published—Second Edition

HANDBOOK OF SEMICONDUCTOR ELECTRONICS

Edited by LLOYD P. HUNTER
International Business Machines Corp.

Prepared by a Staff of Specialists
2nd Ed. 916 pp., 6 x 9, 678 illus., \$18.50

From this handbook you get a rounded view of semiconductor devices. It helps you understand the basic physical action of transistors, diodes, and photocells, and enables you to assemble the necessary equipment and fabricate semiconductor devices. You also are given data on the design of transistor circuits, and on the most useful applications of devices.

Revised Second Edition more useful than ever before—treats . . .

- Esaki tunnel diodes
- modern methods of device fabrication
- high-frequency applications
- logic and switching circuits using junction transistors
- microwave usage of semiconductors
- design of semiconductor power supplies and power converters . . . and much more

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Send me Hunter's HANDBOOK OF SEMICONDUCTOR ELECTRONICS for 10 days' examination on approval. In 10 days I will (check one) remit \$18.50, plus few cents delivery costs; or \$6.50 in 10 days and \$6.00 a month for two months. Otherwise, I will return book postpaid. (We pay delivery costs if you remit with orders; same examination and return privilege.)

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L-3-30

CIRCLE 206 ON READER SERVICE CARD
March 30, 1962

Weston Instruments division of Daystrom, Inc.

Announce Formation Of New Company

SONIC MEMORY CORP., Copiague, N. Y., was recently formed to engage in research and development on magnetostrictive delay lines and their application. The engineering services offered by the company are available to both users and manufacturers of this type of delay line.

Sales engineering of the company will be directed by Arthur Rothbart, who is a consulting engineer on applications of magnetostrictive delay lines.

PEOPLE IN BRIEF

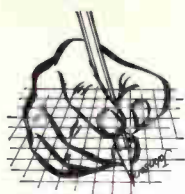
Robert W. Rowe moves from Pulse Engineering, Inc., to Carad Corp. as chief engineer. G. Hal Hudson, recently with Perkin Electronics Corp., appointed operations mgr. of Custom Magnetics, Inc. A. B. Willoughby advances to a v-p of United Research Services and named g-m of its Burlingame, Calif., research center. S. Dean Wanlass, group v-p for Packard Bell Electronics. Defense and industrial group, elected a director of the corporation. Wes Baumgardner, formerly with Hughes Aircraft, joins Computer Control Co. as an applications engineer. George W. Clapp promoted to v-p of United Electric Controls Co. John P. Hansen, an asst. v-p of Hazeltine Electronics div., is appointed mgr. of its Greenlawn Lab. Emanuel Weintraub moves up from exec v-p to president of John E. Fast Co. Lloyd A. Hatch elevated to v-p for long range planning at Minnesota Mining & Mfg. Co. Mones E. Hawley, ex-RCA, now associate director of the systems engineering div. of Planning Research Corp. DeForest E. Sanford, previously with Elgin National Watch Co., joins Electro Nuclear Systems Corp. as operations mgr. of its Missile Ordnance div. John W. Maillet transfers from GE to Boeing as director of quality control for the electronic support section.

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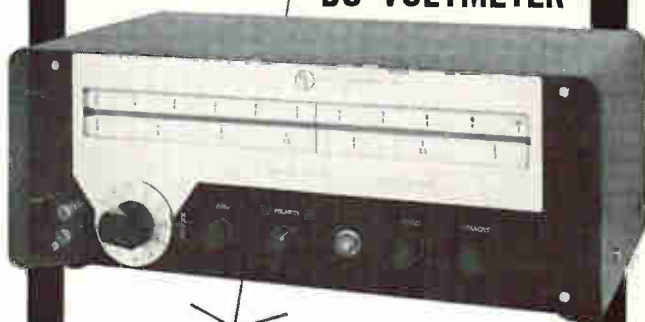
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 CITY ZONE STATE
 HOME TELEPHONE

Education

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 MAJOR(S)
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 DATE(S)

FIELDS OF EXPERIENCE (Please Check)

3-30-62

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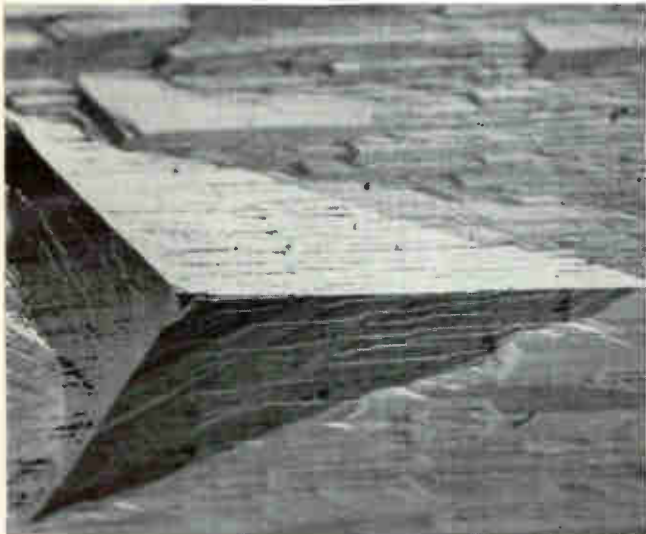
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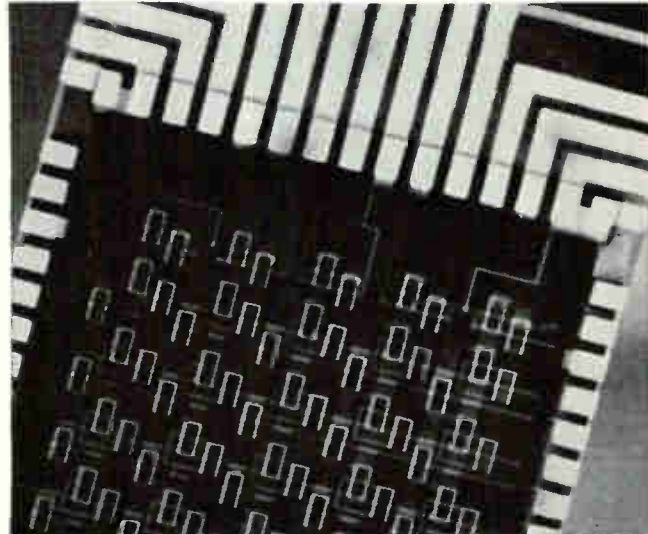
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How can we make invisible parts?



In this high-vacuum vapor-deposition process (enlarged 11x), the film material is nucleating in a fine-grained structure upon a coated glass base.



This thin-film memory cell, consisting of 135 cryotrons built up in a 19-layer "sandwich," combines storage with elementary logic operation.

Science and engineering are speeding up computer logic. And improving reliability. *And* maintaining economy. IBM engineers are studying new kinds of components: devices like tunnel diodes and thin films which may switch within a fraction of a nano-second, and microscopic solid-state circuits which can cut transmission time by reducing the distance electrical signals must travel. But switching speed is only one aspect of components development. Before these minute new devices can be put to use, automatic manufacturing techniques must be found to make them highly reliable and economical.

In manufacturing solid-state components, the quantities of material involved are so small that it is extremely difficult to manipulate them. During deposition, it is necessary to precisely control geometry, purity, and other physical properties which determine electrical characteristics. For example, in the manufacture of thin-film cryotrons, residual gases tend to contaminate metal surfaces freshly deposited upon a substrate. In addition, tapered gradients develop at the edges of the microscopically thin film, destroying its uniform thickness.

To solve these problems in the production of a 19-layer cryogenic memory plane, IBM engineers evaporated metals and insulators at a very high rate onto a heated substrate in a vacuum of 10^{-7} millimeters of mercury. Heating the substrate assisted in the

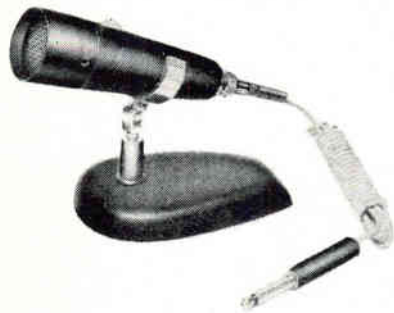
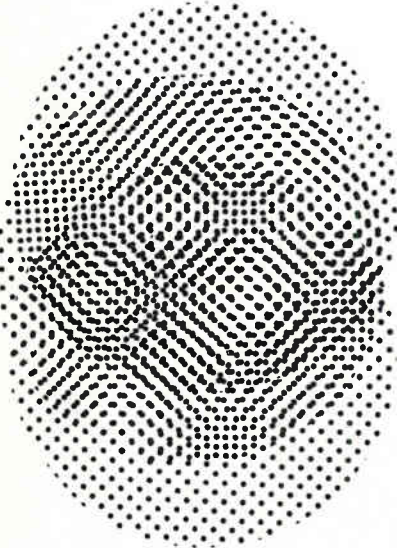
nucleation process to produce sharply defined edges. Once the 17 perforated deposition masks were aligned properly, this process was able to duplicate cryogenic memory planes automatically.

Precision masks play an important role in the production of other components beside cryotrons. IBM's ability to make masks quickly and economically has made it possible to experiment extensively with new device geometries. By diffusing both P- and N-type impurities into germanium through masks of silicon monoxide, IBM engineers have produced an all-diffused ultrahigh-frequency mesa transistor (and a process for manufacturing it efficiently). They have also perfected a masking technique for making silicon devices with different geometries. IBM scientists in other areas are searching for better ways to make magnetic cores, recording heads, and photoconductors. Out of their work may come the components which will set speed records on tomorrow's computers.

If you have been searching for an opportunity to make important contributions in components, software development, manufacturing research, optics, machine organization or any of the other fields in which IBM scientists and engineers are finding answers to basic questions, please contact us. Manager of Professional Employment, IBM Corporation, Dept. 554P5, 590 Madison Avenue, New York 22, New York. IBM is an Equal Opportunity Employer.

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March 30, 1962

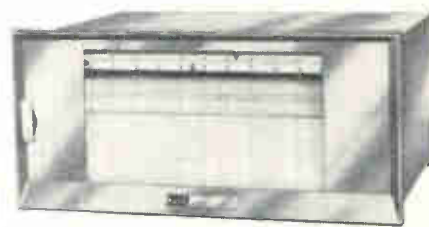
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WRITE or call the factory for the name of the nearest Sales-Service representative to obtain prices and specifications.



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Market Insurance

IN EXAMINING the relationship of government as a buyer to firms in our defense industry, let's have a look at the appropriations bill under which we are currently operating. That bill spells out in specific terms the degree to which advertising is allowable as a contract cost.

Speaking at the Western Briefing Conference on Government Contracts in Monterey, California on October 6, 1961, Donald W. Douglas, Jr., President of Douglas Aircraft Company, Inc. said:

"We must make up our minds whether we regard defense industry as truly private enterprise, quasi-public, or what? If, as we tell the world, we favor private enterprise, do the usual prerogatives of a commercial enterprise apply? May the defense contractor develop his corporate image as an aid to recruitment of personnel, community relations, and the securing of risk capital? The furor over defense contractor advertising leads me to think there is some confusion on this question."

The appropriations bill prohibits advertising as an allowable cost except for procurement of needed employees and critical materials. It says clearly that protection of corporate position in the marketplace is not allowable as a contract cost.

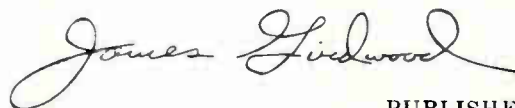
To assume that such advertising costs can be paid from the profit dollar is somewhat naive, especially considering the fact that the government is steadily reducing profit margins. Suppose a corporation exerts 60 percent of its efforts in a given area to government contract work. Suppose, further, that during the following year the government utilizes only 20 percent of this company's capability measured in dollars of output. What is the result? The corporation has to go into the commercial marketplace and endeavor to reclaim 40 percent of its volume. Meanwhile, not having advertised, the corporation, its capabilities and its products are recognized, accepted and preferred to a lesser extent than had they been advertised.

Reduce the problem to simpler terms. Inherent in the price of every product of every manufacturer are such expenses as fire insurance and advertising (market insurance). When the government is the buyer, under

present regulations a reasonable portion would not be allowable for advertising. The government, apparently recognizing that a usable supply source would be lost if the plant burned down, fails to recognize that if the market disappears the result would be about the same.

The best reason for advertising today is tomorrow. Once you need business it is a little late to advertise and it seems that Congress and the Department of Defense should recognize that the advertising provisions of the appropriations bill build into industry-government relations a fundamental inequity. Unless the restriction on advertising is modified or eliminated, advertising costs to corporations will become buried in contract costs and buried so deeply, spread so diversely, as to be unidentifiable. Then the costs to the government will be in places where they cannot properly be scrutinized and approved by contracting offices and renegotiation teams. Hence the government will destroy the very control which should be exercised over such expenditures.

Why will the costs be buried? Because advertising is essential to the survival of a free enterprise operation. Without it, corporations cannot attract capital at equitable rates, cannot maintain reputations which will in turn attract top-grade employees, cannot maintain adequate local area communication, cannot be competitive in the securities market and, most of all, cannot maintain and improve their competitive positions.



PUBLISHER

Excerpt from a speech delivered before the Orlando, Florida, Chapter of the Institute of Radio Engineers, December 13, 1961

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Environmental Conditions	No. of Units	Millions of Transistor Hours	Observed Failure Rate	Upper 60% Confidence Limit
25°C, 10V, 150mW	13,815	45.6	.002	.004
All Units Within Ratings	14,607	46.4	.002	.004

FAIRCHILD 2N1132 MINUTEMAN PART NO. 501M

Environmental Conditions	No. of Units	Millions of Transistor Hours	Observed Failure Rate	Upper 60% Confidence Limit
25°C, 10V, 150mW	21,163	84.6	.004	.005
All Units Within Ratings	21,924	85.5	.004	.005

Note — Failure Rates expressed in % 1000 hours based on assumption of exponential distribution without any acceleration factors.

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RCA 2N1708		
CHARACTERISTICS	TEST CONDITIONS	LIMITS
I_{CBO}	$V_{CE} = 15 \text{ volts}; I_E = 0$.025 μa max.
I_{CEX}	$V_{CE} = 10 \text{ volts};$ $V_{BE} = 0.35 \text{ volts};$ Free-air Temp. = 100°C	15 μa max.
$V_{CE}(\text{sat.})$	$I_C = 10 \text{ ma}; I_B = 1 \text{ ma}$.22 volts max.
$V_{BE}(\text{sat.})$	$I_C = 10 \text{ ma}; I_B = 1 \text{ ma}$.9 volts max.
t_s	$I_C = 10 \text{ ma}; I_{B1} = 10 \text{ ma}$ $I_{B2} = 10 \text{ ma};$	25 nano-seconds max.
t_{on}	$I_C = 10 \text{ ma}; I_{B1} = 3 \text{ ma};$ $I_{B2} = 1 \text{ ma}; V_{CC} = 3 \text{ volts}$	40 nano-seconds max.
t_{off}	$I_C = 10 \text{ ma}; I_{B1} = 3 \text{ ma};$ $I_{B2} = 1 \text{ ma}; V_{CC} = 3 \text{ volts}$	75 nano-seconds max.

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