A McGRAW-HILL WEEKLY 75 CENTS JANUARY 10, 1964

electronics

FLIP-FLOP AND MASTER SLICE

New logic networks use both **pnp** and **npn** devices

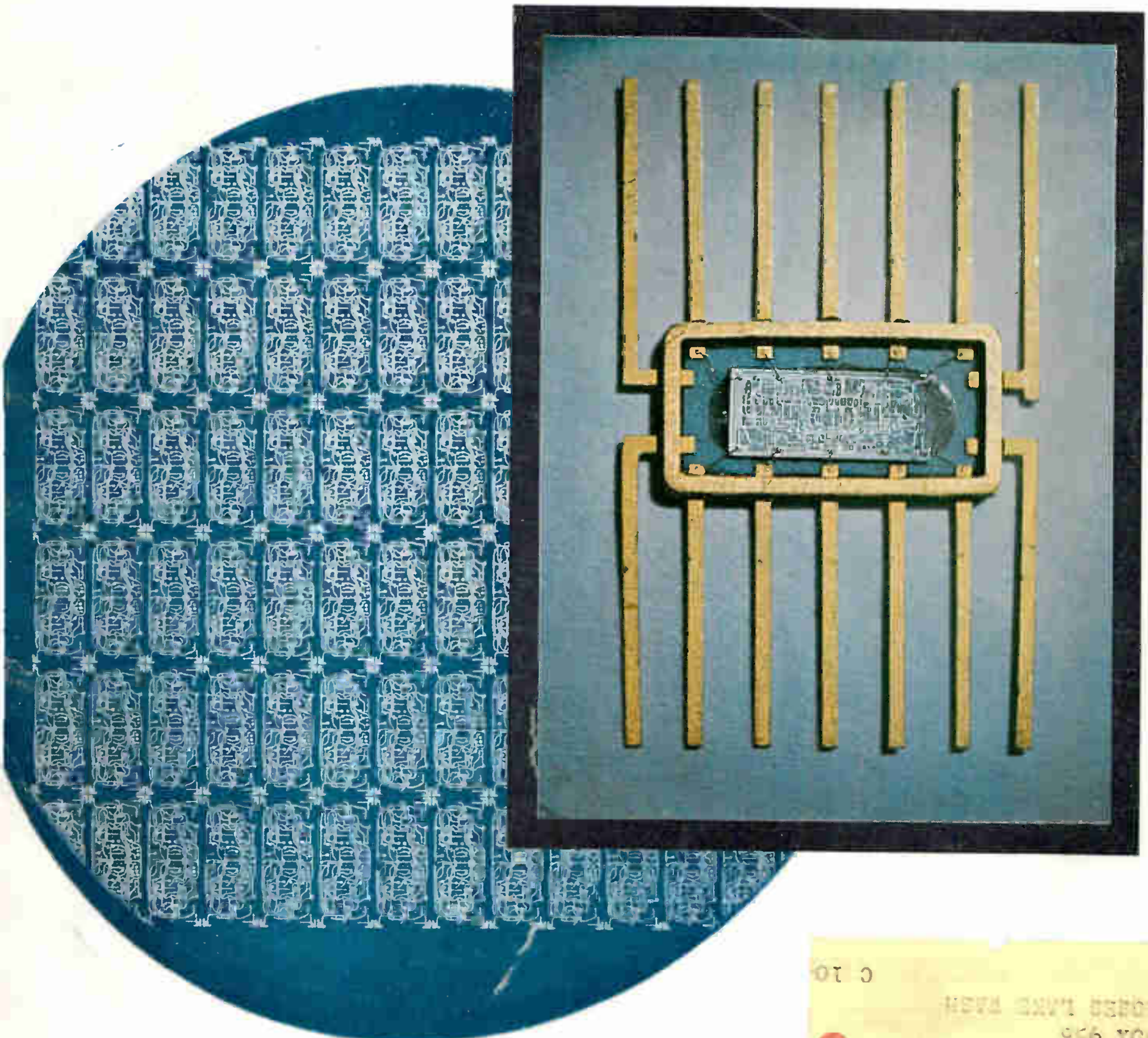
(Photos below)

RECORDING THE WEATHER

Handling inputs from five levels on tower

WHY 4-LEAD PNPN DEVICES?

Resistor to anode gate suppresses rate effect



high resolution, rapid selection

The new hp 5100A-5110A Frequency Synthesizer offers pushbutton convenience for fast, accurate selection of frequencies from 0.01 cps to 50 mc in steps as fine as 0.01 cps. Remote programming in less than 1 millisecond may be accomplished by external electronic switching. The excellent spectral purity is evidenced by the fact that spurious components are more than 90 db down (including power line components) and signal to phase noise ratio is greater than 60 db.

The system consists of the 5100A Frequency Synthesizer and the 5110A Synthesizer Driver. The latter contains a 1 mc quartz crystal oscillator which has a long term stability of ± 3 parts in 10^9 per day. The design of the instrument allows for the use of an external 1 mc or 5 mc oscillator. In any case, the output frequencies retain the accuracy of the chosen driving standard. The 5110A Synthesizer Driver generates twenty-two discrete, spectrally pure signals from the single standard frequency. These fixed frequencies are then fed to as many as four 5100A's by means of rear panel BNC connectors.

Manual frequency selection is accomplished by means of ten columns of pushbuttons arranged in standard decimal notation. Remote programming connections are made through three 50-pin connectors located on the rear of the 5100A. Further versatility in control is added by the fact that it is possible to use a combination of local and remote programming.

Standard instrument design provides a search oscillator which may be used in any one of the eight least significant digit columns. This technique allows the output frequency to be varied smoothly over the range of frequencies covered by the substituted column, either manually or by applying an external voltage.

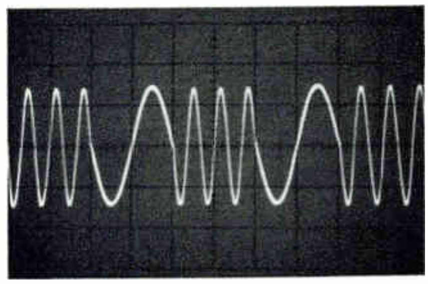
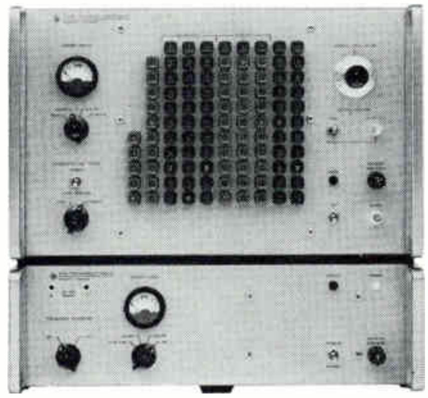


Photo shows rapid frequency switching capability of hp Synthesizer. In this application, Model 5100A-5110A is remotely switched between 1 kc and 3 kc at a 1 kc rate. Sweep speed is 0.5 ms/cm.



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8435R

SPECIFICATIONS

Output frequency:	0.01 cps to 50 mc
Digital frequency selection:	From 0.01 cps per step to 10 mc per step; selection is by front panel pushbutton or by remote contact closure
Spurious signals and harmonic distortion:	All non-harmonically related signals are more than 90 db below (including power line components) the selected frequency; harmonics are more than 30 db below the fundamental
Signal-to-phase-noise ratio:	More than 60 db down in a 3 kc band centered on the signal
Frequency stability and accuracy:	With internal standard, less than ± 3 parts in 10^9 per day; with external standard, same as external standard
Output voltage:	1 v rms ± 1 db from 100 kc to 50 mc; 1 v rms ± 2 db — 4 db from 50 cps to 100 kc into 50-ohm resistive load
Output impedance:	50 ohms nominal
Search oscillator:	Allows continuously variable frequency selection with an incremental range of 0.1 cps up to 1 mc, depending on the digit position being searched; dial accuracy is ± 3% of full scale; linearity with external voltage control is within ± 5% (—1 to —11 volts)
External standard input:	1 or 5 mc, 0.2 v rms minimum, 5 v maximum across 500 ohms; purity of output signal will be determined partially by purity of external standard
Interference:	Complies with MIL-I-16910A (SHIPS)
Temperature range:	0 to + 55° C
Dimensions:	5100A, 10¾" high, 16¾" wide, 16⅜" deep behind panel; 5110A, 5½" high, 16¾" wide, 16⅜" deep behind panel; hardware furnished for quick conversion to rack mount
Weight:	5100A, net 75 lbs.; 5110A, net 52 lbs.
Price:	5100A, $10,250; 5110A, $5,000

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

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new hp Frequency Synthesizer
Lift page for details
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hp FREQUENCY SYNTHESIZER PROVIDES 5 BILLION PROGRAMMABLE FREQUENCIES

Discrete signals, dc to 50 mc

Remote programming—1 msec switching speed

Frequency increments as small as 0.01 cps, as large as 10 mc

High stability and spectral purity—spurious signals 90 db down

JANUARY 10, 1964

electronics

A McGRAW-HILL WEEKLY 75 CENTS

FLIP-FLOP LOGIC. The integrated circuit flip-flop by Texas Instruments Incorporated operates on a single-phase clock and performs *J-K* logic—simultaneous application of logic ONE's at the inputs results in a change of state. It uses a unique steering method that does not require input capacitors. The master slice in the background yields nearly 70 flip flops. *The flip flop is packaged in a 10-lead flat pack (four leads will later be trimmed off). See p 25* COVER

TRACKING WITH LASERS. Being readied for moving-target tests is a new laser tracking system with angular precision better than radar. This low-power system using a semiconductor laser, may be followed by high-power ones for missile-decoy discrimination. *Also in the works is a system to measure missile attitudes after launch* 10

LASER WELDER. Ready for test use this week is a full-scale, automatic system for welding titanium and other aerospace metals with a pulsed laser. *Positioning table moves the work-piece while an optical system shapes the beam* 11

INFORMATION RETRIEVAL. Army Missile Command is planning to update its EDS-0009 information retrieval system by equipping it with optical input and output and providing for facsimile transmission of data. *Eventually, developers hope, the system will accept spoken queries* 14

HIGH-DENSITY SEMICONDUCTOR NETWORKS. Six new integrated circuits—flip flop, 5-input NAND gate, 5-input AND gate, dual 3-input NAND gate, 2-and-3-input AND gate and 4-inverter package—reduce digital system complexity permitting 1-Mc speed of operation while using fewer networks in a system. *Advantages result in part from wider application of "master slice" concept and use of both pnp and npn devices for current gain.*
By C. R. Cook, Jr., and B. M. Martin, Texas Instruments Incorporated 25

SUPPRESSING RATE EFFECT IN PNPN DEVICES. Rate effect is switching of a *pnpn* device into high conduction due to a sudden increase in anode voltage. Switching and power-line transients can cause spurious triggering of *pnpn devices;* even *pnpn* devices themselves can trigger other devices. *New four-terminal pnpn devices allow connecting a resistor from anode gate to anode power supply to suppress rate effect.*
By R. A. Stasior, GE Semiconductor Products Dept. 30

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electronics

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DIGITAL SYSTEM RECORDS WEATHER DATA. This simplified system handles inputs from five wind and five temperature sensors mounted at different levels on a tower. It uses a stepping switch as a multiplexer, digital voltmeter as an analog-digital converter and one amplifier for all sensors. *Thermistors compensate for nonlinearities in resistance thermometer bridge.* By F. J. Goldwater, Hebrew Univ., Jerusalem, Israel 34

LINEAR SCALES SHOW MIXER HARMONICS. Here is a way to locate spurious signals generated by the first six harmonics of two mixed signals. Some of these spurious signals may be at the desired output frequency and consequently cannot be filtered out. *One scale is used for the sum of input frequencies, the other for the difference.* By R. T. Stevens, Sanders Associates 37

SOLAR FLARES. NASA is hoping to devise a technique for reliably predicting solar flares before the first manned lunar flight. *Right now, the data base is being gathered with a variety of equipment, including two new satellite programs* 40

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NOISE REFERRED TO INPUT: 2 mv rms
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Model 133B Dual-Channel Galvanometer-Driver Amplifier provides 18 independent amplifier channels in 7 inches of panel space.

GAIN RANGE: Zero to 4, with ten-turn, continuously variable, locking control
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BANDWIDTH: dc to 100 cps; also available with switch-selected active filters.
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Offset adjustable to zero (± 1 mv. nom. range)
VOLTAGE OFFSET DRIFT: Less than 6μv per hour
INPUT CURRENT: Less than 1 na

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BANDWIDTH: dc — 100 cps
NOISE: 0.05μv rms referred to input
INPUT RESISTANCE: 1 megohm
OUTPUT LEVEL: 0 to ± 5 volts at ± 5 ma

Model 121 Nanovoltmeter provides 0.1 μv full scale bridge balance detector or thermocouple indicator for standards and calibration work, in the field as well as in laboratories.

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Those Sunspots Again

"The fault, dear Brutus, is not in our stars,
But in ourselves that we are underlings."

Shakespeare, Julius Caesar, Act 1, Scene 2

But many faults do lie in our stars. And they work all manner of mischief with men's best laid plans. They may prevent man from reaching the moon, or at least make the journey more hazardous.

The faults in a star are, of course, sunspots. For centuries astronomers have studied and charted these fiery whirlwinds on the sun's face. Statisticians have sought and found interesting periodicity in their occurrence—a 27-day cycle, an annual cycle, an 11-year cycle and even a 101-year cycle.

Their effect on radio and cable communications has been amply demonstrated with cause linked to effect. Sunspots have also been correlated against weather—especially hurricanes, floods and other dramatic phenomena—and against the activities of man—war, pestilence, mental illness, crime. In these latter studies there is as yet no link up between cause and effect although there may be one through the mechanism of positive ions.

Certain, but not all, sunspots spew out highly ionized particles. And these particles, some of them very energetic indeed, raise hob with the ionosphere and with the earth's magnetic field, adding, as it were, a fluctuating a-c component to the earth's ring current. Many highly competent scientists and engineers have devoted their life's work to predicting when these solar bombardments will occur. The problem is especially acute today because solar flares can kill future space travelers or disable their essential communications and navigation apparatus.

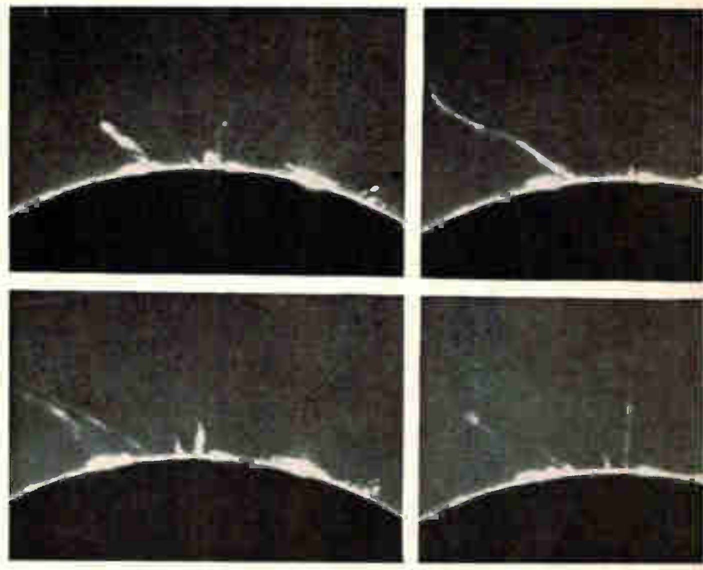
Naturally these bombardments occur most often when the sunspot cycle is at its maximum. And so-called bipolar or double-yoked sunspots are often more troublesome than unipolar ones. A sunspot that acted badly once will usually act up the second time around and this comes to about 27 days as the sun rotates. Furthermore, flares visible on the limb of the sun when photographed by a coronagraph are often precursors of trouble some 7 or 8 days later.

A blast of ionized particles is often preceded by a dose of ultraviolet radiation—the SID or sudden ionospheric disturbance. The particles follow one to three days later since they travel slower than the speed of light. Before the storm, the highest h-f radio signals drop into the mud, especially those on northerly paths. d-f signals behave erratically, often shifting several degrees southward, and the Aurora Borealis and Australis put on their pyrotechnic-like displays.

But these techniques are not going to help astronauts already embarked on long space voyages. Is there a better way?

Scientists and engineers the world over are searching for one by amassing astro and geophysical data and using all modern mathematical tools to discover new and useful relationships. One school of thought ascribes the occurrence of sunspots to a particular conjunction of the major planets and at least one man has been rather successful in predicting ionospheric disturbances from a study of the planets.

But be the answer in the stars or not, the mystery of the solar flare holds a very large key to man's exploration of the cosmos (see p 40).



SOLAR FLARE shoots out more than 150,000 miles in these sequence photos made by the High Altitude Observatory of the University of Colorado, at Climax, Colorado

CONSTANT CONSTANTS—At a recent joint meeting of the IEEE Symbols Committee and a subcommittee of the American Standards Association Sectional Committee on Letter Symbols the discussion turned to considering some of the basic constants used in electrical engineering.

These are the familiar μ_0, the permeability of free-space, and ϵ_0, the permittivity of free-space. It was pointed out, quite rightly, that these quantities are not measurable properties of free-space—if indeed there is really such a thing as free-space at all. Rather, they are properties of the system of units employed.

It has been suggested, therefore, that the terminology be altered and that we begin to speak about Γ_e, the electric constant and Γ_m, the magnetic constant. It may be argued that it may take some time to get used to seeing the well-known formulas

$$\mathbf{D} = \epsilon_0\varepsilon\, \mathbf{E}$$
$$\text{and } \mathbf{B} = \mu_0\epsilon\, \mathbf{H}$$

written

$$\mathbf{D} = \Gamma_e\varepsilon\, \mathbf{E}$$
$$\text{and } \mathbf{B} = \Gamma_m\mu\, \mathbf{H}$$

but it another step towards helping the engineer to realize at all times exactly what he is doing. It seems time to do away with the fiction of properties of free-space that nobody can define much less measure and acknowledge that these properties of free-space are nothing more than convenient constants that make our system of units come out in manageable form.

COMMENT

ATOMIC POWER

Your straw man in the editorial, Crossroads For Atomic Power (p 5, Dec. 6, 1963), seems nicely batted down, but hardly in keeping with your usual objective journalistic style.

Having read a little and heard transcriptions of several hearings dealing with nuclear power plant proposals, I am frankly not aware of anyone seriously questioning the proposal sites on the basis of the nuclear explosion hazard. What you fail to deal with is the statistical hazard of low-level radiation continuously or intermittently released in normal operation, the hazard of meltdown or other thermal excursion that could release heavier flux to a wide area but with no mechanical damage beyond the site boundaries, and the total environment contamination due to unsatisfactory solutions to the refuse disposal problem.

By all means remain dispassionate if you can, but speak to the question. Thousands of curies per month are released into the sea in England, where bathing in the ocean is not very popular anyway, but the greatest potential food supply may one day come from the sea. Davil E. Lilienthal, former AEC chairman, indicates that the waste disposal dilemma is extremely intractable with no solution in sight. We store high-level wastes in containers with a projected lifetime a fraction of the half-life of the waste.

In our country with ample fossil fuel reserves, there is no reason to rush into heavy nuclear power development when relatively clean controlled thermonuclear reactors may be realized soon. However, the AEC seems bent on promoting fission plants not just "in the midst of their customers" but 1,000 feet from active seismic faults, in the most scenically endowed suburban areas, or in the midst of a rich biological specimen preserve.

Certainly, as individuals and as citizens, we should insist in all forums available to us that public safety be given full and open consideration. But let us do our homework first, taking into account the full history of reactor development and accidents, facts favorable to the proposal and unfavorable. Let us consider above all the legacy of contamination, the most vile and filthy refuse ever created on the face of the earth by man or God, we are leaving to our posterity.

RUSS LINTON

San Diego, California

• Our homework in our own backyard—Queens, where a reactor is proposed—indicates that residents there are most concerned about the possibility of a major accident—either an outright explosion or a contained accident that would release large amounts of radioactive material. Neither of these fears seems justified, in our view, by experience with atomic reactors.

Also, most of the recent arguments, pro and con, about nuclear power plants do revolve about the "catastrophe" question. Mr. Lilienthal, himself, brought up this argument at the Atomic Industrial Forum meeting in New York on Nov. 21, 1963; it was also discussed by other speakers at the meeting, and by AEC Chairman Seaborg on Nov. 7. We studied these statements carefully, in the light of our previous knowledge of the reactor safety question, before arriving at a conclusion.

The statistical radioactivity question and the waste disposal question were considered, but not discussed in the editorial. The apparently negligible hazard from the first seems to be cancelled out by the statistical hazard that can be attributed to air pollution caused by conventional power sources. Nor can we see how waste disposal should determine where an atomic power plant should be located. The AEC says that now it generally does not dispose of reactor wastes, but reprocesses them into new fuel elements, or stores them in tanks for later use.

UNITY-GAIN BUFFER

In my article of Dec. 20, 1963, Unity-Gain Buffer Acquires Precision By Feedback, (p 36), are the following errors:

In the first sentence, the word *and* should be removed from line 2.

Equation 1 should read $A_2[(e_i - e_o)A_1 + e_o] = e_o$.

Equation 2 should read $A = e_o/e_i = A_2A_1/(1 + A_2A_1 - A_2)$.

The last expression of Eq. 3 should be $1/(h_{ib2} + R_c/h_{fe2})$.

The last expression of Eq. 5 should be $R_oe_o/e_o[1 - A_2(1-A_1)]$.

The middle expression of Eq. 6 should be $R_o/(1 - A_2 + A_1A_2)$.

Equation 7 should read $i_i = (e_i - e_o)[1/R_{k1} + 1/h_{ib1} + 1/(r_c + h_{ie2})]$.

Equation 8 should read $i_i/e_i = 1/Z_i = (1-A)[1/R_{k1} + 1/h_{ib1} + 1/(r_c + h_{ie2})]$.

Equation 9 should read $Z_i \cong h_{ib1}/(1 - A)$.

In Fig. 2A, both e_1 before the first stage should be e_i.

DAVID K. PHILLIPS

Operations Research Inc.
Santa Monica, California


LTV
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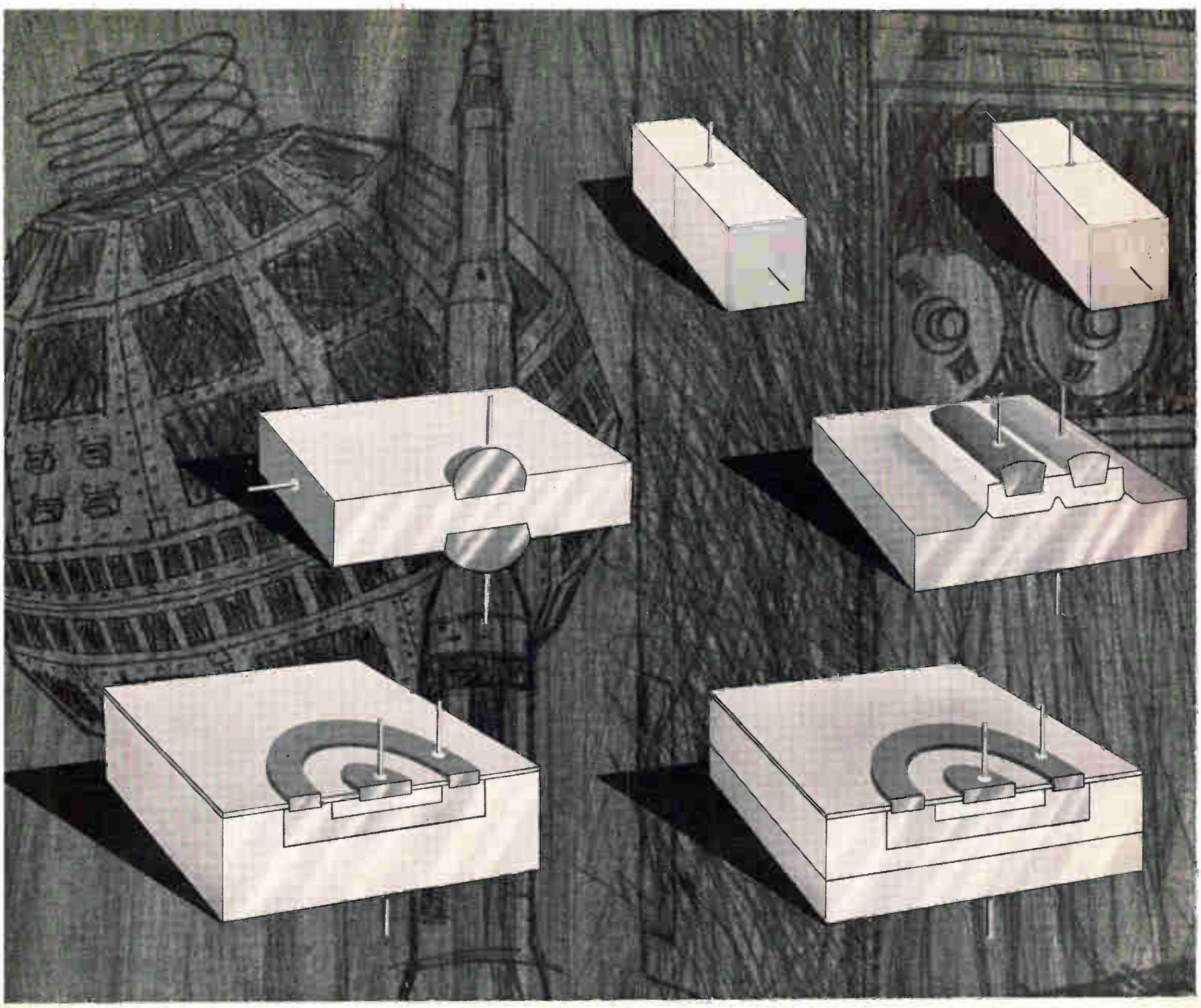

GROWN transistors employ a time-proven manufacturing process for true economy and reliability.

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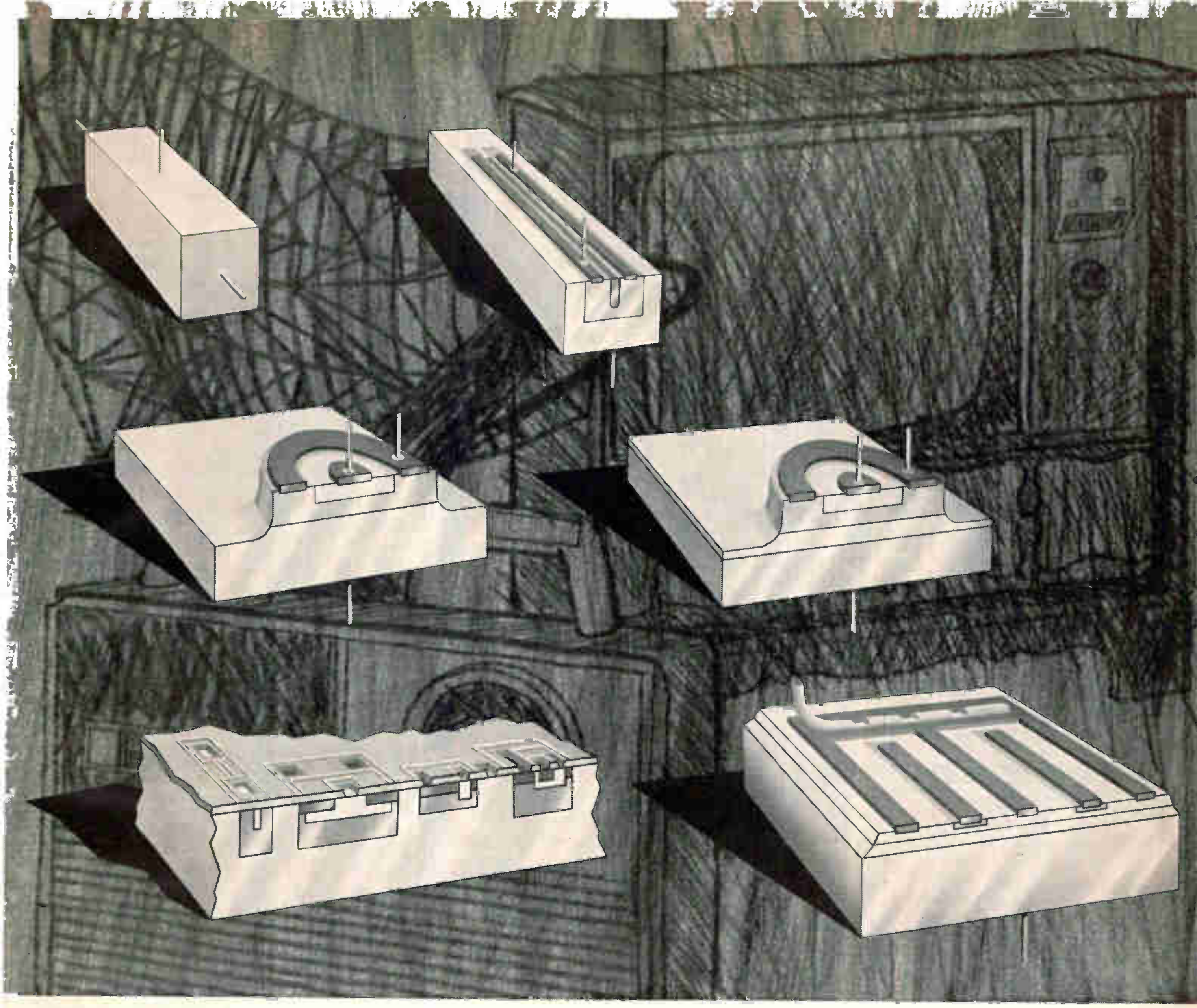

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We are convinced that, just as the "universal transistor" is a myth, so is the "universal technology." Some semiconductor manufacturers offer the planar epitaxial transistor as the solution to all problems . . . others extol the planar-diffused . . . still others acclaim the mesa. Some praise silicon, some germanium.

We make all of these types and many more. We have long experience with both materials and the four basic technologies — grown, alloy, diffused, epitaxial — and our 536 standard transistors represent every combination of these modern techniques.

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We want to sell you the one type that best fits your needs for performance, reliability, and price.

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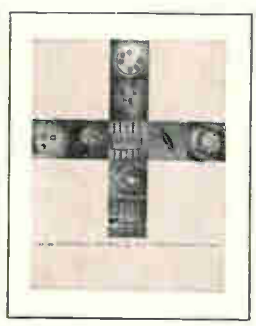
Our vested interest is in your success.

This is not philanthropy. We know that if our customers are successful, Texas Instruments will be successful...because you will be back for more.



The array on these pages illustrates just twelve basic types of devices, and only transistors at that. For the full story, you need a copy of our catalog. Not only does it list our 536 standard transistor types and give their principal characteristics, it also presents our broad line of diodes, rectifiers, capacitors, resistors and special products.

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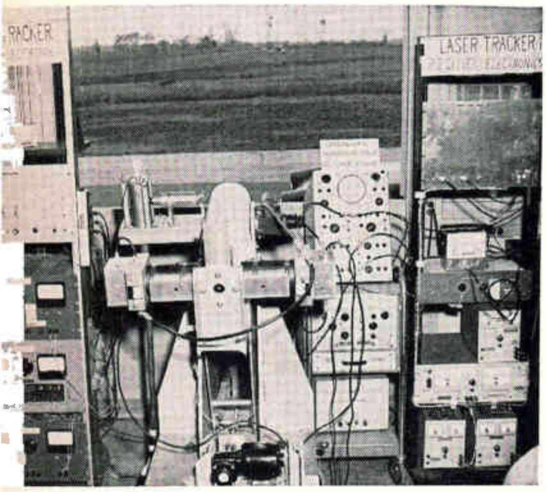
Active Laser Tracker Begins Moving-

A second system will determine missile attitude in flight



LABORATORY laser model detects ¼-inch lateral movement at 1,300 feet

MOORESTOWN, N. J.—Last week, an active laser tracker moved into an advanced test phase, here, at RCA's Missile and Surface Radar Division. Mounted on a radar pedestal and connected to a closed servo loop, the experimental device will soon begin to track moving targets mounted on moving surface vehicles.

Previously tested in a fixed position, the laser has detected a ¼-inch lateral movement of a 2½-inch glass corner reflector at a distance of 1,300 feet. This performance, RCA says, indicates an angular precision several times better than microwave instrumentation radars.

While the device is theoretically capable of even greater precision, beyond this value atmospheric turbulence begins to limit the system for paths near and parallel to the earth's surface.

Two-Coordinate System—Although the existing equipment determines only one coordinate (azimuth), a two-coordinate system has been designed. Four receiving channels would be employed, combined on a monopulse basis to derive azimuth and elevation error signals. A reflecting optical pyramid is used to obtain the four channels. The output from summing amplifiers is fed into display circuits.

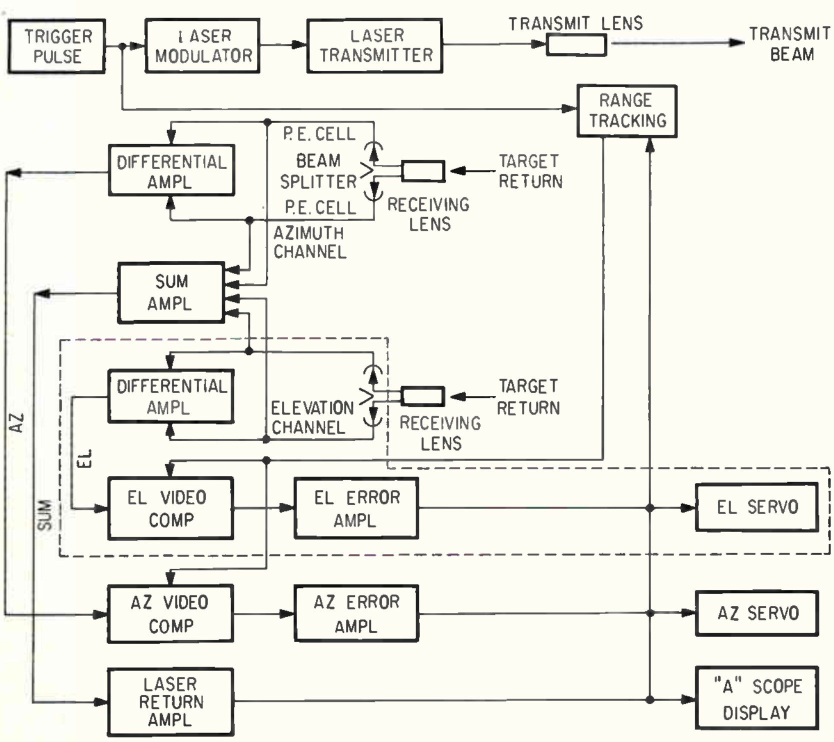
The gallium-arsenide laser is pumped by an electrical current pulse. Liquid nitrogen is used to cool the laser. The present gallium arsenide laser is being used as an interim device to prove out the system. It is anticipated that more powerful lasers would obviously be used in an ultimate application.

Peak output of the laser is at 8,450 angstroms. Receiver band pass is 100 Å in width, peaked at 8,450 Å. (The receiving beam width is ± 1 milliradian.) Accuracy of angular measurements using the instrument is 0.01 milliradian. The receiving antenna aperture is effectively 5 inches. The pulse repetition rate is 300 per second, with a pulse width of 1 microsecond. Peak power is 100 milliwatts.

One application of a tracker of this type would be to track cooperative test missiles, equipped with corner reflectors, during the critical period between launch and the first 60,000 feet. Radar is ineffectual at these low altitudes because of ground clutter and multipath signal return. Although RCA has not designed equipment precisely for this application, such a system would probably need peak power up to 500 watts.

A more advanced application would be a tactical defense system consisting of both radar and laser trackers. The radar would acquire the enemy aircraft or missile, and the laser would examine it for fine details.

A high powered laser could also be used, conceivably, to discriminate between decoys and ballistic missiles. While radar detects decoys by calculating their deceleration rate, a laser would scan the profile of each approaching object and pick out the decoys by their configuration.



PORTION of system in dotted area would provide second-coordinate (elevation) sensor

Missile Attitude Sensing—RCA has completed the design phase of another laser project, a Missile Attitude Determination System (MADS)

Target Tests

By JOHN F. MASON, Senior Associate Editor

—this one under contract from USAF's Electronic Systems Division, Hanscom Field, Mass.

Objective of this work is to develop an advanced optical instrumentation system, external to a missile, which will provide measurements of the missile's attitude. The approach worked out uses lasers as illuminating sources and polarization-sensitive receivers to extract the attitude data.

Accurate determination changes in a missile's attitude in real time during its early launch phase is extremely important for evaluating guidance and control. Existing methods use on-board equipment to telemeter information to ground stations and also use ground-based optical gear to photograph the early launch stage.

MADS will measure in absolute coordinates, the pitch, roll and yaw of a missile from lift-off to 50,000 feet, at a rate of at least ten measurements of all three parameters each second and to an accuracy of at least 0.1 degree for each parameter.

The ground station will be located approximately 25,000 feet from the launch pad. The beams from two lasers of different wave-lengths will be directed from this ground station to a retroreflector package on the missile. This package will reflect its received light back to the ground station and will polarization modulate the beams in a manner determined by the orientation of the missile relative to the beams.

Lasers have been chosen over a conventional light source because at the anticipated range the light intensity on the reflector package is several orders of magnitude higher than if a non-laser light source is used.

At the ground station, the returned light will be passed through a polarization analyzing system which will determine the polarization state of each beam—expressed in two parameters: the eccentricity and orientation of the polarization ellipse.

The system will be set up so that the ellipses of both beams will have the same orientation. They will, however, have eccentricities independent of one another. Thus, there will be three independent variables on the beams, two eccentricities and one orientation, to convey the three independent variables of pitch, roll and yaw. By this means, the attitude of the missile is determined in beam coordinates.

LASER WELDER

MAKES CONTINUOUS BEAD

MELVILLE, N.Y.—Large laser welder, capable of automatically producing long bead welds in metals such as titanium, niobium and beryllium, is undergoing pre-delivery tests at TRG, Inc. Developed under contract from the Air Force Systems Command, Wright-Patterson Base, Ohio, the quarter-million-dollar machine is to be used at the Grumman Aircraft Engineering Corporation for research with aerospace materials, leading to production use of laser welding.

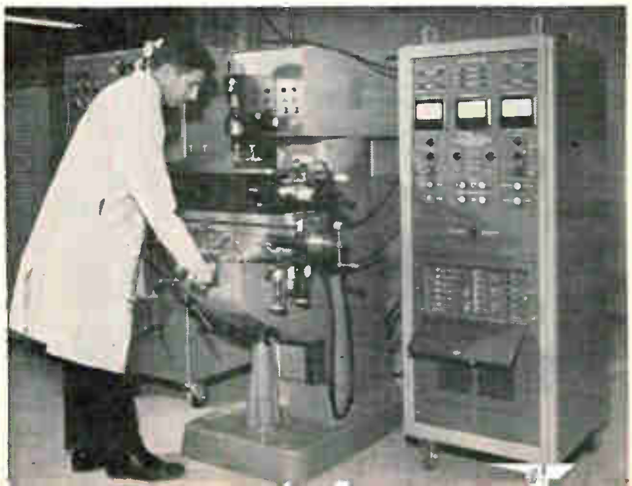
A standard, high-quality ½-inch-diameter by 6-inch-long Linde ruby crystal is triggered, alternately or simultaneously, in a clover-leaf type cavity by two pairs of flash lamps, each pair supplied by a bank of 10 580-μf capacitors charged up to 3 kv. Total energy delivered to the flash lamps is up to 30,000 joules, project engineer Stan Reich told ELECTRONICS. Peak power delivered is of the order of 1.75 megawatts.

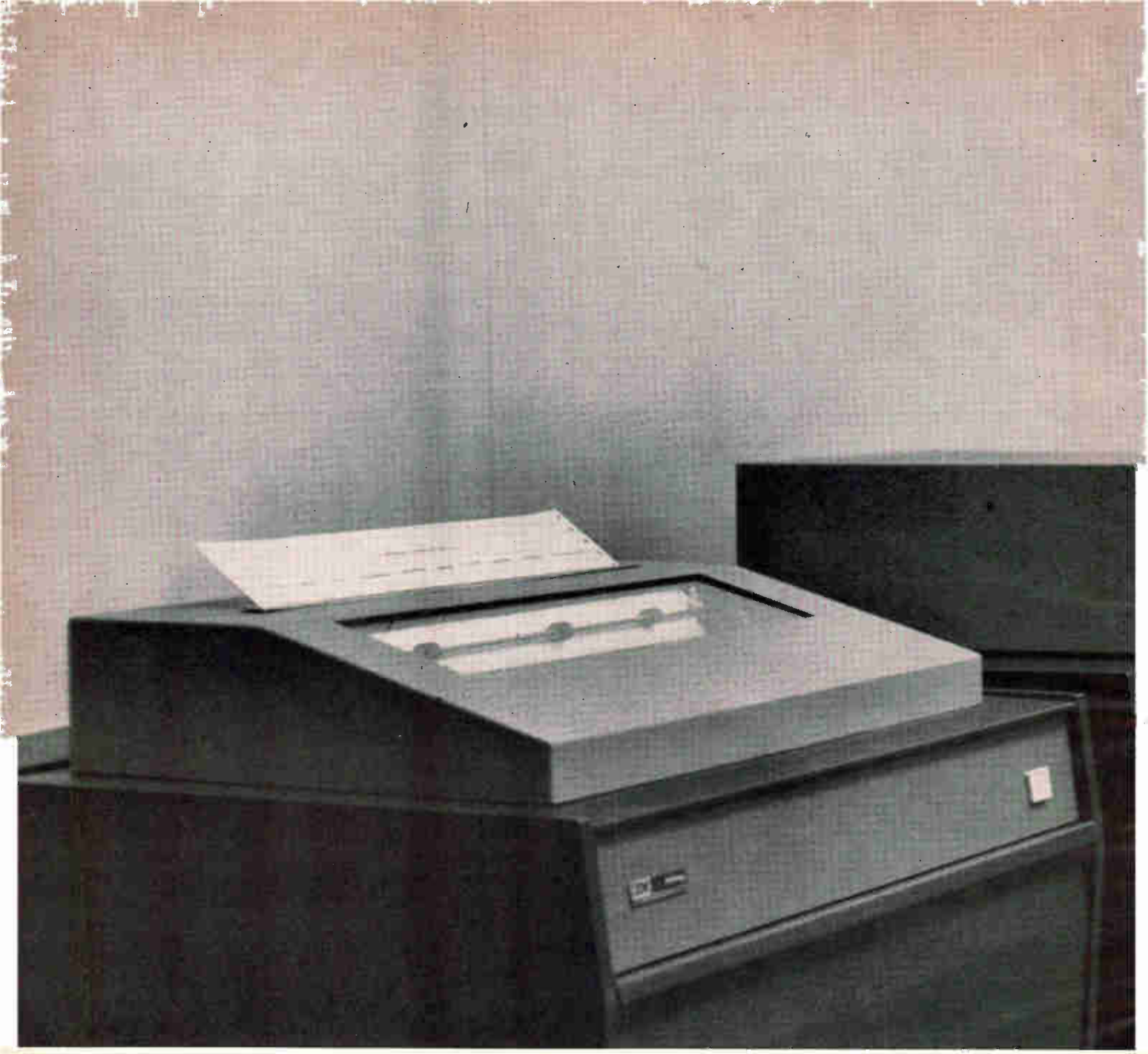
Head Assembly—The entire head assembly of the laser rod, flash lamps and cavity is enclosed in a complex water-cooled jacket; continuous water flow and a heat exchanger keep the ruby temperature down to 70 deg C at flashing rates from 12 seconds to one second.

The light from the ruby crystal is adjusted for convergence with a dichroic roof prism and a movable cube-corner reflector. A dichroic mirror passes only the red light to the optical system. It is then shaped and focused on the work piece by a set of cylindrical and spherical lenses; the beam width can be adjusted from 0.060 to 0.640 inch.

Preliminary focusing and beam shaping is done by an optical microscope, using a red neon lamp. In operation, the welder is fully automatic; the work piece is advanced by an automatic milling table and the laser triggered at a preset rate and energy level. Control is from a remote operating console.

LASER WELDER operates at atmospheric pressure. TRG cites this, plus high power density of beam, as chief advantages, especially for thin-metal welds





ARMY SEEKS OPTICAL READERS

Wants equipment to scan engineering data for input to retrieval system

By R. J. WARD
McGraw-Hill World News

HUNTSVILLE, ALA.—Army Missile Command plans to improve its EDS-0009 data retrieval system with optical input and output equipment and with provision for long-distance facsimile transmission of data sheets.

EDS-0009 is presently being considered for implementation by the Army Materiel Command within its subcommands, of which Army Missile Command (Amicom) is one of seven. Inquiries about the system also have been received from the Navy.

In the present system (see illustration), data on components such as relays and capacitors, references, revisions, range codes and requirements are manually entered with punchcards.

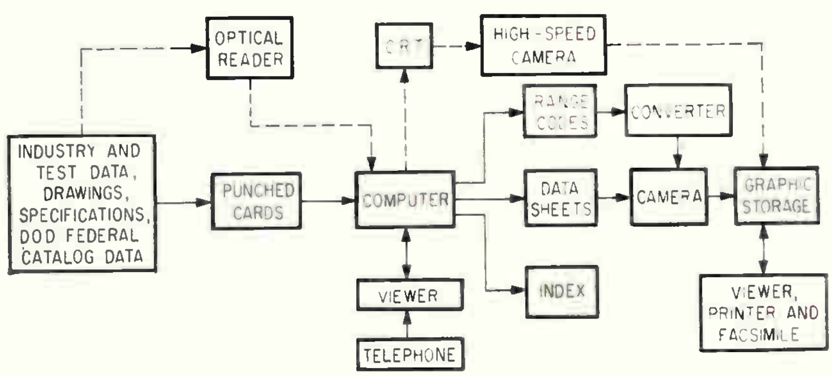
This system, announced late in 1963, is an outgrowth of a Department of Defense assignment to Army in 1960 to devise an engineering data system (EDS) that could be built with off-the-shelf hardware, accept all types of engineering data, and provide well-organized technical information, with rapid retrieval and instant revision. A study by Amicom at Redstone Arsenal showed that of the 100 systems in DOD and industry, none met requirements.

The EDS-0009 concept also may be valid for automatic data retrieval in such areas as research projects and reports, correspondence files and personnel location.

Present System—The system has separate input and output, so that an engineer can search while the central file is being updated. Data from specification, standards, handbooks and the like is first analyzed, and data on each component is then entered on punchcards. The punchcard data is fed into a computer where it is organized, crosschecked for duplication, and assigned codes to identify the content. The computer then enters the codes into punchcards while printing out standardized data sheets for each component. Both data sheets and accompanying binary retrieval code are stored on microfilm, in 100-foot cartridges, each 100 feet containing 600 to 1,500 sheets of component data or drawings.

To find a component, an engineer refers to an index for the code that describes his requirements, selects the proper film cartridge and inserts it in a viewer, and punches the buttons for as many as 60 desired characteristics of a given component into the control panel. The roll is searched in six seconds, and the required data sheet displayed on a viewing screen. If a copy is wanted, pushing another button will deliver one within 30 seconds.

The three items of an EDS station are the viewer-copier, control console and graphic storage unit, produced by Recordak Corp., a subsidiary of Eastman Kodak Corp. Amicom contractors for assembling, encoding and microfilming the initial data on components (relays and capacitors) for the EDS were Western Reserve Electronics in Cleveland, and Brown Engineering of Huntsville, Alabama. Brown prepared the punchcards on relay data and did the computer processing of the relay and capacitor data on an IBM 1401.



DOTTED LINES show how optical equipment would fit into present information retrieval system assembled at Redstone Arsenal

Updating the System—Plans for the EDS include an optical scanner for computer input, and direct preparation of microfilm masters by photographing the face of a crt with a high-speed camera. This equipment would eliminate the punchcards and all related manual operations. Requests for quotations (RFQ's) are being written by Amicom for the development work.

Development of a suitable optical reader is 3 to 5 years away, according to Roland Guard, project manager of EDS. It would read printed engineering data and transmit data automatically to the computer for processing. Automatic screening of catalogs would require just seconds for an item, while it now takes a half hour to prepare data for punchcard input.

Guard said existing cathode ray tube/high-speed microfilm camera systems would, with some adaptation, accelerate the computer output and microfilming procedure. The present output is in two forms: data sheets printed at 600 lines per minute, and range-code cards that are processed by a converter before microfilming along with data sheets. Guard says usable crt/microfilm camera systems include Stromberg Carlson's Model SC-4020 and one by Control Data Corp.

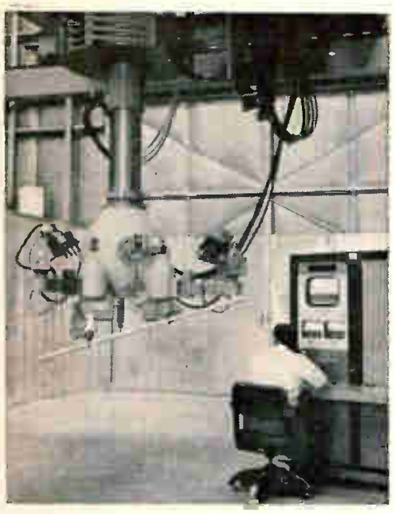
Long-Distance Transmission—Amicom is writing RFQ's for broadening the present EDS concept to include long-distance facsimile transmission over telephone lines.

Guard says Amicom also is working with NASA's Marshall Space Flight Center, also here at Redstone Arsenal, in an effort to link EDS with Marshall's new data switching center. The center is used for automatic communications and data transmission between MSFC headquarters, its Michoud Operations (launch vehicle booster production site) at New Orleans, NASA's Cape Kennedy operations and other points. This would give engineers at these locations instantaneous retrieval of desired information. Heart of the Marshall system is an ITT ADX-7300. Considering the high cost of such computer time, use of EDS in this case would be restricted to inquiries regarding "major items," Guard notes.

20 Years from Now—Guard's staff envisions an ultimate EDS system that will allow a design engineer in California to speak his component requirements into an audio-to-digital converter beside his desk, automatically locate and retrieve the desired data from a master microfilm file in Massachusetts, for example, and present the data to the engineer either on a viewer or in facsimile—all in less than a minute.

However, Guard says that development of an audio-to-digital converter is "easily more than 20 years away."

Remote Maintenance



MINOTAUR I, built by General Mills for Los Alamos ultrahigh-temperature experiments, includes two electro-mechanical manipulators, closed-circuit tv, 500-pound hoist, lights and audio system

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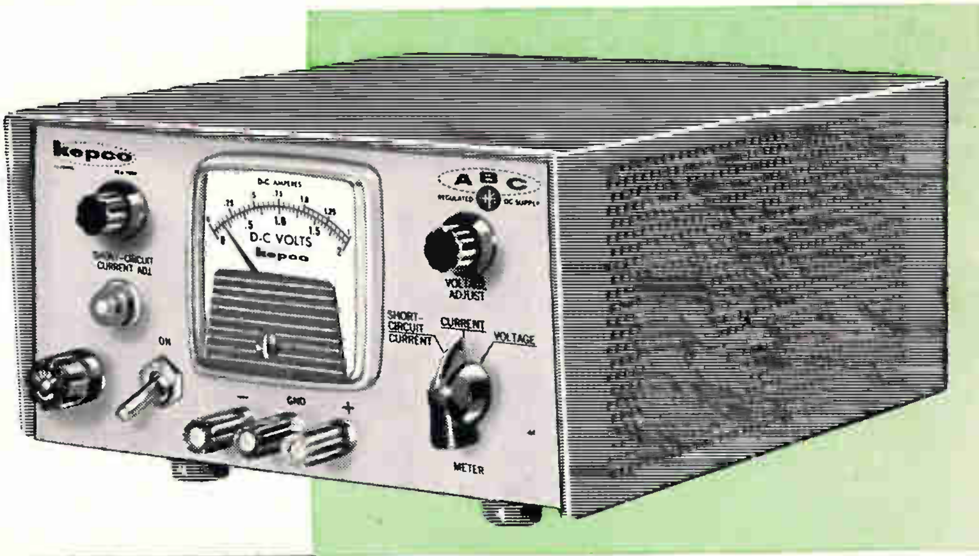

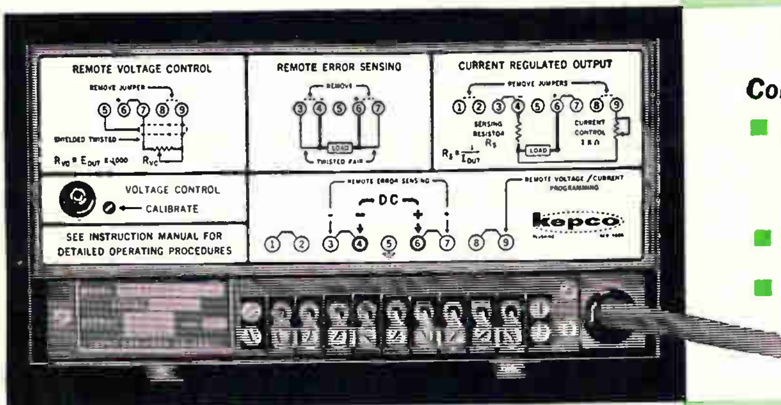

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ALL-TRANSISTOR MODELS

DC OUTPUT VOLTS	DC OUTPUT AMPS	RIPPLE RMS MV	PRICE	*METERED MODEL
0–2	0–1	0.25	$179.00	ABC 2–1M
0–7.5	0–2	0.25	159.00	ABC 7.5–2M
0–10	0–0.75	0.25	119.00	ABC 10–0.75M
0–15	0–1	0.25	159.00	ABC 15–1M
0–18	0–0.5	0.25	119.00	ABC 18–0.5M
0–30	0–0.3	0.25	119.00	ABC 30–0.3M
0–40	0–0.5	0.25	159.00	ABC 40–0.5M

HYBRID MODELS

DC OUTPUT VOLTS	DC OUTPUT AMPS	RIPPLE RMS MV	PRICE	*METERED MODEL
0–200	0–0.1	0.5	199.00	ABC 200M
0–425	0–0.05	0.5	199.00	ABC 425M
0–1000	0–0.02	1.0	274.00	ABC 1000M
0–1500	0–0.005	1.0	274.00	ABC 1500M
0–2500	0–0.002	1.0	334.00	ABC 2500M

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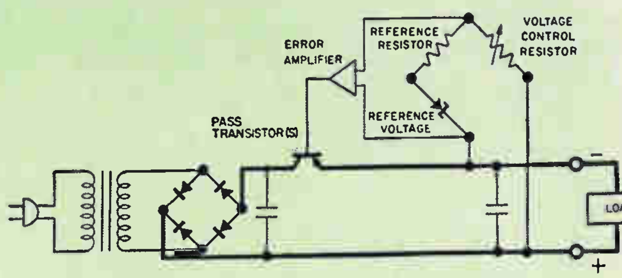
All-Transistor Circuit is illustrated below. The Hybrid Circuit is a unique design which achieves high efficiency and reliability through the use of Transistorized Reference and Amplifiers combined with a Vacuum Tube series pass element for reliable high voltage operation.



All models are designed for continuous operation without derating under all specified line, load and temperature conditions.

* **UNITS** are available without volt/amp meter; delete suffix "M" from model number and deduct $20.00 from price (ABC 2500M, ABC 1500M, ABC 1000M voltmeter only; deduct $15.00).

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DOD Unsnarling Procurement Rules

WASHINGTON—The Defense Dept, is attempting to reduce and simplify the profusion of separate and sometimes conflicting procurement instructions issued by the military services, the Defense Supply Agency and their subordinate units. DOD plans to screen procurement rules, pruning duplications and incorporating what remains into the Armed Services Procurement Regulation (ASPR).

The profusion of separately issued directives has piled up because each service laid down its own detailed supplemental instructions on how to implement ASPR. The consolidation project aims at eliminating confusion and saving money. The project ties in with another effort aimed at developing uniform contract administration procedures.

DOD hopes the revision of ASPR can be completed by the end of the year. While the consolidation is under way, the services and DSA are under orders not to issue new instructions contrary to the objectives of the project. A DOD procurement circular will be issued, probably monthly, to take care of temporary changes.

Secty. McNamara also is pressuring industry to adapt similar cost-cutting programs so that it can quote lower prices. He wants more competitive bidding for subcontracts, better manpower utilization and lower overhead costs.

Teamsters Recruiting Again

NEW YORK—The Teamsters Union's slumbering drive to organize a major share of workers in the electronics industry (p 7, Jan. 11, 1963 and p 24, Dec. 21, 1962) last week came dramatically to life when one of the largest locals of the AFL-CIO Communication Workers of America voted to withdraw from that union. A few days later the executive board of Local 1101 moved to affiliate its 10,000 members with the Teamsters.

At the beginning of the week, the CWA and the Teamsters were engaged in a bitter tug-of-war for the New York Telephone Co. employees, most of whom are equipment maintenance men. The outcome was uncertain but the struggle could have far-reaching consequences for the Teamsters and the electronics industry: if the Teamsters are successful in this drive, they will move on the rest of the Bell System, including the manufacturing plants, and eventually the electronics industry as a whole. Teamster head James R. Hoffa emphasized the importance of the campaign to his union by promising to take personal charge of it once the National Labor Relations Board sets a date for a representational election.

Government Uncovers More Excess Profits

WASHINGTON—Comptroller General Joseph Campbell has added more fuel to the controversy over whether defense contractors have been making excess profits from negotiated contracts. Campbell told Congress that for the fiscal years 1957 through 1963 his accountants found excess profits totaling $74 million on negotiated contracts involving 67 firms. More than $49 million of this amount has been recovered.

Solid-State Switches Will Pulse Radar

CAMBRIDGE, MASS.—A new approach to the generation of short-duration, high-power radar pulses will be introduced to government and industry specialists next Tuesday at MIT. MIT Electronics Systems Lab will demonstrate the modulator, which uses semiconductor and saturable magnetic switching instead of vacuum or gas tubes. Development of the technique was sponsored by the Air Force Avionics Lab, Wright-Patterson Air Force Base.

The solid-state switches operate with relatively low supply voltages. MIT expects they will have a longer lifetime and greater reliability than tubes. Size and weight savings are also expected. A circuit now in operation at MIT uses three high-power silicon-controlled rectifier switches, five saturable magnetic switches and produces pulses of two microseconds duration at one megawatt peak power.

Flat Package Proposed For Integrated Circuits

SUNNYVALE, CALIF. — Signetics has proposed a standard flat package for semiconductor integrated circuits as a possible answer to the industry's search for one with the TO-5's ruggedness, reliability and hermeticity but without the limitations posed by the TO-5's shape. Signetics' new package is ¼-inch square and is fabricated from Corning 7052 hard glass and gold-plated Kovar.

The internal pattern of the leads, imbedded in the glass walls, is similar to the TO-5, allowing standard thermocompression ball bonding and microwelding techniques to be used to connect the leads with the circuit on the chip. Internal lead length is shorter than TO-5 leads, adding shock and vibration strength.

Signetics says it has licensed suppliers to fabricate the package for any of its competitors. Corning, Ultra-Carbon Corp. and Glasstite Industries are making the packages, according to Signetics.

Relay I Transmitting After Cut-Off Date

WASHINGTON — NASA's Relay I communications satellite, scheduled to turn itself off by Dec. 31, 1963, is still transmitting. RCA built the satellite with an electrolytic material that was to have eaten away the connection between the main power lead and the solar panels and believes abnormally low temperatures have slowed down the erosion process. NASA, while lamenting the failure of the cut-off device, is making plans to launch Relay II Jan. 21—without a timer to permit the satellite to operate as long as possible.

Jodrell Bank Building 2nd Radio Telescope

LONDON — The elliptically-shaped dish on the new Jodrell Bank radio telescope is now under construction and is due for completion in early April. This second telescope, costing around $900,000, incorporates a 125-ft. elliptical bowl instead of the semicircular form used in the initial 250-ft bowl telescope. It will be computer controlled in both azimuth and elevation by a Ferranti "Argus" digital machine. Plans are in hand for a third radio telescope. This would be a transportable version with a 100-ft. elliptical bowl.

MEETINGS AHEAD

INTEGRATED CIRCUITS SEMINAR, IEEE New York Chapter; Stevens Institute of Technology, Hoboken, New Jersey, **Jan. 15.**

CHARGE TRANSFER COMPLEX SYMPOSIUM, USAF Scientific Research Labs; Denver, Colo., **Jan. 19-24.**

ANTENNA RESEARCH APPLICATIONS FORUM, Midwest Electronics Research Center; University of Illinois, Urbana, Ill., **Jan. 27-30.**

MANAGEMENT CONFERENCE, ERA; New Orleans, La., **Jan. 28-31.**

ANNUAL MEETING-SEMINAR, Precision Potentiometer Manufacturers' Association, Hollywood Beach Hotel, Hollywood, Fla., **Jan. 29-31.**

INSTRUMENTATION SYMPOSIUM, ISA North Central Area; New Sheraton-Ritz Hotel, Minneapolis, Minn., **Jan. 30-31.**

MILITARY ELECTRONICS WINTER CONVENTION, IEEE-PTGMIL; Ambassador Hotel, Los Angeles, Calif., **Feb. 5-7.**

ELECTRONIC COMPONENTS INTERNATIONAL EXHIBITION, FNIE, SDSA; Paris Exhibition Park, Paris, France, **Feb. 7-12.**

INFORMATION STORAGE-RETRIEVAL INSTITUTE, American University; University, Washington, D. C., **Feb. 17-21.**

PHYSICAL METALLURGY OF SUPERCONDUCTORS MEETING, AIMMPE Metallurgical Society; Hotel Astor, New York, N. Y., **Feb. 18.**

INTERNATIONAL SOLID STATE CIRCUITS CONFERENCE, IEEE, University of Pennsylvania; Sheraton Hotel and University of Pennsylvania, Philadelphia, Pa., **Feb. 19-21.**

NUMERICAL CONTROL PRESIDENTS' CONFERENCE, Numerical Control Society; Hotel Plaza, New York, N. Y., **Feb. 20-21.**

SOCIETY FOR INFORMATION DISPLAY NATIONAL SYMPOSIUM, SID; El Cortez Hotel, San Diego, Calif,. **Feb. 26-27.**

SCINTILLATION-SEMICONDUCTOR COUNTER SYMPOSIUM, IEEE, AEC, NBS; Hotel Shoreham, Washington, D. C., **Feb. 26-28.**

ADVANCE REPORT

ANTI-MISSILE RESEARCH ADVISORY COUNCIL MEETING, *Advanced Research Projects Agency; U. S. Naval Postgraduate School, Monterey, Calif., April 27-29; Feb. 15 is deadline for submitting three copies of manuscripts to Dr. J. Menkes, Institute for Defense Analyses, 1666 Connecticut Ave., N.W., Washington 9, D.C. Some topics include re-entry studies and experiments, environmental effects of ICBM defense, launch-phase physics, array radars, field measurements and discrimination; also tentatively these: penetration aids (including maneuvering re-entry vehicles), defense system effectiveness, terminal versus nonterminal defense system considerations.*

Electronic Device Displays Stock Quotes

NEW YORK—Trans-Lux, known for its ticker-tape projectors, last week announced an electronic display system using segmented matrix-type indicators. Called Electroquote I, the system has two 10-foot rows of indicators, each 3 inches high, the top row for stock codes, the lower for prices. The system uses sequential posting, erasing one stock at a time and then writing in a new one.

The solid-state electronics for driving the indicators includes a serial-to-parallel converter, diode matrix encoder and ring counters. The circuits, simplified because they drive only one indicator at a time, consist of less than two dozen cards.

Minuteman Contract Totals $152.6 Million

NORTH AMERICAN Aviation's Autonetics Division has been awarded a $152.6-million prime contract for continued development of the guidance, flight control and ground equipment for the Air Force's improved Minuteman intercontinental ballistic missile. The cost-plus incentive contract runs through Dec. 1, 1965. The improved Minuteman uses microelectronic subsystems (p 14, Nov. 1). Autonetics expects to subcontract two-thirds of the award.

DOD Unifies Clearances For Private Researchers

PENTAGON has made it easier for private citizens such as scholars and other researchers to gain access to classified defense information. Under a new standard ruling, private citizens will be treated as if they were civilian workers for DOD. Once they have passed a security check, including a search for criminal or subversive records or connections, they are eligible for admission to the files of any of the armed services or defense agencies. Formerly, each service section imposed its own code on outside researchers.

Cathodoluminescence Pumps Laser

WESTINGHOUSE has demonstrated a cathodoluminescent pumping technique with a solid-state laser operating in a pulsed mode. The "pump" is a crt with an internal pipe about one-half inch in diameter. The laser crystal —in this case, calcium tungstate doped with neodymium—is inserted in the pipe.

The crt has standard electron tube cathode arranged in a coaxial design. The electrons are accelerated through a high potential and bombard a special phospher film deposited on the internal pipe. The technique results in a higher net efficiency then most other methods, Westinghouse says. It also provides a means of controlling a laser over a wide range of pulse lengths and, because it is free of large amounts of heat, will permit a pulse rate higher than any previously obtained, the company says.

Laser Gives 100 mw Of Continuous Power

PERKINS-ELMER says it has developed a helium-neon laser that produces 100 mw of continuous power at 6,328 Å. The parallel twin-plasma tube configuration was attributed to a research team led by John Atwood and J. Dane Rigden. Power output from one tube is coupled with the other by precision optical prisms to produce a single high-intensity beam. The unit is 72 inches long and weighs 35 pounds.

The laser operates in a mode with a divergence of only three times the diffraction limit. When focused by an f/1 lens it develops a power density approaching 1 megawatt per square centimeter.

Conelrad Successor Goes Into Effect

WASHINGTON—A revised plan for the Emergency Broadcast System became effective last week when it was adopted by the Federal Communications Commission with concurrence of the Department of Defense and Office of Emergency Planning. The revised plan follows closely the EBS interim plan adopted last July to replace Conelrad. Under the new plan, only radio stations holding National Defense Emergency Authorizations continue on the air after declaration of an emergency. Using a combination of national, regional, state and local networks employing wire lines, f-m station relays and micro-wave circuits, appropriate levels of government have immediate access to the public in any time of stress.

Russians Complete Huge Accelerator

MOSCOW—USSR State Atomic Energy Committee took possession last week of the world's largest linear electron accelerator, a 240-meter-long tube built in a concrete tunnel surrounded by earthwork. Located at Kharkov Physio-Technical Institue, it can generate pulses of up to two billion electron volts and will be used for theoretical studies into the structure of elementary particles.

Electrons are accelerated at a frequency of 50 cps to speeds approaching that of light; designed current of each pulse is 10 ma. An undisclosed number of copper resonators, machined to accuracy of 10 microns, provides the accelerating push. Accelerated electrons are conducted to the experimental chamber by vacuum tube.

IN BRIEF

RYAN Aeronautical Corp.'s design has been selected by RCA for the landing radar to be used on LEM.

BRAZIL is now selling Mexico electronics equipment with preferential tariff treatment under a Latin American Free Trade Association agreement. Tv antennas and permanent magnets are included.

NAVY has given Ling-Temco-Vought two contracts, one for $2,266,192 and the other for $1,139,770, for the Australian - developed Jindivik target drones.

HAYAKAWA has introduced a 16-inch color tv set selling for about $553, a low for Japan.

PURDUE University engineers have developed a cable of thin inner and outer conductors backed up with thicker metals. Designed for the AEC, it can transmit a lot of information before being destroyed by a test blast, Purdue says.

SINGER CO. and Gertsch Products have signed a tentative agreement under which Singer would acquire Gertsch. Fairchild Camera has purchased Electro-Sensitive Products, Inc., effective Jan. 31. Boonton Electronics has bought Binary Electronics Inc.

ULTRASONIC device developed by Aeroprojects Inc. for the AEC quickly determines the position of the steam-water layer in a boiling water reactor, the company says. Only a corroson-resistant probe with a vibrating plate at its end extends into the reactor core.

BENDIX reports it has developed a "simple, inexpensive, multi-purpose satellite that can be adapted to a variety of experimental packages." First of the 30-sided aluminum structures went to the University of Iowa for use in NASA's Injun Explorer project.

NEW ENGLAND electronics, aerospace and nuclear propulsion industries reported declines in employment during 1963, according to the U. S. Dept. of Labor. About 7,400 jobs were lost in the electrical-electronics industries.

ELECTRONICS magazine will be one of the exhibitors at the International Electronic Components Show in Paris Feb. 7-12.

ECHO II is now scheduled for launch Jan. 23 from the Pacific Missile Range on a Thor-Agena B.

Military Spending Decline Seen in Next Fiscal Year

Military spending will begin to decline slightly in the new fiscal year starting July 1. Full details will be in the federal budget that goes to Congress January 21. The word is that the request for defense funds will be about $1 billion less than this year's $52-billion spending. Defense officials believe this marks a turning point. They foresee further small drops in defense spending over the next five years, barring some new crisis. This shift is attributed to a peaking of the strategic weapons buildup and Defense Secretary McNamara's cost-reduction program.

Military Program Cuts Include Typhon Missile

The turndown in spending could be upset by some expensive new breakthrough in military technology or new programs. However, in the coming fiscal year, the armed services face a scaling-down or rejection of a number of new programs they wanted.

Air Force wanted to begin development of two new planes: a manned, missile-firing, long-range bomber capable of low-altitude, high-speed dashes in target areas, and a new long-range air-defense interceptor. It apparently will get only a small fund to continue studies on the bomber. Air Force asked for an additional 150 Minuteman missiles; it will get 50 more, for a total of 1,000.

The Nike X antimissile missile won't go into production as Army hoped. And Army's request for new money to finance weapons modernization has been cut sharply.

Navy's new Typhon air-defense missile will not be continued. Control and guidance problems are blamed. A start will be made on a revamped and simplified version. Nor will Navy get the three extra nuclear-powered attack submarines it wanted over the six already planned for fiscal 1965.

Nonlunar Space Programs Face A Tight Year

The Administration cut NASA's budget request of $5.5 billion to $5.3 billion for fiscal 1965. A supplemental request of $150-$200 million will be made early this year, however. NASA says it needs the extra money to carry it through fiscal 1964.

The hold-down on 1965 funds means that the manned lunar program, Apollo, will get a higher percentage of NASA funds than the previous 75 percent. Non-Apollo programs have been pared back sharply. Requests for new R&D facilities that don't support Apollo have been dropped. The squeeze may force NASA to get more mileage out of its advanced synchronous communications satellite program, by using the satellite for additional scientific data collection and equipment testing.

NAS To Advise House on Federal Science Programs

A new National Academy of Sciences agreement to advise and do studies for the House Science and Astronautics Committee elevates the 100-year-old quasi-governmental Academy to new influence over federal science programs.

The Academy has been drawn upon heavily in the past by the executive departments. NAS thinking is customarily very close to the views of the White House Office of Science and Technology. Federal programs originally proposed by NAS include the interagency oceanographic program and portions of the space program.

Instead of asking NAS to evaluate federal programs that NAS helped design, the Committee expects to ask NAS for such studies as: "How is federal sicence distorted and which areas are being neglected?" "How can basic research be better applied to new technology?" and "How can promising areas for new basic research be identified for increased budgetary support?"

TECHNICAL INFORMATION

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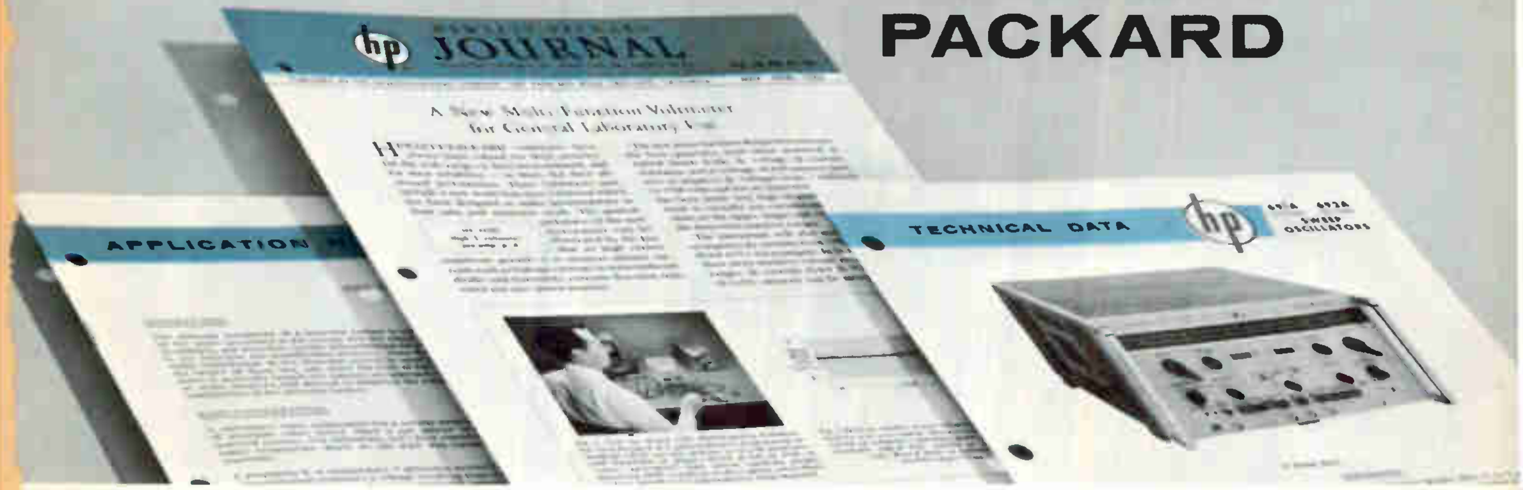

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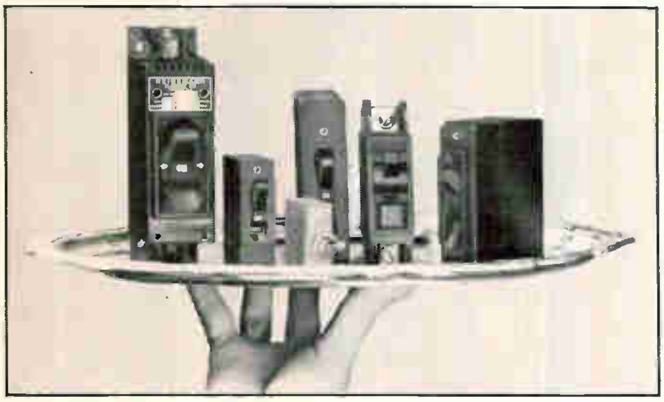

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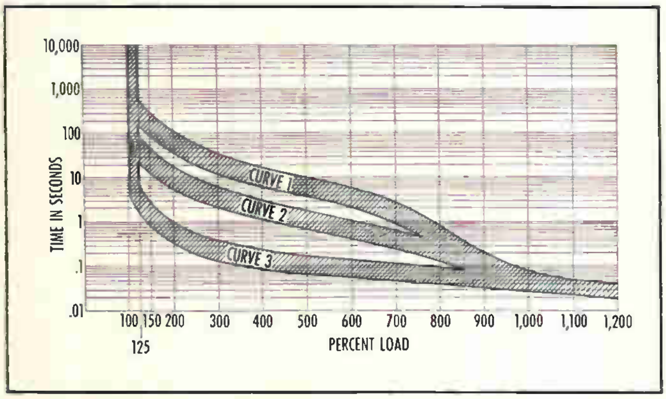

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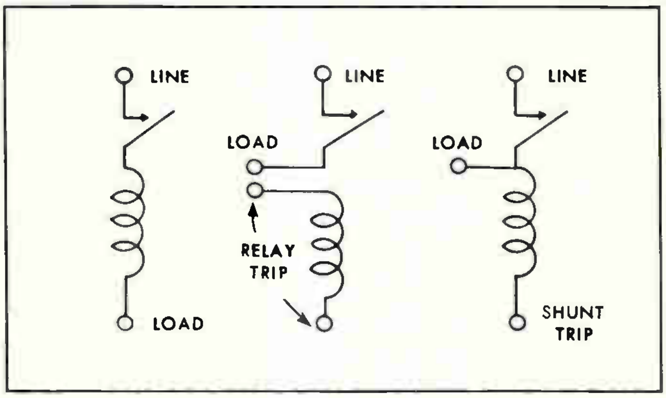

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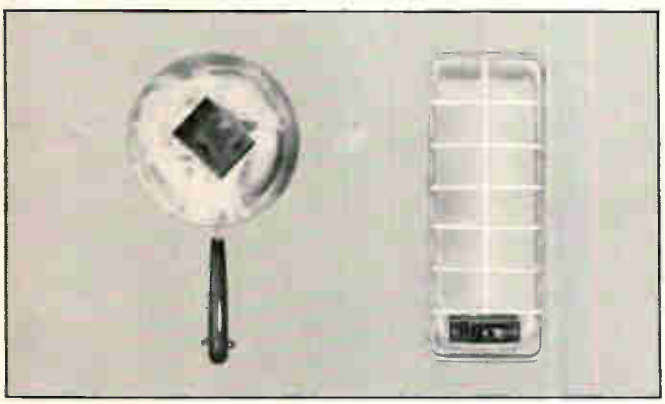

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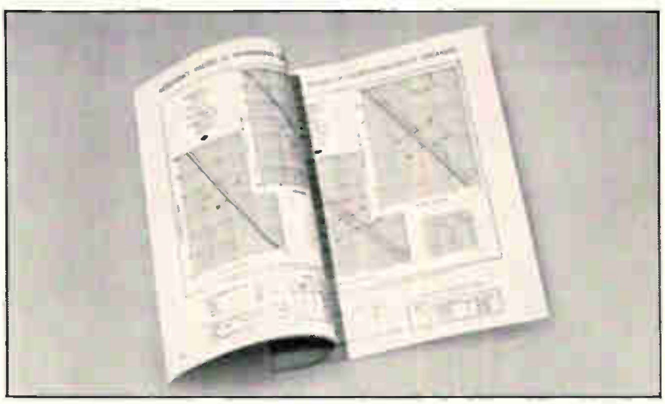

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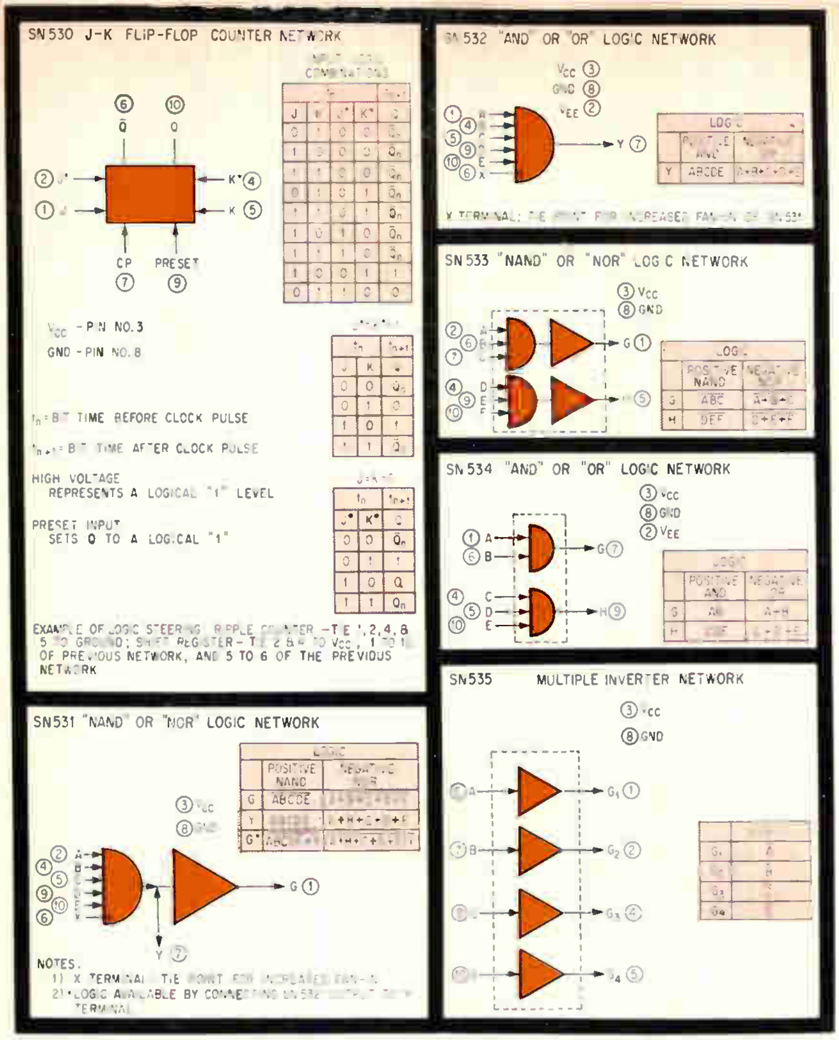

LOGIC DIAGRAMS for Series 53 semiconductor networks—Fig. 1

NEW SEMICONDUCTOR NETWORKS

Reduce System Complexity

Fabrication and design features allow 1-Mc speed of operation and fewer networks per system. Series consists of six standard devices

By **CHARLES R. COOK, JR.**
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Design Engineer

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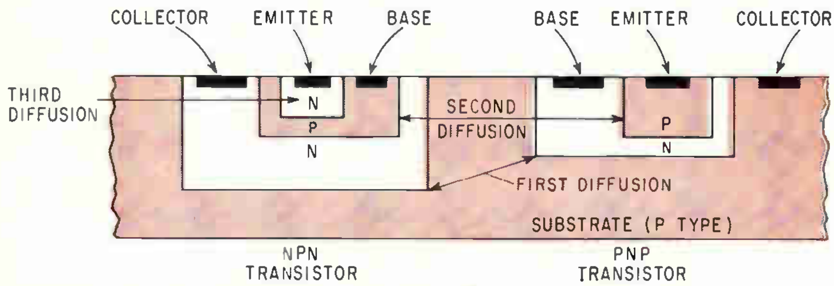
SEMICONDUCTOR integrated circuits are becoming a familiar product in design applications, particularly in the digital computer area. A new series of Solid Circuit semiconductor networks, called Series 53, has been developed that is designed to operate above 1 Mc.

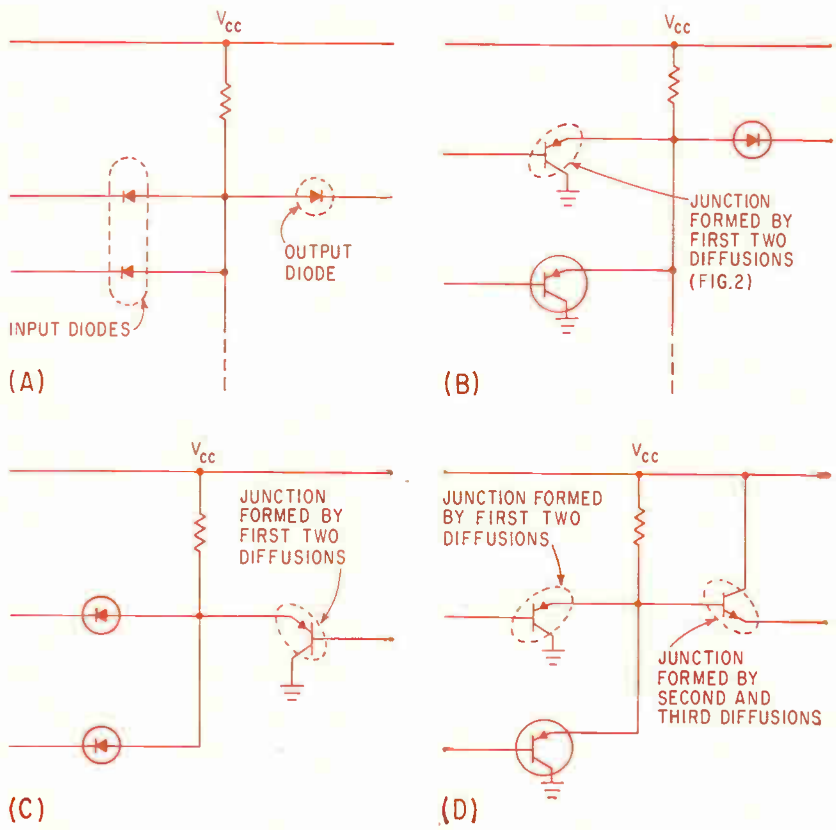
Series 53 is designed for application in general-purpose computers. Of particular note is the excellent loading capabilities of the individual networks, which together with the ability to cascade the non-inverting gates minimizes the number of units required to perform logic operation. Further, through the use of dual gates, inverter and a complete *J-K* flip-flop/shift register in one network package, system usage of networks can be often substantially reduced with Series 53 as compared to other integrated circuit types. The fewer networks required per system can have real impact on reliability—minimizing connections, size, and weight, as well as cost.

Presently, Series 53 (see the front cover) consists of six standard high-speed digital devices: SN530, a single-phase *J-K* flip-flop; SN531, a 5-input NAND gate; SN532, a 5-input AND gate; SN533, a dual 3-input NAND gate; SN534, a 2-and-3-input AND gate; and SN535, a 4-inverter package. Logic diagrams are shown in Fig. 1. Flexibility of the "master slice" concept makes it simple to add devices to the line as the need appears.

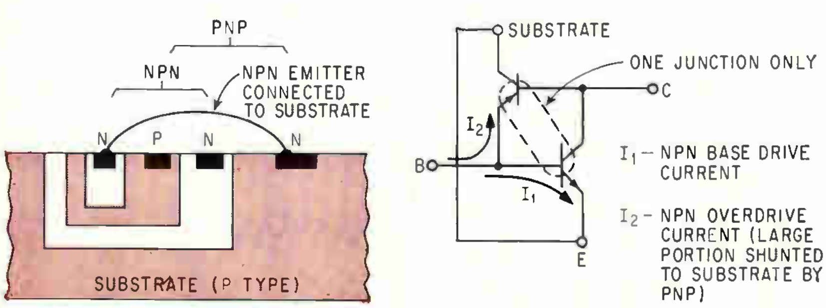
Series 53 Structure—The Series 53 uses a triple-diffused process to produce the four-layer silicon structure shown in Fig. 2. P-type starting material forms the substrate into which subsequent collector, base, and emitter diffusions are made to form isolated *npn* transistors. The collector diffusion also forms the base of the common-collector (substrate) *pnp* transistors, resistor isolation regions, capacitor areas, and crossover tunnels. The base diffusion forms *pnp* emitters, resistors, and capacitor areas. The emitter diffusion dopes a collector ring on the *npn* to reduce R_{cs}, lowers resistivity of crossover tunnels, and forms capacitor areas.



NPN/PNP triple-diffused structure—Fig. 2



DIODE AND/OR gate (A); input diodes replaced with pnp (common collector) transistors (B); output diode replaced with pnp (common collector) transistor (C); input diode replaced with pnp and output diode replaced with npn transistor (D)—Fig. 3

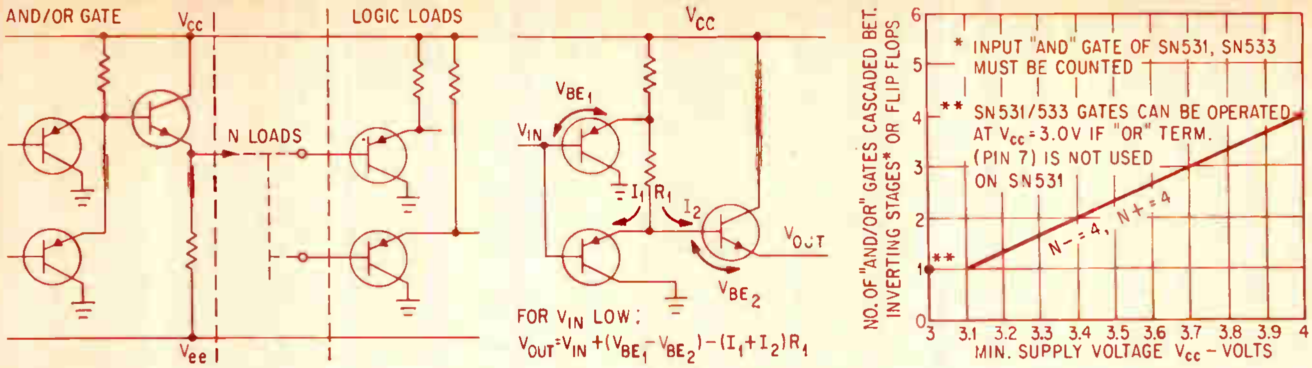


PNP ACTION in npn transistor can limit saturation—Fig. 4

The collector diffusion uses a two-step process to optimize both *npn* and *pnp* structures. In the first step, only the *npn* collectors are doped, whereas the second step dopes both *npn* collectors and *pnp* bases. This produces *n*-type collector diffusions of different depths to optimize *npn* R_{cs} and *pnp* h_{FE}. The deep region forms the collector of the *npn* while the shallow region forms the base of the *pnp*'s (Fig. 2).

The triple diffusion process produces *npn* transistors with R_{cs} of 50 ohms or less. It is possible to produce integrated transistors with improved characteristics by using epitaxial techniques, but these processes are significantly more expensive up to the point of packaging and testing. Although the cost of packaging and testing presently overshadows material preparation cost, automation of packaging and testing will soon leave material processing as the significant part of total cost. This should give the triple-diffused process a definite cost advantage.

Use of PNP Action—Present integrated circuit techniques require a four-layer structure to produce isolated transistors on a single substrate. The first two diffusions into a *p*-type substrate produce a *pnp* transistor (Fig. 2). The utilization of the substrate in forming the *pnp* structure can be helpful if these diodes (base-emitter junction of *pnp* transistor) are used for particular circuit components. For example, the junction formed by the first two diffusions may be used for gate input diodes, as shown in Fig. 3A. They will appear as "diodes with current gain" (*pnp* emitter followers) as shown in Fig. 3B. On the other hand, if they are used for the output diodes of Fig. 3A, current will be shunted into the substrate as shown in Fig. 3C. For this reason the out-



(A) (B) (C)

FANNING OUT from AND/OR gate (A); Series 53 gate input circuit (B); number of cascaded AND/OR gates permitted (C)—Fig. 5

put diodes cannot use the first two diffusions, but must use the last two (B-E junction of *npn* transistor, see Fig. 2).

If the first diffused layer of the structure (the collector of the *npn*) is connected to V_{CC} as in Fig. 3D, the output diodes will also exhibit "current gain" (*npn* emitter follower). It is possible to kill the lifetime in the base of the common-collector *pnp* so that current lost to the substrate will be small. This would allow the first two diffusions to be used for output diodes, but would also eliminate the current gain in the input diodes (Fig. 3B).

The *pnp* action inherent in a triple-diffused *npn* transistor can limit saturation. Figure 4 shows the four-layer device fabricated with three diffusions. The substrate and emitter will normally be connected together as shown. As the base-collector diode becomes forward biased, the overdrive current will be shunted to ground, thus limiting saturation. This gives the same effect as minority carriers drifting across the collector and being collected at the substrate.

Series 53 Logic—The basic Series 53 logic gate is a straightforward AND/OR gate. It is similar to diode logic, but improvements have been made by replacing the input diodes with *pnp* transistors and the output diodes with *npn* transistors (Fig. 3D). This produces a device with higher d-c input impedance and lower d-c output impedance.

The input sink currents of the Series 53 gates are considerably reduced from that of diode logic (current gain of input *pnp*'s), so that it is possible to fan out from a non-inverting AND/OR gate (Fig. 5A). In addition, resistor tolerances can be wide since variations here can be absorbed by the transistor gains. The low output impedance (*npn* emitter follower) also gives this gate the capacity to fan out to loads that require a source drive. Some of the other Series 53 devices require this type drive.

Series 53 non-inverting gates can be cascaded before restoring logic levels in an inverter. A dual transistor input circuit (Fig. 5B) is used to ensure that logic levels are maintained in cascaded gates. This is necessary to guarantee that $V_{out} \leqq V_{in}$ when V_{in} is at a low level. On the other hand, there will also be a voltage drop through the device when the input is high. This drop limits the number of cascaded gates. The number allowed depends on the supply voltage used (Fig. 5C).

NAND Gate—The NAND gate is the same as the AND gate described previously followed by an inverter (Fig. 6A). This gate has a fan-in of five, but may be increased to a maximum of twenty by supplementing it with standard AND gates (Fig. 6B). In addition, this gate may be "ORed" with AND gates by connecting the AND output to the *Y* output of the NAND gate (Fig. 6C).

The triple transistor inverting output stage (Fig. 6A) is designed to have "low output impedance" (approximately 50 ohms) for both source and sink loads. Source currents are supplied by the *npn* emitter follower when the output voltage is high, while sink currents are shunted to ground by the saturated common-emitter transistor when the output voltage is low. The same output stage is used on all Series 53 inverting outputs.

Flip-Flop—The Series 53 flip-flop operates on a single-phase clock and performs *J-K* logic. (See Fig. 1.) A *J-K* flip-flop is one in which simultaneous application of logic "1"s at the inputs results in a defined change of state. All logic states are defined and no indeterminate condition

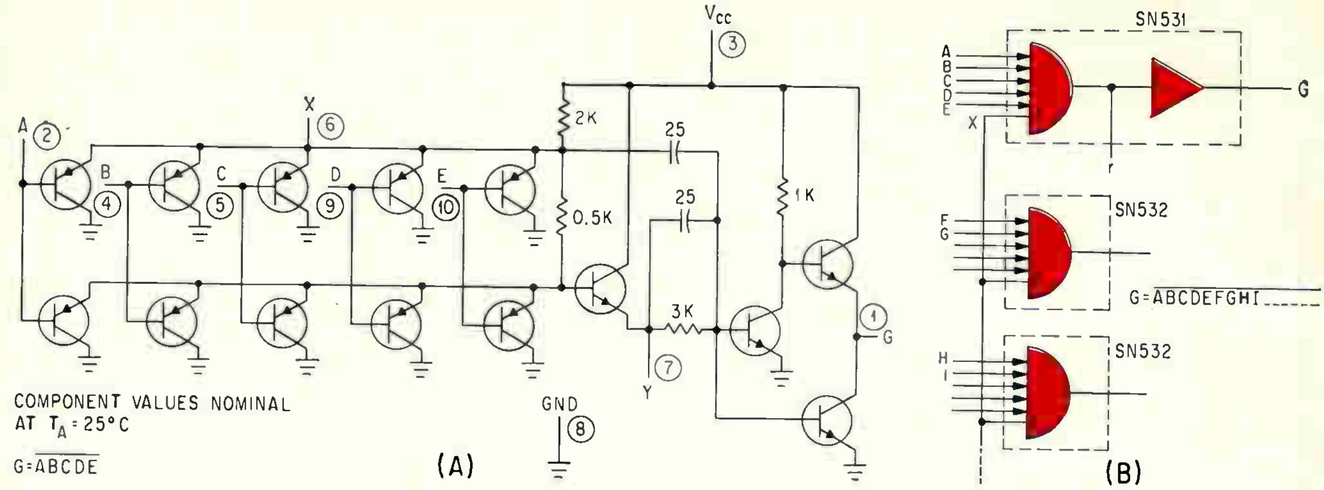
Maximum Output Drive Capability of Series 53 Networks—TABLE I

	Max. Allowable Loading	
	N^+ Loads	N^- Loads
SN530 Output	10	10
SN531 [1]		
Inv. Output	10	10
Y Output	2	4 [2]
SN532 Output	4	4
SN533		
Each Gate Output	10	10
SN534		
Each Gate Output	4	4
SN535		
Each Inverter Output	10	10
4 Inv. in Parallel	40	40

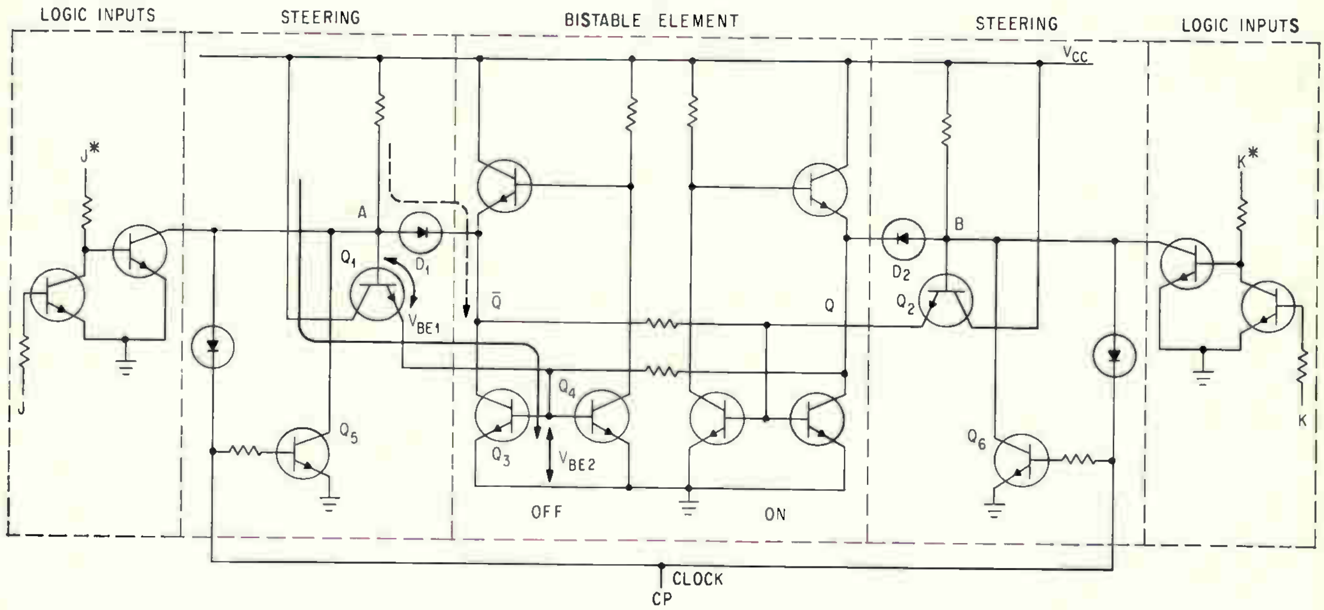
[1] If both the inverter and Y terminals are being used as outputs, maximum loading from both is allowed [2] n^- fan-out is allowed only if the Y output is being "ORed" with an SN532 or SN534

Weighted Value of Loads Represented by One Input of Particular Series 53 Network—TABLE II

Network	Weighted Value of Each Input	
	n^+ Loads	n^- Loads
SN531, 532, 533, 534	0	1
SN531 (Inverter Only)	2	1.5
SN532, 534 Outputs (Output appears as a load when performing "OR" function)	0	1.5
535 (Each Input)	2	0
535 (4 Inv. in parallel)	8	0
SN530 (Logic Inputs)	1	0
Clock Pulse	2.5	2.5



SN531 NAND logic gate (A) can have fan-in increased by supplementing with AND gates (B). In addition, the gate may be as shown in (C)—Fig. 6



SN530 J-K flip-flop consists of bistable element, steering and and logic input sections—Fig. 7

exists. Such *J-K* flip-flops have been widely used in logic design, but have not previously been available in integrated form. Complementary inputs have also been provided, so that full *J-K* operation can be obtained for positive and negative logic. In practical designs, use of the complementary inputs will result in a substantial reduction in the number of gates or inverters required.

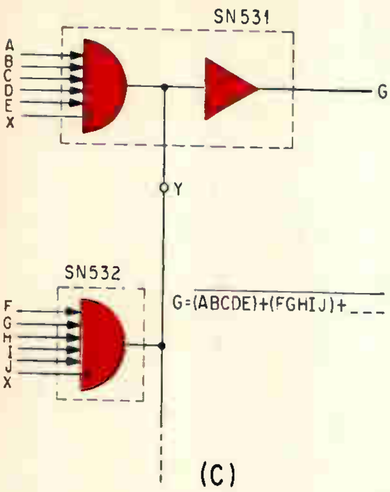
The *J-K* flip-flop has been designed to operate without the conventional storage capacitors. Intermediate storage is provided by control of propagation through the input stages rather than a precise *R-C* circuit, permitting reliable operation at high speeds. Circuit operation can best be understood by dividing the flip-flop into the three basic sections shown in Fig. 7—the bistable element, steering, and logic inputs.

Bistable Element — The bistable element is composed of two low-impedance inverters with *R-C* cross coupling. Both Q and $\overline{Q}$ outputs, therefore, have good drive capabilities for both source and sink loads. Output stages of this type with large voltage swings not only provide good drive sources for other devices in Series 53, but also are excellent for driving capacitive loads and various interface loads.

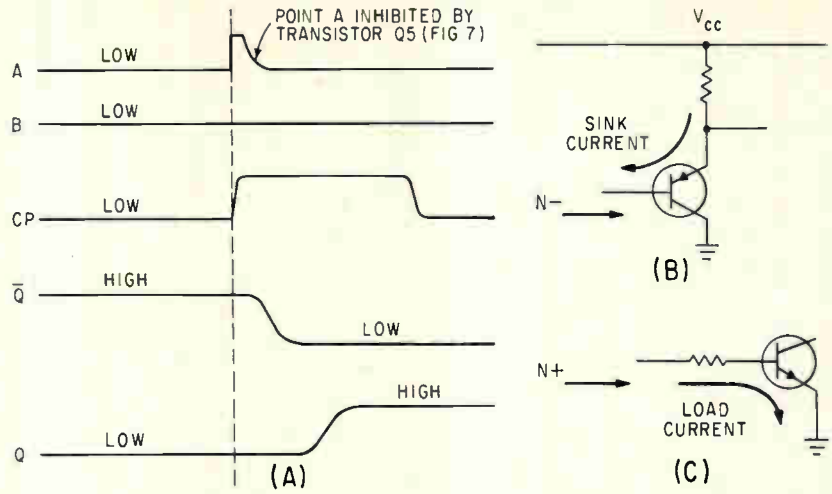
Steering — The flip-flop uses a unique steering method that does not require input capacitors. Turn-on switching action is controlled by the bases of common-collector transistors Q_1 and Q_2—points *A* and *B* respectively. For analysis, assume that output $\overline{Q}$ is high. Since this is a turn-on circuit, the device may be switched by steering the clock pulse (*CP*) to apply drive current to the bases of Q_3 and Q_4. In other words allowing point *A* to assume a level $V_A = V_{BE1} + V_{BE2}$. Disregarding transistors Q_5 and Q_6, an equation may be written describing the logic for points *A* and *B*:

$$A = (J + J^*)\,(Q)\,(CP)$$
$$B = (K + \overline{K}^*)\,(Q)\,(CP)$$

Notice that switching is dependent



"ORed" with AND gates connected



FLIP-FLOP switching waveforms (A); n− load (B) and n+ load (C)—Fig. 8

Component Count—TABLE III

Transistors		
Type	Quantity	
npn	28	
pnp (common collector-substrate)	10	
Capacitors		
Value	Quantity	
25 pf	4	
15 pf	1	
Total capacitance—115 pf		
Resistors		
Value	Quan.	Taps
8 k	2	1.5–1.5–5.0
4 k	2	1.0–2.0–1.0
4 k	2	1.5–1.5–0.3–0.7
3 k	2	1.5–1.5
3 k	4	2.0–1.0
2.5 k	2	1.0–1.0–0.5
2.0 k	2	1.0–1.0
3.9 k	2	1.5–0.25–0.15–2.0
0.7 k	2	None
0.3 k	6	None

Total resistance—70.0 k
Tunnels (crossover paths)—13
(In addition, capacitors may serve as tunnels)

on the present state of the flip-flop (outputs Q and $\bar{Q}$) as well as the logic inputs—thus *J-K* action.

For d-c stability, points *A* and *B* cannot be allowed to assume a high level together. For this reason, transistors Q_5 and Q_6 are used to inhibit points *A* and *B* respectively a short time (propagation delay) after the occurrence of a positive clock pulse. Voltage waveforms (Fig. 8A) show the time relations of points *A*, *B*, clock pulse (*CP*), and outputs Q and $\bar{Q}$ when switching output $\bar{Q}$ from off to on.

Transistor Q_1 serves as a low-impedance drive to the bases of Q_3 and Q_4 to turn the inverter on (solid line in Fig. 7). Once the inverter is on, however, base current is diverted from Q_1 by clamp D_1 (shown by the dotted line), so that the overdrive is reduced.

Logic Inputs—Flip-flop logic inputs are common-emitter stages. Complementary inputs are supplied on both *J* and *K* for increased versatility. Intermediate signal storage on the *J* and *K* inputs is sufficient for reliable shift register operation. These steering inputs require a d-c drive source and can be driven from either inverting or non-inverting gates.

Series 53 Loading—In general there are only two types of d-c loads that must be considered:

n^- load—requires a current sink (Fig. 8B).

n^+ load—requires a current source (Fig. 8C).

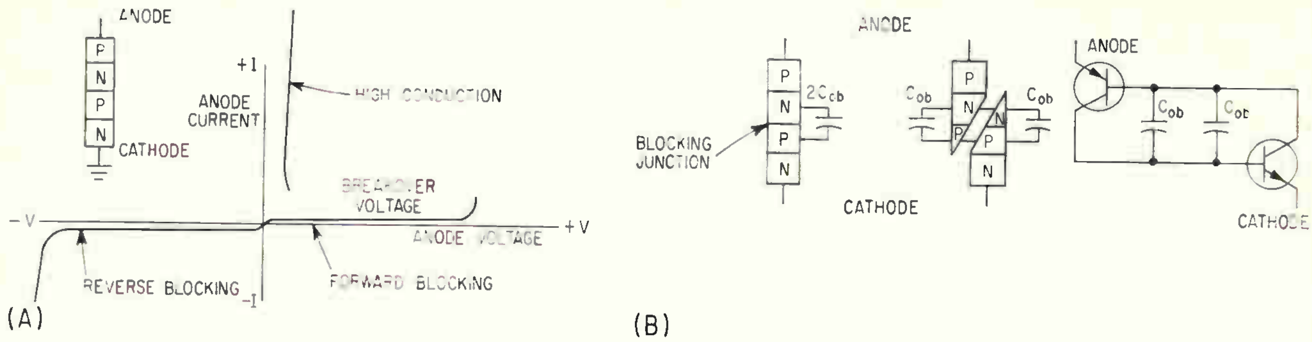
The Series 53 has inputs that require both of these type drives. For example, the gate inputs require a driver to act as a current sink only (n^- load) while the flip-flop steering inputs require a driver only to supply current (n^+ load). If a driver can act as both a sink (output voltage low) and a source of current (output voltage high), then it can drive both types of load. Each Series 53 output and input is rated for n^- and n^+ drive capabilities (Table I) and drive requirements (Table II), respectively. All possible combinations of loads can be recognized by using these two tables.

Master Slice—The Series 53 master slice component count for each 65 × 150 mil bar is given in Table III. Each component is isolated and all interconnections are made with evaporated aluminum. The large number of components available makes it possible to place complex circuits on a single bar without bonded interconnections.

None of the circuits use all of the components, but some use more than others. The relative difficulty of producing a working circuit is dependent on the total junction area used and the area of surface covered by aluminum.

Circuits produced on the master slice require widely differing combinations of component specifications and tolerances. For example, one circuit may require low R_{cs} *npn* transistors while it can tolerate wide resistor tolerances. On the other hand, another circuit may require closer tolerances on resistors but may not be critical on *npn* R_{cs}. The master slice concept permits assignment of the best material to each of these circuits without loss of any material. In addition, a single device may have different evaporated lead patterns which may be used to select resistor taps and thereby adjust resistance values if resistors are running high or low.

Given this flexibility, it is possible to use resistors with tolerances of ± 50 percent, *npn* h_{FE} from 15 to 1,000, *pnp* h_{FE} from 0 to 1,000, and R_{cs} up to 300 ohms. In short, it is possible to use all material that is ready for evaporated aluminum leads. This is a distinct advantage of the master slice fabrication technique.



PNPN anode characteristic (A); transistor analog (B) breakdown into equivalent circuit with junction capacitance—Fig. 1

How To Suppress Rate Effect

four-layer devices can turn into a bind if inadvertent triggering defeates the circuit

OVER ANOTHER HURDLE

Circuits using pnpn devices, such as four-layer diodes, silicon controlled rectifiers and silicon controlled switches, may switch prematurely if anode voltage is applied suddenly, or if subjected to high frequency transients. Methods to prevent rate effect usually sacrifice switching speed, recovery time or triggering sensitivity. Rate effect and its mechanism, and device and circuit techniques to minimize it are discussed, along with a design approach which eliminates rate effect entirely in many applications

By **RICHARD A. STASIOR**
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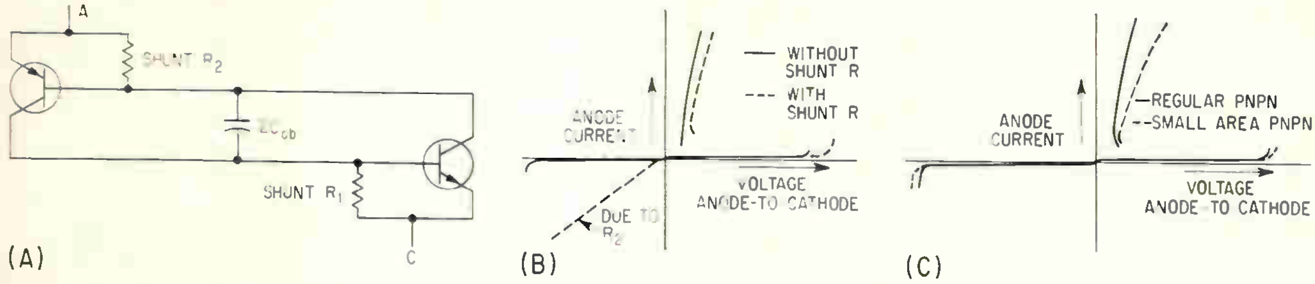
THE PHENOMENON of a *pnpn* device switching into high conduction due to a sudden increase in anode voltage is rate effect (RE). Anode voltage transients can have many sources such as power turning on, relay or switch contacts bouncing or hash on power lines. Even *pnpn* devices themselves may generate transients capable of switching on other devices. On d-c, where *pnpn's* are used for their latching or memory capability, reset pulses may retrigger the devices.

Figure 1A shows a typical *pnpn* characteristic. With the anode positive with respect to the cathode, the *pnpn* may either block voltage or conduct heavily. The reason for this ambiguity is seen by analyzing the *pnpn* in terms of the two-transistor analog shown in Fig. 1B. The transistors are connected in a positive feedback configuration, that is, the collector current of one transistor is amplified and returned as base drive by the other transistor. If the effective transistor betas are low enough that $(\beta npn)\ (\beta pnp) < 1$, the feedback is insufficient for regeneration and the transistors block. If $(\beta npn)\ (\beta pnp) \geqq 1$ switching occurs into the high conductance region. While the *pnpn* is blocking, the anode current is essentially the leakage current of the blocking junction. The transistor betas are low at this low current level. If the anode current were raised, beta would increase rapidly permitting regeneration to begin.

In Fig. 1B, the blocking junction capacitance is pictured as transistor C_{ob}. As the anode voltage is increased C_{ob} is charged by current through the two outside junctions. The capacitor charging current is also base current for the transistors. The resulting collec-



INCREASING I_Q critical with shunt resistors (A); anode characteristic (B). Reducing area decreases C_{ob} (C) —Fig. 2

In PNPN Devices

The leeway allowed circuit designers by design. The most common of components, the resistor, comes to the rescue

tor currents may raise the betas sufficiently to cause switching. For a linearly rising anode voltage the charging current $i_Q = C_{ob}\ dv/dt$ indicates that i_Q and therefore the base currents can be reduced by slowing down the rising anode voltage. As long as i_Q remains below some critical value the *pnpn* will continue to block. Through device design C_{ob} can be minimized or i_Q critical increased to insure blocking. Through circuit design dv/dt is controlled and in some cases i_Q critical also.

This equation suggests that even a low amplitude voltage transient, if fast enough, could reach i_Q critical and turn-on the device. This is not the case, however, as is evident if the transistors are considered as charge-controlled devices. The current i_Q must be applied long enough to establish sufficient charge in the base regions to bias the transistors well into their active high beta regions. The charge required is inversely proportional to the frequency response of the transistors. The charge control concept explains why every *pnpn* device has a minimum anode voltage which can be applied instantaneously without causing switching.

Minimizing Device RE — *pnpn* devices minimizing rate require special design which invariably compromises other characteristics. The transistor analog of Fig. 1B is useful in suggesting special designs and in evaluating their performance. For example, the resistors shunting the emitter junctions in Fig. 2A, divert the capacitor charging current from the transistors, raising i_Q critical. While shunt resistors can readily be designed into a *pnpn* structure they decrease triggering sensitivity and increase holding current. The resistor across the *pnp* emitter also increases leakage during reverse voltage biasing, Fig. 2B.

Lowering the center junction capacitance through reducing the area of the *pnpn* minimizes rate effect. The lower capacitance is offset somewhat by beta peaking at a lower current in a smaller device. The smaller area also reduces thermal mass for surge currents and raises the forward voltage as indicated in Fig. 2C.

Reducing transistor f_T by widening the base regions raises the charge required to turn them on. This, in turn, raises i_Q critical, but only at the expense of lower turn-on sensitivity, and lower turn-on and recovery time. Poorer turn-on sensitvity is due to the low beta which correlates with wider base regions. Turn-on time is slower because of lower frequency response in the regenerative loop. The wider base regions store more charge resulting in slower recovery time.

Minimizing Circuit RE—The simplest and most common method for avoiding rate effect uses a capacitor to apply anode voltage gradually. Figure 3A shows the anode waveform of a basic silicon controlled rectifier (SCR) flip-flop. The SCR gate-lead simplifies the circuit and does not invalidate the earlier discussion based on two-terminal devices. As one SCR turns-on, it turns-off the other by a negative pulse coupled to the anode. As the anode voltage across the off SCR rises, the capacitor not only controls the rate, but also gives the slowest rate at high voltage where the SCR is most sensitive. Resetting an SCR with the similar circuit in Fig. 3B may cause rate effect triggering. Pushing the reset button turns-off the SCR but releasing it raises the anode above the supply voltage instantaneously to a value dependent on the resistor ratio. This transient rise may turn-on the SCR either by rate effect or by exceeding the breakover voltage.

The *pnpn* devices can be designed to have shunt resistors across the emitter junctions, minimizing the gate-to-cathode impedance, which often improves performance. At high temperatures where leakage tends to turn-on a *pnpn*, an inductor from gate to cathode (Fig. 4A) shunts the leakage well. This is one reason for the popularity of transformer coupled triggering circuits. On the other hand, the transformer inductance does not shunt the gate during a rapid rise in anode voltage. A capacitor offers better rate-effect suppression, Fig. 4B.

A shunting impedance may prove ineffective in large-area devices since the shunting effect is limited only to the vicinity of the gate lead. The narrow layers of high-frequency devices exhibit high sheet resistance which also limits the shunting effect. In other cases the built-in shunting resistors are so effective that additional shunting is inconsequential.

A natural extension of shunting is to reverse bias the gate junction. Since the capacitor charging current must overcome the bias before regeneration can occur, I_Q critical is raised considerably. More important, the entire junction can be reverse biased regardless of the gate layer sheet resistance.

Eliminating Rate Effect—A different approach to eliminating rate effect is made possible by using such silicon controlled switches as the 3N58, 3N59, and 3N60. These *pnpn* devices have leads connected to all four layers, allowing connection to the *n* region next to the anode which is not available in conventional SCR's. Figure 4C shows a typical SCR circuit with a capacitor (*C*) to control the rise of anode voltage. The waveform (Fig. 4D) shows the SCR triggered at *A*. At *B* the reset button is closed permitting the SCR to recover. Opening the button at *C* allows the anode voltage to rise. Regardless of the length of time between *B* and *C* the anode voltage must still be applied gradually. This is implied by the dotted waveform shown at *C'*.

Figure 5A shows the same function performed by the four-leaded silicon controlled switch (SCS). The device is set and reset in identically the same manner as is the SCR in Fig. 4C. The only change is to add a single resistor (R_{GA}) from the *n* region to the anode voltage supply. For convenience, and by analogy to the SCR gate, this *n* region is referred to as the anode gate.

The SCS is triggered on at *A*, Fig. 5B. At *B* the reset pulse is applied. At C the reset button is released allowing the anode voltage to rise abruptly. This is permissible because the blocking junction capacitance (2 C_{ob}) is charged up prior to the rise in anode voltage. The dashed anode-gate waveform superposed on the anode waveform indicates that the voltage drops simultaneously on both leads when the device is triggered on. The anode gate remains a fraction of a volt (V_{sat} of the *npn* transistor) off ground while the device conducts. At point *B* recovery begins and is completed at *B'*.

The equivalent circuit at this time is as shown in Fig. 5C. With the anode grounded *pnpn* characteristics cannot exist. The *npn* portion is now in effect an *npn* transistor without base drive. Consequently the collector rises to the supply voltage, charging C_{ob} as it does so. Releasing the anode results in a slight further charging of C_{ob} by the anode junction capacitance, but this occurs before the device regains its *pnpn* characteristics. Thus the anode voltage may rise as abruptlv as desired with rate effect problems nonexistant. This uses fewer components and is lower in cost than any other way of suppressing rate effect.

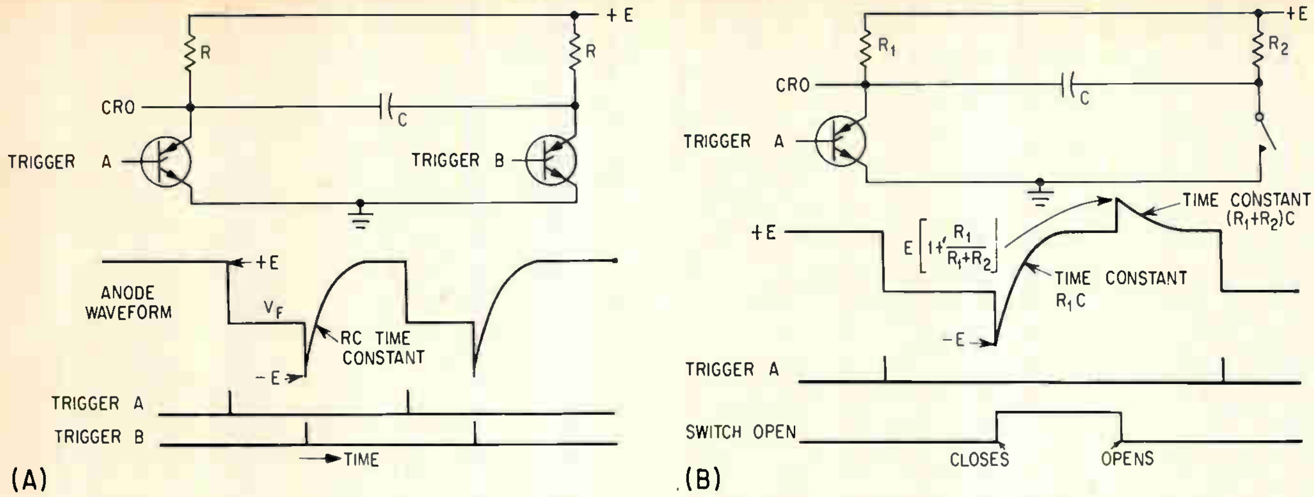
Practical Solutions—As a fringe benefit, completely charging C_{ob} in this way allows the use of high frequency device geometry to give fast turn-on time and minimum charge storage volume for fast recovery. Resistor R_{GA} is chosen to give a short time constant with the blocking junction capacitance. This capacitance is less than 5-pf in the 3N58 series of silicon controlled switches permitting anode voltage to be reapplied within two microseconds of recovery if R_{GA} = 100,000-ohms. Since R_{GA} shunts the anode junction, its effect on triggering sensitivity must be considered. The 3N58, characterized to trigger at a maximum gate current of 1 μa, will trigger at less than 5-μa if R_{GA} = 100.000-ohms.

If positive transients on the anode power supply are a problem, returning R_{GA} to a more positive voltage will suppress them. Using R_{GA} = 100,000-ohms and 10-volts reverse bias on the anode, the triggering current will not exceed 20-μa.

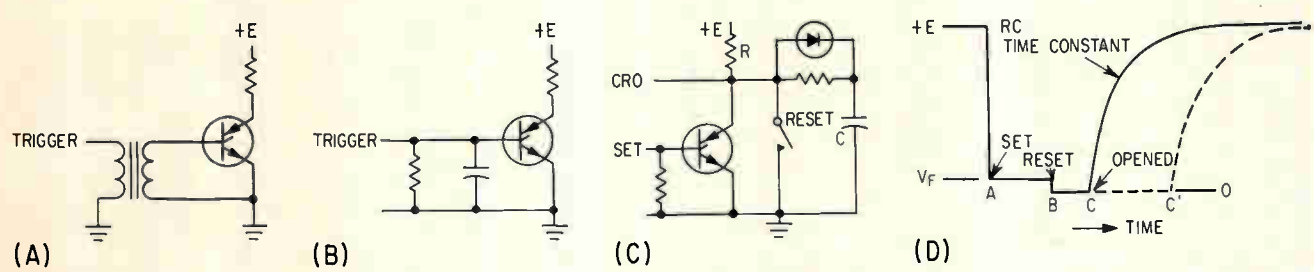
Some practical circuits will illustrate how rate effect can be eliminated. Figure 6A shows a basic SCR latching circuit such as might be used to latch on a lamp whenever an input-voltage level is exceeded. Resetting the circuit by opening the anode supply lead exposes the SCR to fast transients and possible turn-on due to rate effect. Adding the 100,-000-ohm resistor (Fig. 6B) and using a four-lead device permits the switch to reclose arbitrarily fast. By returning the 100,000-ohm resistor to +24 volts, Fig. 6C, spikes up to 12-volts amplitude on either supply cannot turn-on the SCS.

The natural extension of this circuit, to a multiple-input voltage-sensing circuit, is shown in Fig. 6D. The voltage as several inputs can be monitored. If any input exceeds the threshold voltage the relay is pulled-in to sound an alarm or to shut down the equipment. Simultaneously with the relay pulling-in, a lamp lights to indicate the input responsible for pulling in the relay. In this circuit the lamps reduce triggering sensitivity substantially but on the other hand they suppress rate effect. Using a 3N60 offers greater uniformity between devices, resulting in more uniform triggering.

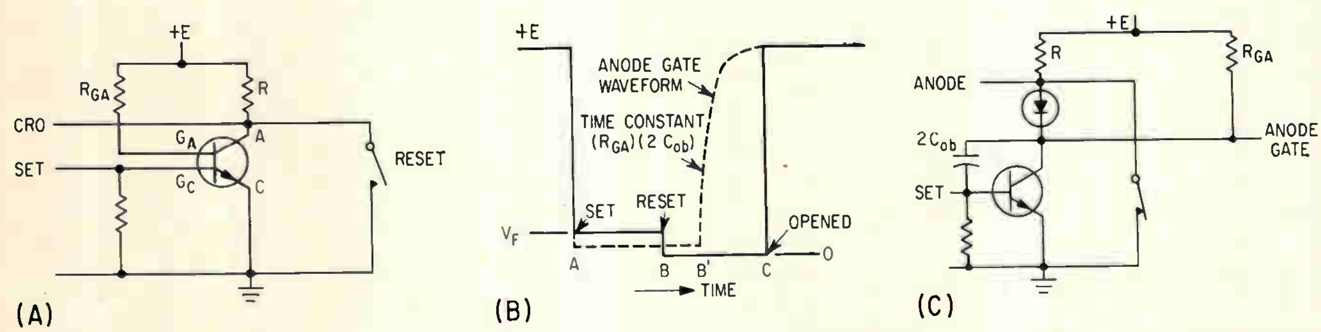
Conclusion—By having all four layers of a *pnpn* structure accessible to the circuit designer the 3N58 series of silicon controlled switches permits complete suppression of inadvertant triggering by rate effect. This is accomplished without sacrificing device switching speed, recovery time, or triggering sensitivity. Total cost of suppressing rate effect is that of one low wattage resistor, whose value is independent of the other circuit parameters.



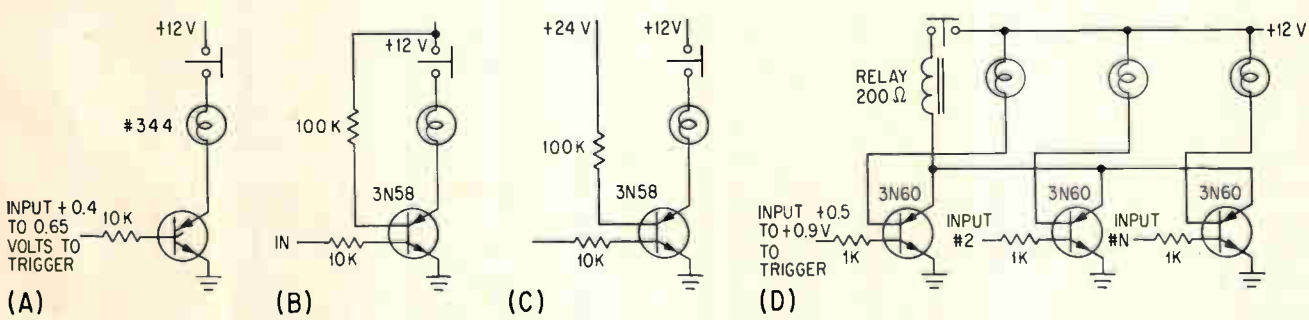
SCR flip-flop avoids rate effect (A) which affects circuit with mechanical reset of silicon controlled rectifier (B)—Fig. 3



GATE BIASING of silicon controlled rectifier circuit for d-c stability at high temperature (A); suppression of rate effect (B). Mechanical reset for rate effect suppression (C) by using capacitor to control anode voltage rise; waveforms (D)—Fig. 4



SUPPRESSING rate effect using a four-lead pnpn (A), and waveforms (B). Equivalent circuit, switched closed (C)—Fig. 5



LATCHING CIRCUITS of basic SCR type (A); with rate effect suppressed (B); and with both transients and rate effect suppressed (C). Multiple-input voltage-sensing circuit (D) with both audible and lamp alarm provisions. Lamps reduce sensitivity substantially, but on the other hand they suppress any rate effect—Fig. 6

LOW-COST DIGITAL

By **F. J. GOLDWATER**
Dept. of Meteorology,
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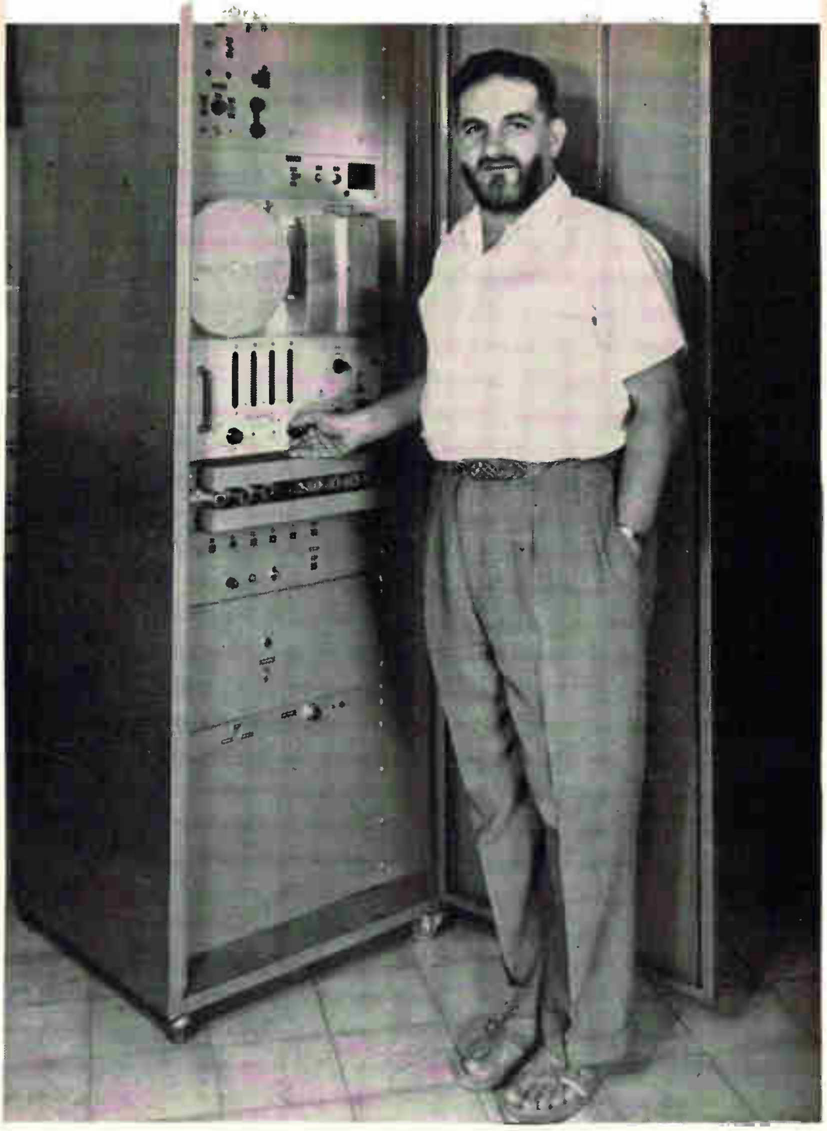
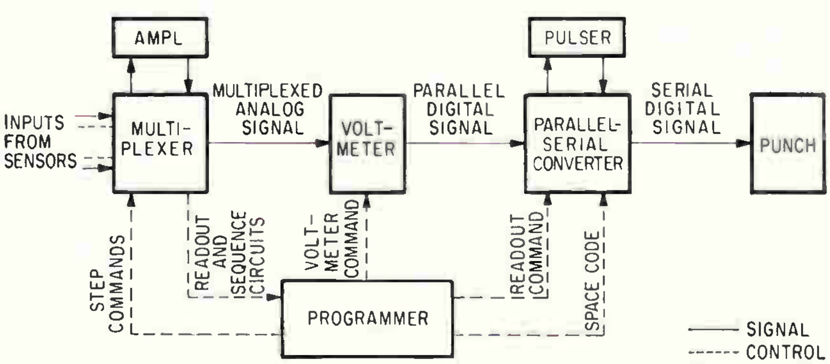
Jerusalem, Israel



AUTHOR adjusting the digital voltmeter

TREND IS REVERSED

The trend towards bigger machines to do our work sometimes continues because of momentum, despite the fact that the task may call for a relatively simple and inexpensive system. More often than not, by minimizing complexities a better system is evolved. The author has accomplished this with his new meteorological data recording system that features simplicity of operation and low-cost. As a result high reliability is ensured



METEOROLOGICAL data recording system uses digital voltmeter as an analog-to-digital converter—Fig. 1

DIFFUSION of aerosols in the atmosphere may be determined by direct measuring techniques,[1] but Sutton[2] and Pasquill[3] have proposed certain assumptions from which such diffusion may be predicted by measurement of meteorological parameters. This method requires measurement of wind speed, wind direction, and temperature variation with height. In particular, the average wind velocity for a given period must be determined and the rms deviation from this vector computed, as must the average temperature at each of several heights. In most cases these data have been obtained by reduction from graphical recordings; in some cases analog-digital conversion has been applied to standard analog recorders.[4]

Digital systems specifically designed for meteorological research have been built[5] and analog computing techniques have been applied prior to actual analog recording.

Analog computers are simple and effective but must be applied in some definite formulation and do not permit a rerun of data with a change of computing program. An additional difficulty involves the prediction of average wind direction to provide a base line from which to measure deviation.

These considerations led to the choice of digital recording in a form suitable for direct input to a computer which is programmed to perform the necessary computation. By making changes in the computer program, the same set of data may

SYSTEM Records Weather Data

Medium-speed apparatus uses stepping switch as multiplexer, digital voltmeter as a-d converter, one amplifier for all sensors. Temperature is measured with a resistance bridge

be used as a basis for different computations; for example, the calculation of diffusion according to Pasquill[3] or Sutton.[2]

Operation—Commercially available systems were found to be complex and costly. Therefore a simplified system was designed providing for inputs from five wind and five temperature sensors to be mounted at five different levels on a tower. The sensors have time constants ranging from 5 to 20 seconds and the scan time for a complete recording cycle is 15 seconds, providing a certain amount of preliminary filtering. The output of each sensor is connected to a digital voltmeter by a multiplexer. Then the output of the digital voltmeter is applied, through a parallel-serial code converter, to a paper-tape perforator that records the data. The same system may be used to drive a card-punch or automatic typewriter. Figure 1 shows system operation.

Components—A synchronous motor-driven multiple switch (programmer) provides both timing and programming. This device commands the multiplexer to advance to the next sensor.

For the multiplexer, a telephone-type stepping switch was chosen. The large number of switch points and levels provide flexibility and asynchronous operation allows for variation of the system program. The absence of offset voltages and the extremely high ratio of open-to-closed circuit resistance allow such a switch to be used and thus permit the use of a single d-c amplifier for the entire system. Gold-plated contacts are used for the low-level circuits to eliminate spurious emf's and corrosion problems. The high-level signal circuits handled by the switch look into the high-impedance voltmeter input, eliminating the effect of small changes in contact resistance.

A single d-c amplifier is used for amplifying the output of all the low-level sensors to the 1-volt full scale range of the digital voltmeter. This unit (Airmec Model No. 855) has a relatively long time constant of 0.5 second and is connected to the thermometer outputs during the readout of the wind sensors to allow settling to the proper reading. Since the units are to be installed at levels on the tower with maximum temperature differentials of 3C, the provision of a settling time of 2.5 seconds assures a negligible error of 0.02C in the worst case. The wind sensors are adjusted to provide the required 1-volt full-scale output and require no amplification.

Instrument—The voltmeter (Beckman/Berkeley Div. Model No. 535ORH) is keyed by the programmer. This voltmeter was chosen because of its relatively low price and fast operation. A reading is obtained within 20 msec and so this operation may be assigned a time interval during which no other operation is occurring thus reducing transient suppression problems. The voltmeter provides a sign code and a binary-coded output of three decimal digits, 4 lines per digit. The sign code and these three 4-line groups are scanned one by one by relays operated by the programs. The output of this relay converter is applied to a switching and pulse generating network to provide the necessary driving pulses on the appropriate inputs of the tape punch. This unit (Tally Model No. 420) has an operational speed of 60 lines per second. The low punch time permits sequential code conversion and the code converter is restored to its non-operative state after punching.

The d-c power required by the stepping switch, relays and tape perforator is supplied by a regulated power supply consisting of four 12.5 volt units connected in series. This construction reduces peak voltages and power dissipation for the transistors used.

Provision is made for a daily check to be performed manually, with appropriate test circuits for each section of the equipment selected by switches. Since five sensors are used for each parameter, and the values of these parameters must follow a definite curve, a sensor drifting badly out of calibration is quickly located.

Sensors — The choice of sensors posed certain problems. Even the smallest commercially available resistance thermometer elements have relatively long time constants. That used (Degussa P 4) consists of a platinum element sealed in a glass envelope 2 mm diameter by 25 mm long. This unit has a time constant of 26 sec in still air, which is just fast enough for the total scan time of 15 sec for the system. Faster response could be obtained by the use of fine-wire resistance elements without the protective glass covering, fine-wire thermocouples, or very small thermistors. Our experience and that of other investigators[1,5] has shown that none of these other solutions is satisfactory.

Installation of a variable-resistance temperature sensing element at the top of a tower that may be as high as 125 m and 50 to 100 m from the instrument shed, poses certain problems. The standard three- and four-wire compensated bridge circuits are satisfactory only when continuously balanced. Such balancing is normally accomplished by servo-methods and the temperature read out by the position of the slider on the variable resistor used for balancing. It was decided that such a system would be overly complex. What was desired was a circuit in which the output voltage would be proportional to the temperature.

At first this indicated the use of a constant-current source with separate current feed and voltage pick-off conductors to eliminate the effect of the variation of the lead resistance with temperature. The output voltage of the 100 ohm (0 deg C) unit would vary from 100 to 119.4 mv with the maximum allowable current of 1 ma. To obtain an output proportional to temperature would require a second regulated 100 mv source. Switching such a source from one sensor to another might prove difficult and the alternative of providing separate secondary supplies for each unit was not attractive.

The bridge circuit designed to eliminate these difficulties uses zero temperature coefficient resistors mounted near the resistance thermometer element (see Fig. 2). Such a bridge will introduce a small nonlinearity when supplied from a constant voltage source. A double bridge was developed that corrects for the nonlinearity by a negative resistance coefficient element. This element consists of a thermistor and resistor in parallel at the temperature being measured (see Fig. 2 and Ref. 6). The ground return is taken from a resistor adjusted to be equal to that of the sensing element at 0 deg C. A calibration point is taken from a resistor at 50 deg C. The actual reading obtained from this resistor depends upon the ambient temperature because of the compensating element. The third lead is used for readout. A specially designed power supply provides a d-c output at low a-c impedance and with high isolation from ground, to minimize hum. With this arrangement, a permanently grounded d-c amplifier may be used.

Errors—The errors encountered in the operation of the system were basically of two types, those due to the progressively deteriorating operational condition of the instruments and those due to ambient temperature variations. The digital voltmeter showed slow drifts both in zero and in full-scale calibration that were traced to varying ambient temperatures and tube aging. Under laboratory conditions, the ambient could be held between 20 deg C and 30 deg C and the maximum error in the voltmeter then did not exceed 0.3 percent. But it was decided that an air-conditioned instrument shed would be required for field use since solar radiation loads on a field-type instrument shed could raise its inside temperature to 50 deg C during the Israeli summer. The amplifier in the resistance thermometer circuit also showed drifts in zero and full-scale calibration of approximately the same magnitude as the digital voltmeter, but generally in the opposite sense, reducing overall error of the temperature measuring circuit. Errors of this magnitude are not important in the measurement of meteorological parameters since the sensor error can easily be an order of magnitude larger.

The work described in this paper was supported by the Reactor Safeguards Committee of the Israel-Atomic Energy Commission.

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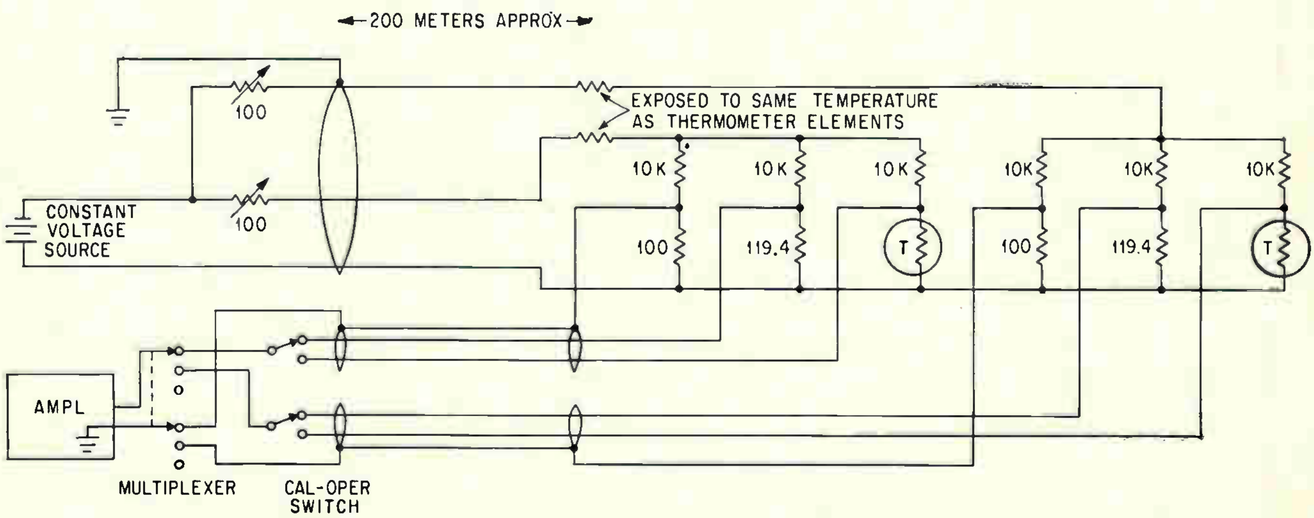

RESISTANCE thermometer bridge uses thermistors to correct for nonlinearity—Fig. 2

Linear Scales Show Mixer Harmonics

Simplified method locates spurious signals generated by the first six harmonics of two mixed signals: one scale is for the sum, the other for the difference, of input frequencies

By **ROGER T. STEVENS,** Sanders Associates, Inc., Nashua, N. H.

WHEN two r-f signals are mixed to produce a sum or difference frequency output, the mixing is inherently a nonlinear process that produces harmonics of the two incoming signals, resulting in spurious outputs corresponding to these harmonics and the various combinations of their sums and differences. If the relation of the incoming signals and local oscillator frequencies is chosen unwisely, some of these spurious signals will be at the desired output frequency, so that they cannot be filtered out. In many cases, the resulting distortion of the i-f signal is intolerable.

Many charts and tables have been published that make it possible to determine where the spurious frequencies lie, but they all are so general and so complex that they do not substantially simplify the task of the design engineer. The two linear scales shown here quickly and easily locate and identify all of the spurious signals generated by the first six harmonics of the two incoming signals. One scale is for use when the desired output signal is the sum of the two input signals and the other scale is used when the output must be the difference of the two input signals. The only other information required is the ratio of the lower frequency input signal (F_L) to the higher frequency input signal (F_H). For example, an input signal of 88 to 108 Mc is mixed with a local oscillator of 98.7 to 118.7 Mc to produce a 10.7-Mc i-f signal. The ratio F_L/F_H varies between 0.893 and 0.911. Looking at scale 2 (since the desired output is the difference frequency) we see that no spurious signals occur over this range and, therefore, the choice of local oscillator and i-f frequencies was satisfactory.

Equations—The derivation of the equations for these spurious signals is simple. The relation for the case of a desired difference signal output is

$$\pm (mF_H - nF_L) = F_H - F_L$$

where m and n are integers representing the particular harmonics of the desired signal. This equation can be rewritten in terms of the frequency ratio F_L/F_H

$$F_L/F_H = \frac{m-1}{n-1} \text{ or } \frac{m+1}{n+1}$$

To make up the scale, all combinations of the first six harmonics of each input were calculated, but solutions that gave $F_L/F_H > 1$ or negative were discarded since these cases are excluded by definition.

The corresponding equation for the case of the sum frequency being the desired output is

$$\pm (mF_H - nF_L) = F_H + F_L$$

This can be reduced to

$$F_L/F_H = \frac{m-1}{n+1} \text{ or } \frac{m+1}{n-1}$$

The scale was calculated from this formula in the same way that the difference frequency scale was determined.

(continued on p 39)

PCM

TELEMETRY GROUND STATION

A BENDIX/CORRELATED DATA PRODUCT

from Bendix-Pacific

The latest from Bendix-Pacific—Model DDS-1000 solid-state Pulse Code Modulation ground station. This is a digital decommutation station capable of demodulating and processing all serial digital information. Outputs are available in a wide variety of serial or parallel digital formats, as well as analog signals for real time visual analysis of data. Flexibility is implemented with self-powered modular sub-assemblies for universal applications, as well as mechanization for special requirements. Silicon semiconductor devices are used throughout the system for high reliability and optimum performance over a wide temperature range.

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Model DDS-1000 is a development of Correlated Data Systems Corporation and available exclusively from Bendix-Pacific. Contact Bendix-Pacific, North Hollywood, for complete information.

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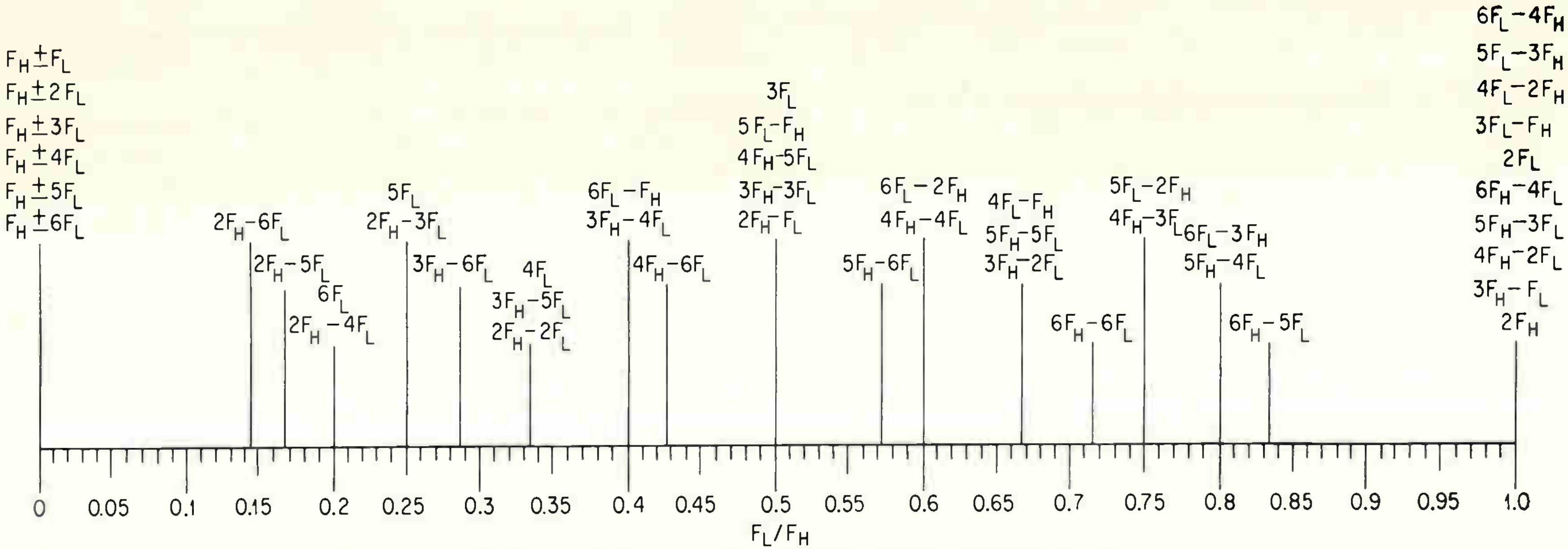
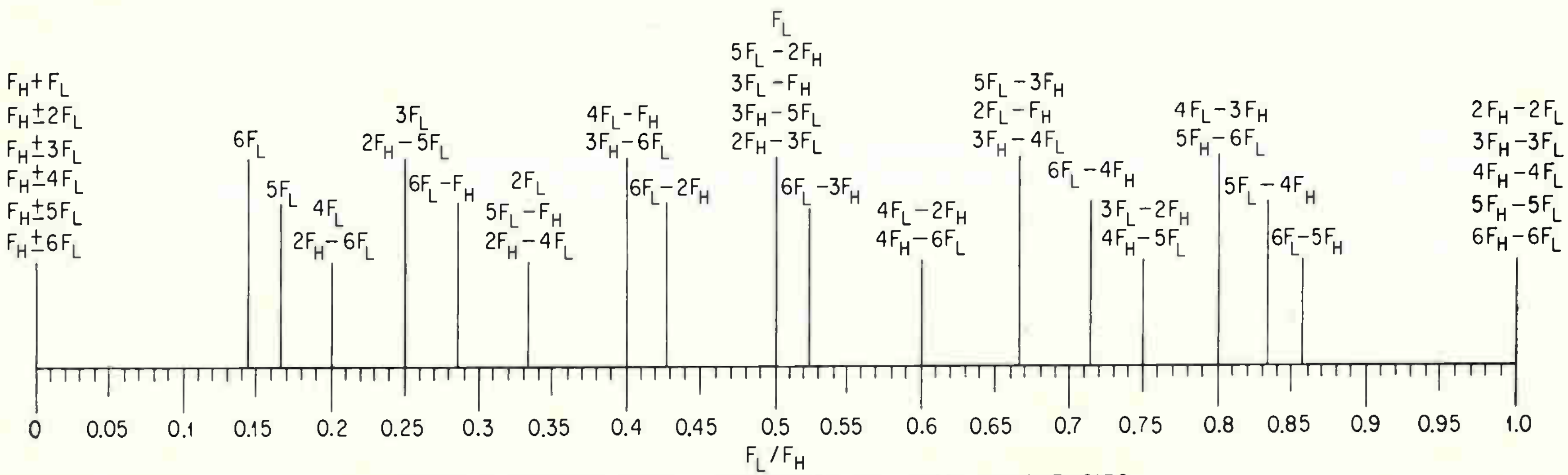


SCALE 1: DESIRED OUTPUT = SUM OF INPUT FREQUENCIES



SCALE 2: DESIRED OUTPUT = DIFFERENCE OF INPUT FREQUENCIES

Wanted: Solar-Flare

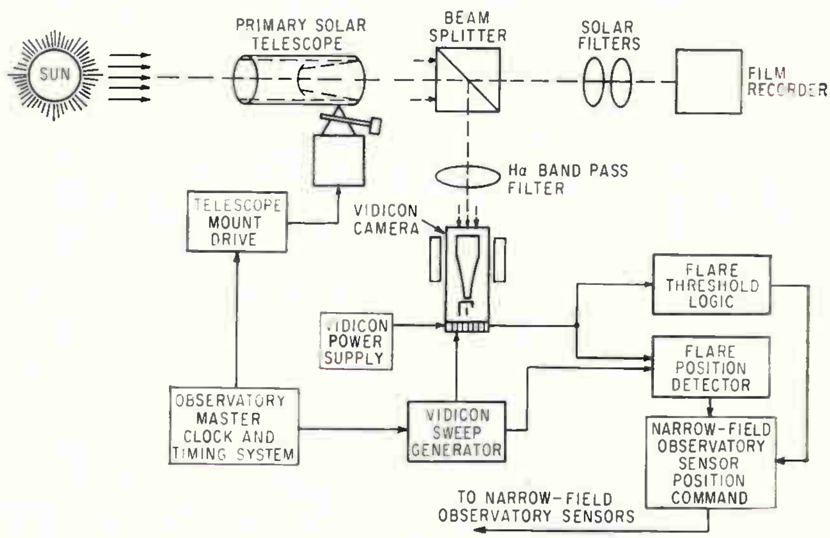
Reliable technique can minimize the radiation hazards of space flight

By **JOEL A. STRASSER**
Assistant Editor

NASA IS EXPECTED to publish soon a report underscoring one of the major problems of manned space flight: developing the data base, techniques and eventually equipment to reliably predict solar flares.

The problem looms larger as 1970, the date planned for the first lunar landing, draws closer. With reliable flare prediction, flight hazards and the weight penalties for radiation protection can be minimized on lunar or interplanetary flights.

The forthcoming report will summarize a symposium on solar-flare physics, held at Goddard Space



SOLAR-FLARE ALARM by Republic Aviation uses video digital techniques to detect flares, could be used on ground or in satellites

OPTICAL CLASSIFICATION OF FLARES

	Duration (min)		Area* (10^{-6} the area of the visual solar hemisphere)		Average Hα Line Width	Relative
Importance	Average	Range	Average	Limits	at Maximum (Å)	Frequency
1⁻ (subflares)			72	<100	1.5	
1	20	4 to 43	160	100 to 250	3.0	0.72
2	30	10 to 90	349	250 to 600	4.5	0.25
3	60	20 to 155	973	600 to 1,200	8	0.03
3+	180	50 to 430		>1,200	15	

* One millionth of the solor hemisphere equals 3.04×10^6 km^2.

Predictors

Flight Center. The conclusions are said to be that theoretical work on solar flares is still elementary and that a prediction capability beyond three or four hours is not yet feasible.

Progress, however, is being made in identifying precursor events—events preceding a solar flare. Kinsey A. Anderson, of NASA, has developed a way to predict solar proton events two or three days in advance. Other methods are in development, but none can be thoroughly tested until solar activity increases again in about three years.

J. W. Evans, of Sacramento Peak Observatory, a center of solar-flare study, expects a five-day forecast capability by 1970. Forecasts would have a 100-percent reliability and a false-alarm rate of 50 percent.

Earth satellites and space probes, rockets, balloons and ground-based observatories have all been helping collect solar-flare data. NASA, other government agencies, Air Force, universities and private companies are sponsoring solar-flare investigations.

What Solar Flares Are—Difficulty of protecting astronauts against solar flares was reported last summer as a main reason why the Soviets put off their heralded plans for a lunar landing.

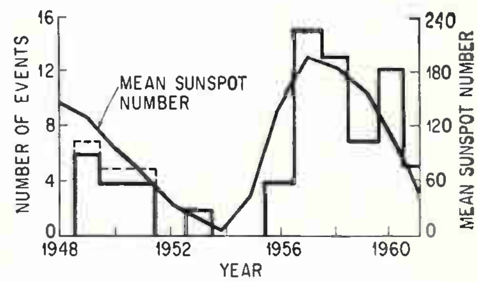
Solar flares spew into space intense streams of protons and x rays that can endanger astronauts, damage electronic and other spacecraft components and disrupt space communications.

The flares are bursts of hydrogen-alpha (Hα) intensity on the sun, within 100,000 km of a sunspot. Flares expand rapidly to as much as a billion square miles on the solar disk, reach peak intensity in one-half hour or less and slowly decay. They are classed from 1− to 3+ in importance, depending on their area and intensity (see chart).

The little that is known about solar flares shows that they occur most frequently when sunspots are in the maximum part of their 11-year cycle, primarily in the declining half of each cycle (see graph). This seems the most reliable characteristic on which to base a prediction technique.

New Satellites—To add to the data gathered by several satellites, including Explorers and Orbiting Solar Observatory (OSO), NASA will launch seven Interplanetary Monitoring Platforms (IMP) and an Advanced OSO (AOSO).

The first IMP was launched in November into a 122,800-mile-high orbit (ELECTRONICS, p 40, Nov. 29, 1963, outlines solar-flare related experiments). The IMP program's stated purpose is to develop "a solar-flare prediction capability for Apollo." Investigation of the solar-flare mechanism will be the major mission in 1967 of AOSO. NASA is expected to announce details on AOSO shortly.



SUNSPOT CYCLE'S relationship to solar-flare occurrence

Ground Observatories—Ground observatories around the world have collected a significant amount of solar-flare data.

The goal of Sacramento Peak Observatory (SPO), part of AFCRL, is to study photo emission and understand it well enough to identify precursor features and to establish adequate solar-flare forecasting techniques.

New type of spectroscopic magnetometer at SPO will provide magnetic-field mapping by means of the Zeeman effect with a resolution of 1 to 2 sec. This year, construction will begin on a 30-inch evacuated solar tower telescope. Coupled with the Doppler-Zeeman Analyzer, this will provide the most advanced observational technique in existence for determining small detail on the sun.

At Harvard College Radio Observatory in Fort Davis, Texas, swept-frequency receivers are operated over ranges of 25 to 600 Mc and 2 to 4 Gc. This observatory discovered flare-associated radio outbursts called "U" bursts, and identified type-IV radio signals emitted by proton showers. Other SPO-sponsored research is being carried on at observatories and institutes in the U. S., Norway, Italy, Greece and France.

Naval Research Laboratories measurements have confirmed that solar x rays cause flare-associated sudden ionospheric disturbances, and that Lyman-alpha variations are not geophysically significant. Douglas Aircraft is operating solar-flare monitoring centers for the National Science Foundation at Sheperd Bay, Canada and McMurdo Sound, Antarctica. Martin Company's Research Institute for Advanced Studies is preparing cosmic-ray satellite experiments for the Air Force. Lockheed also operates a solar observatory.

Detectors—Neutron monitors operate continuously at many locations around the world, to detect high-energy protons.

Riometers (relative ionospheric opacity meters) measure the ionospheric absorption of h-f extraterrestrial radio noise.

Direct primary particle detectors have flown on balloons, sounding rockets and satellites to gather information on solar cosmic rays. Three groups of detectors are used: nuclear emulsions; simple omnidirectional or wide-angle counters; and complex electronic systems including both a small solid angle and fine energy discrimination.

Alarm System—Solar-flare alarm (see diagram) described by Norman Gutlove, of Republic Aviation, employs video digital techniques. When a flare is detected in the threshold circuit and flare coordinates located in the position circuit, a signal sent to the telescope reposition command unit directs the telescope to turn toward the flare. Information on detection and position can be displayed and recorded.

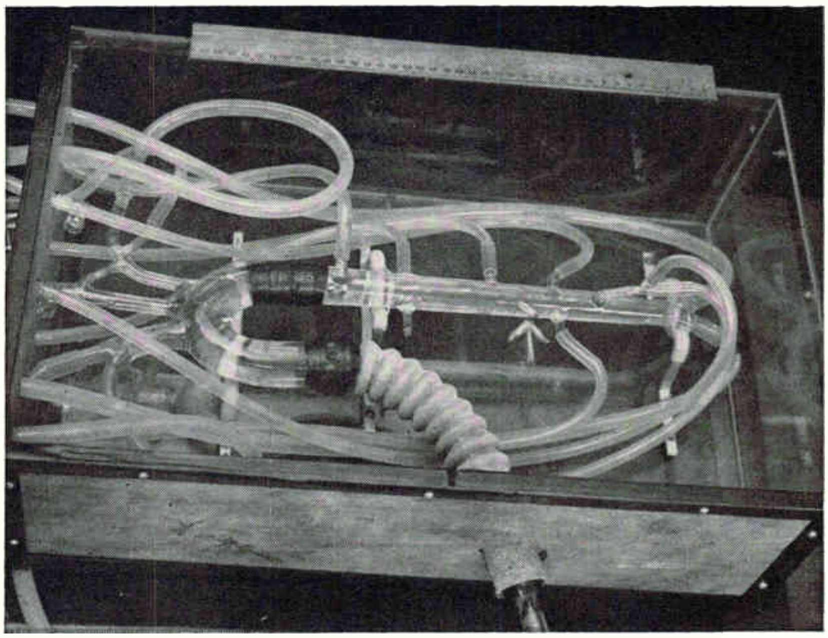
In lab tests, system accuracy was ±2.5 percent. Republic foresees applications aboard solar-oriented scientific spacecraft, as well as ground-based observatories.

Miniature Magnet Travels Through Body

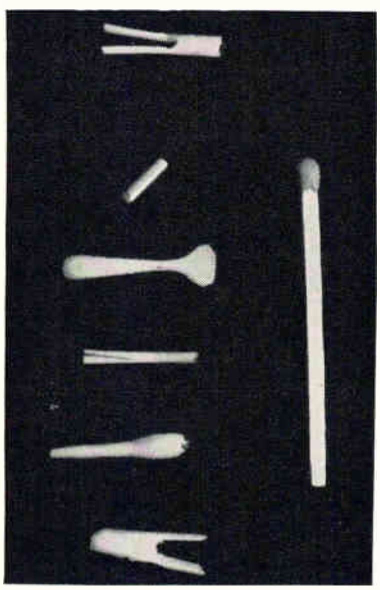
Steered by external fields, device traverses bloodstream, may replace catheters

THE "POD" is a new miniature medical device that can be inserted into a vein or other passage in the human body, then propelled and guided by externally applied magnetic fields to perform a variety of medical tasks in places and organs that are normally inaccessible to doctors.

Several experimental versions of the Pod have been developed by Prof. E. H. Frei and Dr. H. N. Neufeld at Israel's Weizmann Institute of Science. The basic element is a small permanent dipole magnet, imbedded in a chemically inert unit about a millimeter in diameter and four millimeters long. The material absorbs x-rays for easy fluoroscopic monitoring. It can be propelled through blood vessels at speeds up to 40 cm/a sec.



TRANSPARENT model of main arteries, with water flowing through the tubes, is used for research in remote magnetic control of Pods



SEVERAL MODELS of the Pod, for different applications, are compared. Average diameter is one mm, length four mm

The simplest means of propulsion of the Pod is by applying constant magnetic fields that have to be varied only in accordance with the changing directions of the unit during its progress through the body. Since the Pod is essentially a constant magnetic dipole, magnetostatics allow easy calculation of the translatory and rotatory forces.

According to Dr. Frei, switching of the necessary magnetic fields may be accomplished through servomechanisms operated by the attending physician, or, in complicated cases, by a preset program on a computer. Progress of the Pod can be monitored on a fluoroscope or by magnetometers; where the Pod is carrying radioactive material, nuclear detectors can be used for monitoring.

Many Applications—Among the functions the Pod can fufill in the body is the delivery of small amounts of concentrated drugs to specific areas; collecting of tissue or fluid samples from various organs; and minor local surgery such as cutting or widening. Such procedures could take the place of catheterization, which is, at present, time-consuming and difficult, sometimes even impossible, Frei said.

Experiments have been conducted at the Weizmann Institute introducing Pods into the circulatory system of living dogs; usually the Pod was attached to the end of a thin nylon thread. The researchers have also demonstrated the device's operation in models of human arteries, both with and against the direction of flow of a liquid simulating blood.

Several other possible applications include use as a flowmeter in a blood vessel, using a Pod with the same specific gravity as blood.

The Pods have been made in various sizes and shapes, depending on intended application. Some are flexible and thin, to allow passage through small vessels; others are pointed; still others consist of four parts and are hollow, for delivering drugs.

Plans for future research include the investigation of Pods in heart pacemaker applications, as tele-

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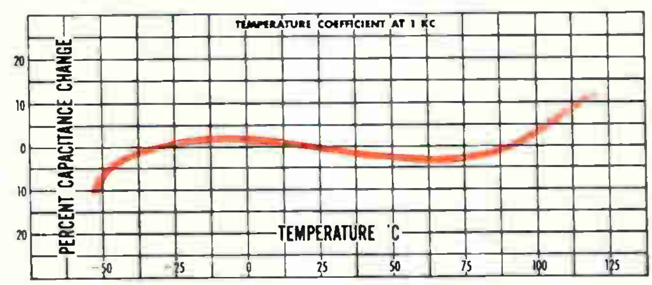

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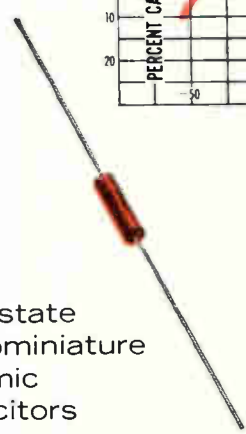

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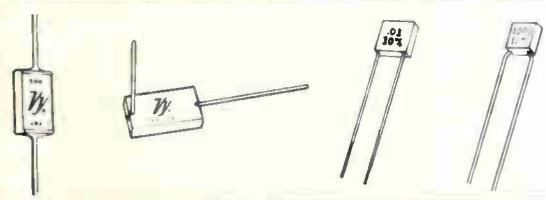

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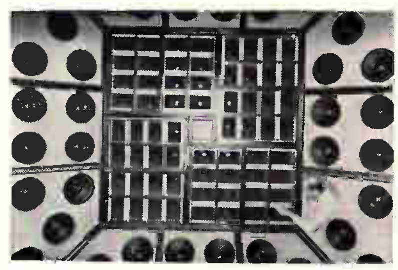
metry pressure transducers, and for intracranial applications.

Biggest "Hi-Fi" Checks Parts With 150 Decibels

LITCHFIELD PARK, ARIZ. — The "world's biggest and most precise hi-fi" set drives 48 circumferentially placed woofers and 64 mid-range tweeters from 37 to 10,000 cps. and generates sound levels up to 150 db in order to check aircraft and missile parts for resistance to vibration, shock, altitude and temperature.

The Arizona Division of Goodyear Aircraft Corporation, who built the equipment, says that the environmental tester is so powerful that a record played through its amplifier could be heard 20 miles away.

Sound actually used comes from a zener-diode noise source, controlled for sound type, intensity and frequency at a test console. An analyzer monitors the type of out-



OUTPUT END, top, of acoustic testing facility at Goodyear's Litchfield Park, Ariz., plant, has 48 circular woofers, placed circumferentially around 64 trumpet-shaped mid-range speakers. At bottom, reverberation chamber for omnidirectional sound bombardment of parts under test put, its frequency and db level, while additional equipment records all test factors.

A urethane foam rubber-filled sound sink absorbs the unused audio energy from two square testing chambers and a third, reverberant chamber that resembles a plump submarine. The reverberant chamber's walls bounce the sound back and forth to hit the object under test from all directions.

Aurora Thickness Measured By Polar-Orbit Satellite

SATELLITES IN POLAR orbit have shown that auroras of the northern hemisphere are much thicker than generally believed, according to Richard Sharp of Lockheed Missiles & Space Co. Observations of low-energy electrons and protons were made with eight specially designed instruments aboard a satellite that made six passes over the northern auroral zone. These measurements revealed that the profile of a typical aurora can extend up to several hundred miles in thickness, and clarified a divergence of opinion among experts concerning how much of the aurora was visible. The experiment also showed that most normal auroras are caused by electrons rather than protons since no protons were recorded by either the high-energy or low-energy proton counters.

Fiberscope Aids Color Tv Surgery

A FIVE FOOT LONG fiber-optic bundle has been used to televise an ear operation in color. A color tv camera, a delicate operating microscope, and the fiberscope designed by American Optical Co., were combined to show the operation to physicians attending the annual meeting of the Southern Medical Association in New Orleans, La. A color picture measuring nine by twelve feet was made of an operating field smaller than a dime.

The fiber optic bundle, about the thickness of a garden hose, transmitted the image from the microscope to the tv camera using over 675,000 aligned glass fibers.

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InSb Detectors for Infrared Systems

Cooled detector offers high sensitivity at 4.5 to 5.5 microns

By **JOSEPH E. SLAWEK, JR.**
Vice President
Davers Corporation
Horsham, Pennsylvania

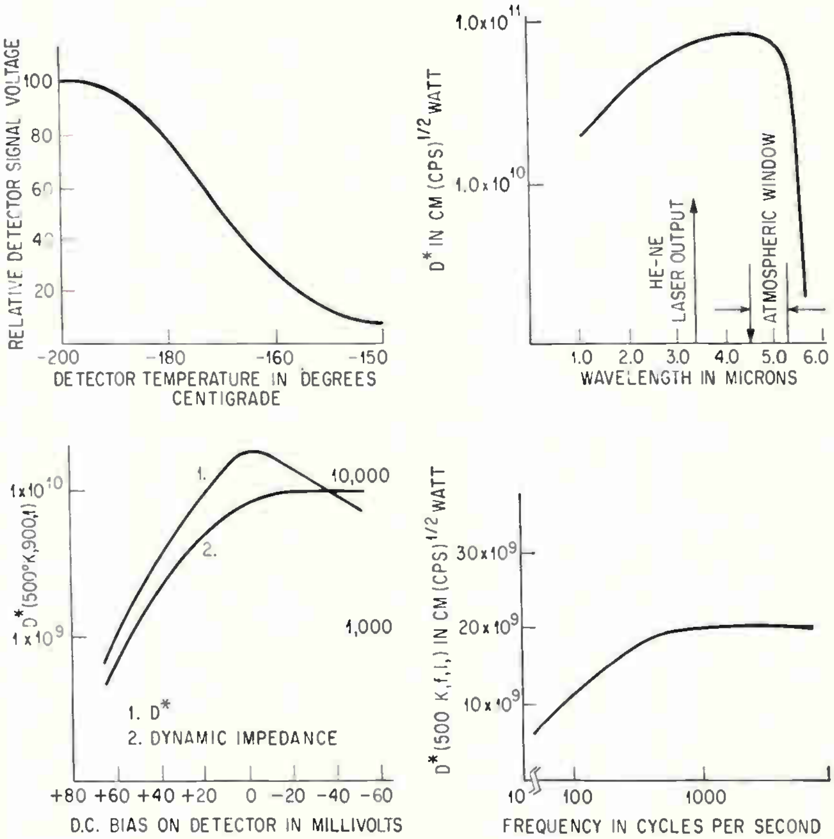
COOLED infrared detectors are finding increased usage in search-track radar systems, missile guidance systems, target recognition systems, early warning systems, and—more recently—monitoring laser radiation and thermal mapping of microminiature circuits. Once considered fragile, state-of-the-art type devices, confined for the most part to laboratory use, these detectors have now become readily-available, reliable components that are capable of meeting stringent military specifications.

One detector, the photovoltaic InSb detector, has received an increasing degree of attention. The InSb detector operates at liquid nitrogen temperatures, and is sensitive to radiation from the visible wavelengths to approximately 5½ microns. It owes its increasing acceptance to unequaled sensitivity in 4.5 to 5.3 micron wavelengths—an atmospheric window of considerable interest to system designers.

The InSb photovoltaic detector, operating at sensitivities approaching the theoretical limit, is now available in production quantities.

InSb Detector Characteristics TABLE

D* (500°K,900,1)	10 x 10^9 cm/watt
D* (5 micron,900,1)	46 x 10^9 cm-watt
Responsivity	4 x 10^3 volts/watt
Impedance (zero bias)	8 x 10^3 ohms
Time Constant	2 x 10^{-6} seconds
Field of View	120 deg
Detector Active Area	.090 in. dia

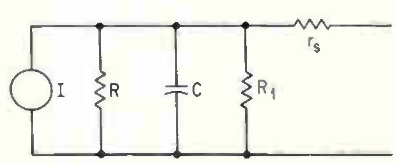


SPECIFICATIONS for InSb detectors given in charts above are (left to right, top to bottom): signal voltage versus detector temperature; spectral response of InSb detector; D* of detector versus d-c bias voltage and dynamic impedance of detector versus d-c bias voltage; and D* of detector versus chopping frequency

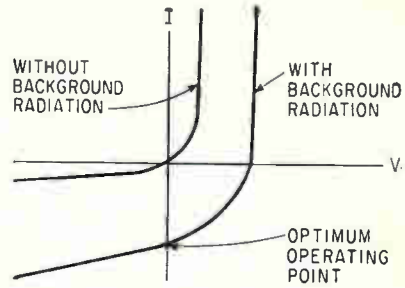
The techniques used to produce this device permit fabrication of numerous mosaic arrays of varied configurations.

Design Data — The photovoltaic InSb detector normally consists of a broad-area diffused p-n junction mounted in a dewar type envelope. The detector is similar to other photovoltaic devices such as the solar cell, with one important difference: normal background radiation will affect the operating point of the InSb detector. The InSb detector is essentially a diode with I-V characteristics and an equivalent circuit similar to other diodes. The equivalent circuit of the InSb detector is shown in Fig. 1. Figure 2 shows I-V characteristics on the InSb detector with and without background radiation (at room temperature).

Characteristics—If the detector is operated in the open circuit condition, the presence of background radiation will drive the diode into a low resistance portion of the I-V curve, thereby degrading detector



EQUIVALENT circuit of InSb detector—Fig. 1



I-V CHARACTERISTICS of InSb diode—Fig. 2

sensitivity. Optimum signal to noise ratio is usually obtained at zero bias (d-c short circuit) which can be obtained using d-c biasing techniques or—if the d-c resistance is less than 20 ohms and the a-c impedance is relatively high (several hundred to several thousand ohms) —a choke or transformer.

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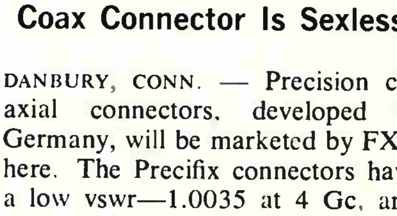
Coax Connector Is Sexless

DANBURY, CONN. — Precision coaxial connectors, developed in Germany, will be marketed by FXR here. The Precifix connectors have a low vswr—1.0035 at 4 Gc, and 1.01 at 13 Gc. According to an FXR spokesman, the new connector will permit the design of coaxial components for use where only



ANY TWO Precifix connectors of the same size can mate. Known as size A, these are the smallest size available waveguides were suitable previously.

Development — The Precifix connector was originally developed by Lothar Rohde—one of the partners of Rohde and Schwarz, a European electronics company — to fulfill a need for a good connector for measuring instruments operating at decimeter wavelengths. Thousands of these connectors have been used on Rohde and Schwarz instruments, and sold on the European market.

Mating Geometry—One of the features of the Precifix connector is that the geometrical line of connection is absolutely defined and repeatable. The connector mates at the same point, and always has the same electrical length. Also, the connector is "sexless"; that is, any two connectors can mate, since neither is male or female.

Large Size — Rohde and Schwarz have made large Precifix connectors capable of passing 60 kilowatts at 1 Gc. The devices have been used with six f-m transmitters, each of 10 Kw, feeding a single antenna.

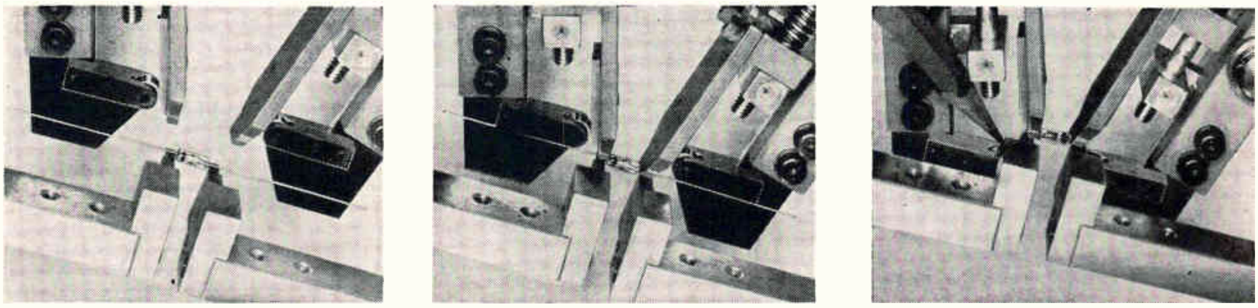
Mass Production—FXR has started tooling up for mass production of both sizes of Precifix connectors. According to Matthew L. Devine, president of Amphenol-Borg, with mass production the connectors can sell for $15 to $20 in quantity lots. This price, combined with high performance, is expected to make the connector useful for many applications in phased array radar systems.

Soviets Cite Improved Material for Cathodes

VIENNA—Soviet researchers found lanthanum boride (LaB_6) the best material for cathodes whose emission is excited by an electric field.

Czech Technical Digest (No. 12, 1963) says that work function of LaB_6 is 2.68 eV, its resistivity 27.2×10^{-6} ohm/cm, its melting point 2,200 deg C.

LaB_6 adds a ten-fold improved stability to cathode sputtering as compared with tungsten, report claims. Service life is about 1,000 hours. Best heating range was between 1,200 to 1,700 deg C.



NONMARRING resilient fingers grasp leads between component body and bending points. Rollers approach at a 15 deg angle and roll over lead. Shear and tensile stresses are avoided

Resilient Rollers Form Leads

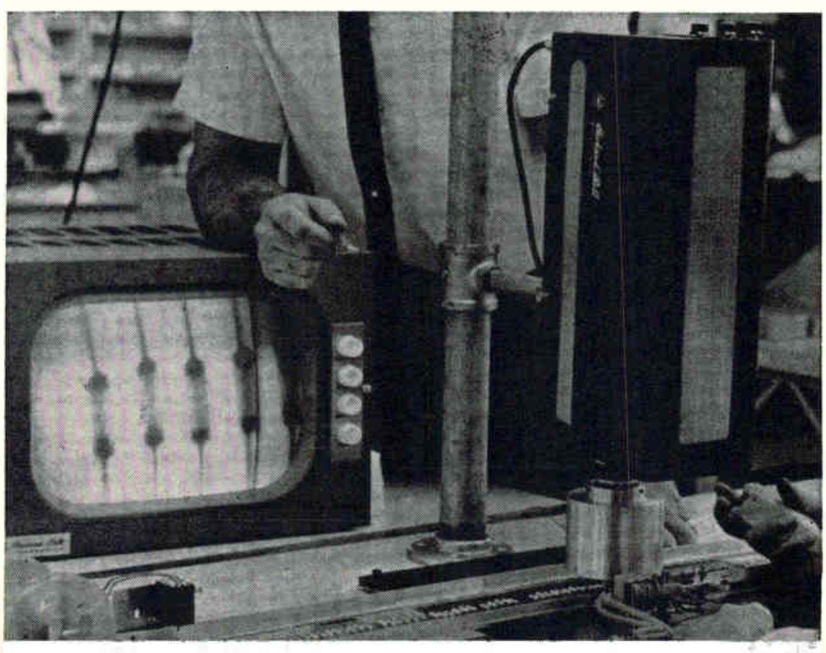
Metal-to-metal contact avoided, preventing nicks, scratches and stresses

By F. L. SIMPSON
Chief Engineer
Develop-Amatic Engineering
Palo Alto, Calif.

LEAD FLATTENING and scarring during forming of axial leads of electronic components usually indicates that tools used for bending exert concentrated pressure at the bend point. Burnishing action can flatten the component lead and scarring can remove protective plating. High standards set by Department of Defense and the armed forces for the forming of leads are necessary because a scratch or nick cause malfunctions in costly equipment.

A new machine by Develop-Amatic uses nonmarring pads to hold leads gently in place during forming accomplished by roller action of the forming rollers. Both pressure pads and forming rollers are made of resilient material that has high lubricity and high memory. The roller arm approaches the lead wire at 15 degrees from the norm to further reduce shear forces which can induce a tensile stress on the component body. This method meets rigid MIL specs, raises production output and cuts production costs.

Procedure—In this semiautomatic or fully automatic method, components are loaded into a feed chute on handling cards. The chute is adjustable to receive components 0.09 to 1.0 inch diameter by 1 to 2 inches length. Adjustment for body size of component is accomplished with a small Allen wrench and an adjusting knob. Adjustment of the trimming and forming tools is



CCTV Aids Inspection

CLOSED CIRCUIT TV and a direct image fluoroscope are used for inspection of hermetically sealed resistors. Image is magnified 12 to 15 times by the tv system produced by Packard Bell Electronics, Los Angeles, Calif., and permits processing of 5,000 resistors per hour also made with a small Allen wrench and adjusting knob.

When the machine is adjusted and the feed chute filled, the shuttles drop one component at a time into the trimming tool. The shuttles are fastened to the chute, one to a fixed member, the other to a movable member, and adjust with the chute. They accept all wire diameters to 0.045 inch, independent of component body size, because shuttles feed from the axial leads.

Solenoids activate the shuttles, which are coordinated with the trimming and bending tools through a cam-operated microswitch. The lead trimming tools are also solenoid operated and are adjustable for any length of cut. As the component is fed into the trimming tools, the axial leads are cut to length with no axial shock transmitted through the lead into the component body.

After trimming, the component is fed into the forming tools where the leads are formed to the desired bend configuration. For the high reliability MIL spec operation, the 90 degree bend is accurate to within 30 minutes of arc. This bend is normally a minimum of 0.125 in. from the body although in some cases it may be reliabily formed closer. It is during this operation that hand forming, or other conventional methods of forming when steel comes in contact with component leads, can cause marring or burnishing that contributes to the malfunction of the electronic component.

Hydrogen Made On-Site Reduces Heat treating Cost

PRODUCTION OF PURE HYDROGEN for the heat treating of magnetic parts is expected to save Magnetics, Inc., Butler Pa. $50,000 a year. A recently installed Drever ammonia dissociator feeds the system with impure hydrogen (75 percent H and 25 percent N). It is then compressed, heated, and fed to a diffusion cell where the hydrogen is separated. The system is controlled by a gas analyzer manufactured by Hays Corp., Michigan City, Indiana. The remaining gas, a by product, is used as furnace atmosphere.

Vacuum Forming Aids P-C Part Assembly and Soldering

A METHOD OF holding and locating component parts, such as transistors and condensers on printed circuit boards during production that allows automatic soldering and assembly operations, has been developed by Atlas Vac-Machine Corp., Rochester, N. Y. It is used by several leading manufacturers of radios, television and military electronics, the company reports.

Procedure—A small templet is placed on the forming bed of an Atlas Vac Model R-12, self-contained portable, up-drape vacuum forming machine. Smaller than the printed circuit board, templet keeps it raised approximately ⅛ inch above the bed. A clear sheet of 0.005 gauge acetate is fed into the forming clamp of the machine and closed. The heater is drawn over the film until it becomes thoroughly softened and the forming bed is raised into the plastic sheet. The vacuum is drawn under the printed board to form the film around the board and components. After cooling, the encased printed circuit board is removed and may be trimmed.

A MESSAGE TO AMERICAN INDUSTRY · ONE OF A SERIES

Business Aid To Education: Let's Broaden The Base

The total amount of financial support that American business corporations are giving to our colleges and universities is increasing rather impressively. But the number of companies contributing to this expansion is woefully small. If business support of higher education is to attain the proportions it clearly should attain, there must be a large increase in the number of companies participating — and soon.

The Council for Financial Aid to Education estimates that business firms contributed about $200 million to education last year. This was up from a total of about $178 million in 1960; and preliminary indications are that business-giving will exceed $200 million this year. As a total, this is a relatively impressive figure. It becomes more impressive when viewed against the fact that it will be about two and one half times as much as business firms were giving to education ten years ago.

A Flaw In The Picture

But there is a grave flaw in this picture of business-giving to higher education. The giving is concentrated in relatively few business firms that provide large sums, while hundreds of thousands of firms do little or nothing at all. Of the $200 million contributed to education by business in 1962, the Council for Financial Aid to Education found that about $70 million, or more than a third of the total, came from only 150 companies, each of which contributed more than $100,000. In fact, increased giving by large corporate contributors accounted for most of the total increase in corporate giving between 1960 and 1962.

There are no figures comprehensive enough to determine precisely how many business firms contribute to the support of higher education in the United States. But studies indicate that virtually all of this aid comes from less than one per cent of U.S. business establishments.

Unused Capacity For Business Giving

At the present time, there are more than four and three quarters million business establishments in the U.S. A great many of them, of course, are one-man establishments which are not able to help higher education financially. But there are tens of thousands of others which have unused capacity to help.

Inquiries by the Council for Financial Aid to Education indicate that almost half of the nation's 500 largest industrial corporations have no programs to help our colleges and universities financially. With combined profits after taxes of almost $2 billion in 1961, these firms represent an imposing, untapped potential for help. And so do tens of thousands of smaller companies. Their gifts would be smaller, but their numbers would compensate for necessarily smaller amounts by coming in much larger numbers.

The Council for Financial Aid to Education has set a goal of $500 million for annual corporate aid to our colleges and universities by 1970. Very conservatively estimated, the total expenditure for higher education at that time promises to be $9 billion to $11 billion a year. This makes $500 million a relatively modest share in the support of educational operations so vital to the welfare of the nation and the business community.

Needed— A Much Broader Base

But if this goal is to be reached, the base of corporate support must be broadened. This means more and more effective work by the colleges and universities in seeking support from smaller companies. It means more readiness by more firms to listen with understanding and sympathy, and then to use their capacity to give financial support accordingly.

Viewed narrowly, it is in the selfish interest of business firms to help our colleges and universities financially. By doing so, they give essential support to basic research, centered in the universities, upon which the business system depends heavily for the opening of new scientific frontiers. Financial support for higher education also helps to insure a continuing supply of well trained graduates which business firms must have to insure their own continuing success.

By making it tax exempt, the federal government, in effect, assumes half of the cost of financial aid for higher education by business. But this fiscal fact does not detract from both gratitude and respect which business firms can win for themselves by providing such aid. And in the last analysis, if financial aid is not provided voluntarily, it can confidently be expected that business will ultimately provide much of it involuntarily, through taxation.

Viewed in terms of the broad public interest, the business community has an opportunity to play a key role in providing our colleges and universities with the financial strength essential to assurance of their successful development which, in turn, is basic to the success of the nation.

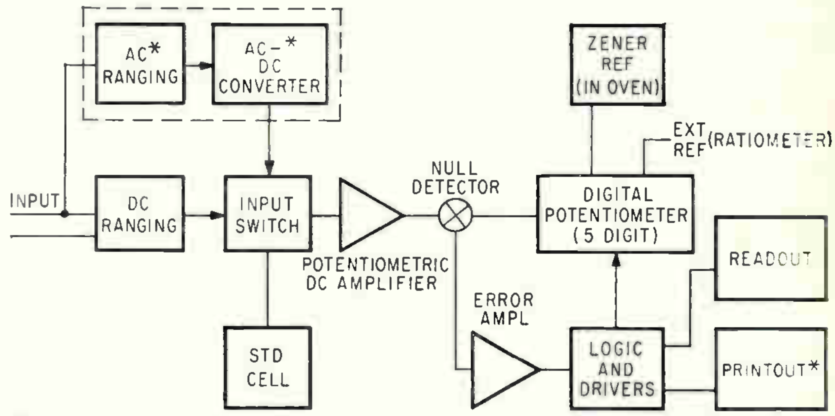
There are few, if any, financial operations that can pay larger returns in advancing the national interest, as well as the more immediate interest of the business community, than that of seeing our colleges and universities receive steadily increasing financial support from more and more business firms.

This message was prepared by my staff associates as part of our company-wide effort to report on major new developments in American business and industry. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or part of the text.

Donald C McGraw
PRESIDENT
McGRAW-HILL, INC.

DVM Features Remote Readout

Unit will measure a-c and d-c voltages and ratio



*INTERNAL PLUG-IN (CAN BE INSTALLED IN FIELD)

MODEL 2350 and 2351 production-line digital voltmeters will measure d-c voltage from 0 to 999.-99 with 0.005-percent accuracy and ratio from ±0 to 0.99999:1, ±1 digit. Moreover, model 2351 will also measure a-c voltages from 0 to 999.99 with accuracy between 0.1 and 0.2 percent. Units display measurements in 5-digit readout and have a 6th monitoring analog meter signal. Sensitivity is 10 μv, common-mode rejection is 120 db and overload protection is provided without fusing.

The readout assembly is unusual and flexible; it will tilt plus or minus 20 degrees, can be remoted at up to 6 feet from the instrument and permits bulb change without tools, shock hazard or interruption of operation.

A signal-conditioning d-c amplifier within the guard shield is a major factor in the unit's specifications. By means of feedback techniques, this amplifier raises the signal level prior to digitizing, minimizing the effects of thermal emfs and noise. It also isolates the digital circuits from the input circuits, assuring that there will not be feedback into the system from the dvm. As the signal level at the chopper is relatively high, the error amplifier does not require extreme sensitivity. This allows other error-amplifier design aspects such as response time to receive additional consideration.

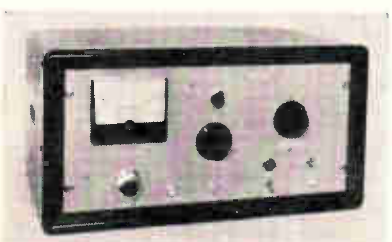
The a-c to d-c converter in the 2350 provides a-c, d-c and ratio measurements in one instrument requiring only 7 inches of rack space. This converter has more than 80 db of feedback and does not require frequency compensation.

Only one frequency compensation adjustment is required in the instrument. This occurs within the attenuator where two resistors are matched within 1ppm and calibrated to 0.001 percent. A standard cell within the unit provides long-term stability checks, while leads are provided for double checking stability with an external reference. Auto Data Sales, Houston Instrument Corp., 4950 Terminal Ave., Bellaire, Texas.

CIRCLE **301,** READER SERVICE CARD

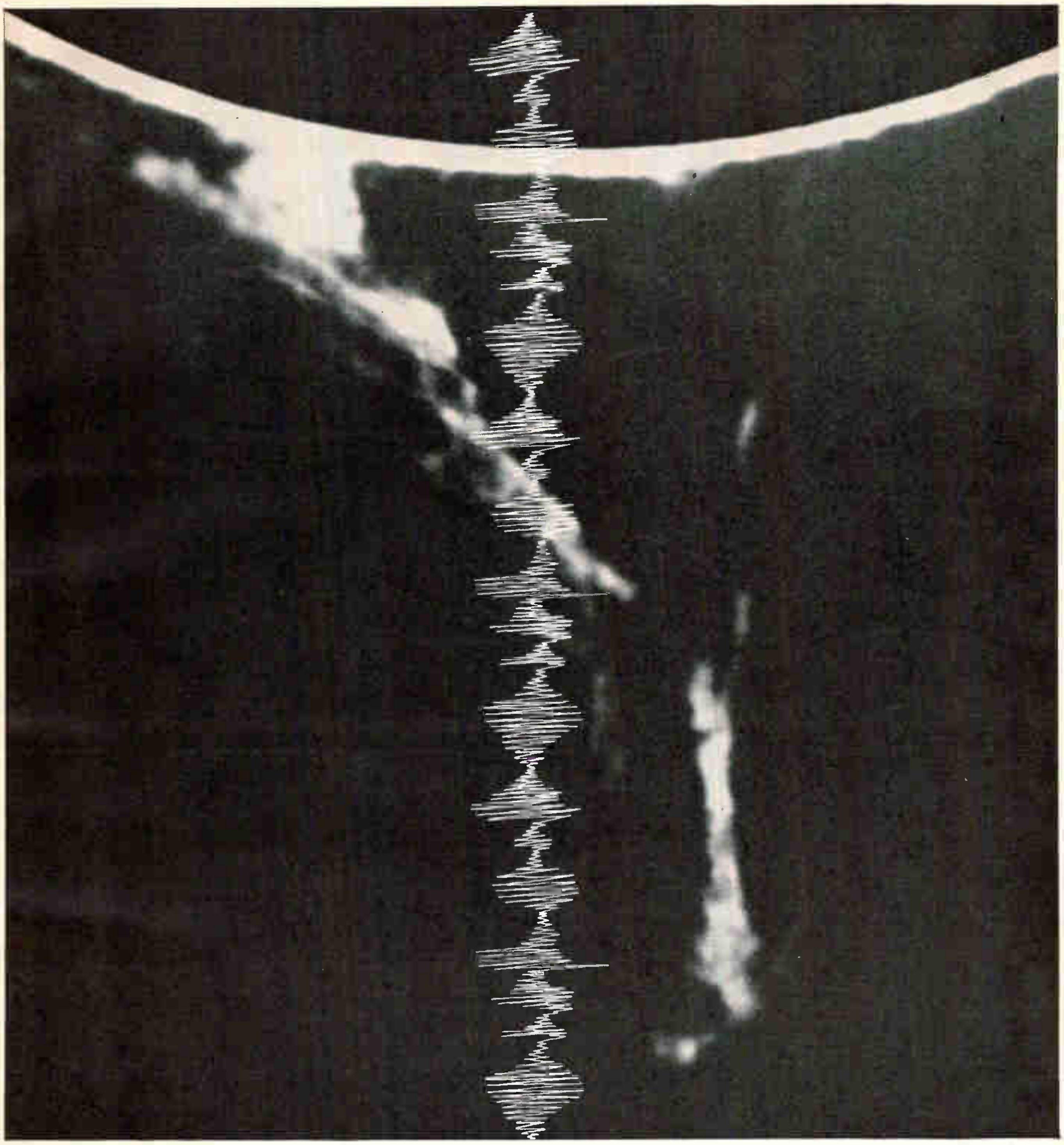
Laser Pulser Provides Variable Widths

LASER diode pulser for use with semiconductor junction lasers such as gallium arsenide and indium arsenide types has pulse rise time of less than 20 nsec. Unit provides pulse widths of 0.25, 0.5, 1.0, 2.5, 5 and 10 μsec that are selectable at the turn of a switch. Pulse height is continuously variable and pulse repetition rates are controlled by an internal oscillator yielding rates between 50 and 5,000 pps. The unit has an output impedance of 25 ohms; pulse transformers are available for matching from 0.1 ohm to 5 ohms. The pulser operates on 115 v a-c. A front panel meter displays average pulse current and an output connector permits viewing current pulse and repetition rates on an oscilloscope. Electro Powerpacs, Inc., 5 Hadley St., Cambridge 40, Mass. **(302)**



X-Band Power Source Is All Solid-State

MICROWAVE solid-state power source can replace standard reflex klystrons in many applications and has inher-



Who gathers sun storm data on one recorder, replays it exactly on 8 others? AMPEX

Here's something new under the sun; nine different recorders with identical electronics and heads. For the first time, you can record a missile shot at Canaveral and play it back exactly on a different recorder at Seattle, Santa Monica, Huntsville, or Woomera. There's no longer a need for duplicity of recorders to insure precise reproduction. And it's no longer necessary to bring field recorders back to the lab for playback. Another advantage of the new Ampex family: the electronics are interchangeable. This cuts down on the amount of spare parts you need. Electronics can be shuttled around where they are needed and not remain idle in an unused recorder. The new Ampex family includes the FR-1200, the FR-1300, the FL-300, the FR-100 C, the DAS-100, and the modernized FR-1100, FR-100 A, FR-100 B, and FL-200. Each offers superb performance and outstanding reliability, with frequency response to 300 KC Direct, to 20 KC FM and PDM. Each is designed for versatility in the lab or in the field. Now, all are truly compatible. For additional information on this Ampex family write to the only company providing recorders, tape and core memory devices for every application: Ampex Corporation, Redwood City, California. Sales and service engineers throughout the world.

AMPEX

ent advantages over vacuum tubes such as no warm-up time, low power requirements, wide operating temperature range, low noise and extended life. Units are simple to apply, ruggedly constructed and reportedly more stable than their conventional counterparts.

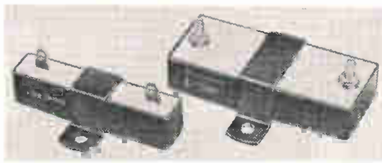
Model VPS-X has an easily mounted, metal case that provides protection as well as heat sinking for internal components. A crystal-generated fundamental frequency assures extreme stability. The device uses only a single, unregulated d-c power source and eliminates multi-voltage supplies.

Model VPS-X provides 120 mw of c-w output power, has stability within ±1 db between 8.6 and 10.6 Gc, has bandwidth of 1% and short-term frequency stability of 1 part in 10^6. It requires 45 v d-c at 450 ma. Varian Associates, Solid State Products, Beverly, Mass.

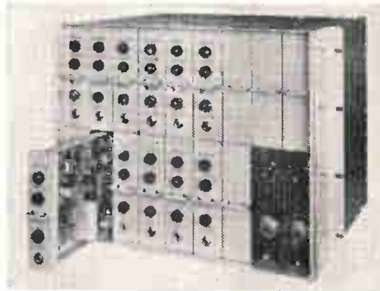
CIRCLE **303,** READER SERVICE CARD

Resistors Withstand Heavy Duty

A HEAVY-DUTY heat-sink type resistor is available with the resistance winding embedded in a high grade potting compound in a steel casing with "L" bracket mounting. Origi-



nally developed as a ballast resistor for solid-state ignition circuits, it can be used in other resistor applications especially where severe duty is required or where one or more resistors are desired in one case. Quick-connect terminals, standard tabs, or studs can be furnished. Sizes are 25 watts and up. Milwaukee Resistor Co., 700 W. Virginia St., Milwaukee, Wisc. 53204 **(304)**



SSB Multiplex Provides 12 Channels

SOLID-STATE, single sideband multiplex modules provide 12 direct channels in the 64 kc to 108 kc range. Featuring all-transistor modular design, units afford unusual design simplicity at lower cost.

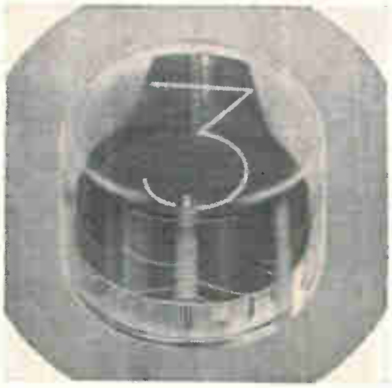
Silicon transistors are used throughout each module as are glass-base printed-circuit boards selected to meet military standards. Units operate from 24 v d-c or 48 v d-c or can be provided for operation on 115 v a-c.

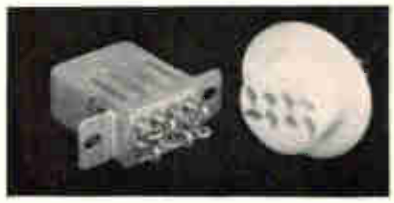
Designated type 53A, modules provide 12 toll-quality telephone speech channels based on CCITT standards and use substantially less rack space than conventional counterparts. To minimize common-equipment complexity and failure possibilities, each channel modem includes its own carrier-frequency oscillator and signaling oscillator. The twelve channels thus generated (base-group), may then be connected to the transmission facility or used with appropriate group modulators as the basis for deriving master or super groups for systems of up to 600 channels capacity.

The type 53A operates from 24 or 48 v d-c or 115 v a-c. A complete 12-channel package requires only 14-inches of rack space, and weighs 35 pounds. An arrangement of modules as a group is shown in the photo. Budelman Electronics Corp., 375 Fairfield Ave., Stamford, Conn. **(305)**

Readout Tube Has Ultra Long Life

A LINE of numerical readout tubes is announced. The characters in the tubes are formed by neon glow which has good readability even with high ambient illumination. Neon glow readout tubes do not fade with age. The NL-8421/5092 and NL-6844A, with 0.610-in.-high characters, have ratings and characteristics typical of various types available: maximum ionization voltage, 170 v d-c; minimum supply voltage, 170 v d-c; average cathode current, 1.5 to 3 ma; and viewing distance, up to 30 ft. National Electronics Inc., 628 North St., Geneva, Ill. **(306)**





Test Sockets Cut Inspection Time

TEST SOCKETS are available to check out solder terminal components with plug-in ease. Company says they offer a 75-percent time reduction over clipping leads. The virgin Teflon body of the socket assures dimensional stability even under wide variations of temperatures. Test temperatures can range from − 100 F to + 400 F. Teflon will also take the most abusive physical use. Automech Associates Inc., 159 Washington Ave., North Haven, Conn. **(307)**

LITERATURE

PERMANENT MAGNETS Indiana General, Magnet Division, Valparaiso, Ind. Six-page bulletin 40 is entitled "Applying Indox Permanent Magnets to D-C Motors."
CIRCLE **360**, READER SERVICE CARD

PRECISION RESISTANCE DECADES Shallcross Mfg. Co., Selma, N. C. Catalog RD550 supplies complete specifications for over 175 standard resistance decade models. **(361)**

A-M DETECTORS Spectran Electronics Corp., 146 Main St., Maynard, Mass. Circuits and components for a-m detectors capable of high dynamic range are described in a four-page application note and transformer catalog. **(362)**

FREQUENCY DISCRIMINATOR Helipot Division of Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif. Data sheet describes model 790 Hallefex frequency discriminator. **(363)**

PULSE TRANSFORMERS Gudeman Co. of California, Inc., 7473 Avenue 304, Visalia, Calif. Bulletin GB6340 covers a series of molded miniature pulse transformers. **(364)**

INSULATING MATERIALS 3M Company, 2501 Hudson Rd., St. Paul 19, Minn. Technical information on compatible basic insulating materials has been assembled for handy engineering reference. **(365)**

ULTRASONIC CLEANING SYSTEMS Westinghouse Electric Corp., P. O. Box 868, Pittsburgh, Pa. 15230. A 4-page bulletin describing ultrasonic cleaning systems, generators, transducers, and tanks, is available. **(366)**

SWITCHES Micro Switch, a division of Honeywell, Freeport, Ill. Catalog 67e has been expanded to include the round as well as rectangular designs in the series 2 line of lighted display and pushbutton switch devices. **(367)**

INSTRUMENT HOUSINGS Zero Mfg. Co., 1121 Chestnut St., Burbank, Calif. Catalog C63 describes a standard line of deep-drawn aluminum instrument housings in 12 sizes. **(368)**

POWER SUPPLIES Sorensen, a unit of Raytheon, Richards Ave., South Norwalk, Conn. Operating techniques and special uses of the new DCR constant current power supplies are discussed in an applications bulletin. **(369)**

LABORATORY SUPPLY Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N. J., has published a technical bulletin covering type TR040 wide-range, low-cost laboratory supply. **(370)**

SOLID-STATE RELAYS Tri-State Electronics, Inc., 2734 Lee Highway, Falls Church, Va., offers two bulletins describing its polar solid-state and neutral solid-state electronic relays. **(371)**

TEST THERMOMETERS Atkins Technical, Inc., P. O. Box 14405, University Station, Gainesville, Fla. A series of data sheets describes a line of general purpose test thermometers. **(372)**

OF THE WEEK

PRECISION POTENTIOMETERS Polara Corp., 55 Milbar Blvd., Farmingdale, N. Y. A product bulletin describes the SM-18 precision slidewire potentiometers for servo applications. **(373)**

R-F COAXIAL CONNECTORS Applied Engineering Products Co., 375 Fairfield Ave., Stamford, Conn., 06904. Catalog No. 164 describes a line of subminiature coaxial r-f connectors. **(374)**

MINIATURE PRECISION CONNECTORS Connector Division, Waltham Precision Instrument Co., Inc., 285 White St., Danbury, Conn., 06813. Catalog 1163 describes Gorn miniature precision connectors. **(375)**

D-C VOLT/AMMETER Ballantine Laboratories, Boonton, N.J., has available a technical bulletin describing model 365 d-c volt/ammeter. **(376)**

TRANSIENT VOLTAGE DETECTOR Regent Controls Inc., Harvard Ave., Stamford, Conn. Bulletin 103TD describes model TD763 automatic transient voltage detector. **(377)**

CRYSTAL-CAN RELAY General Electric Co., Schenectady 5, N. Y. Bulletin GEA-7650 describes type AV half-size crystal-can relay. **(378)**

L-F NOISE GENERATOR Elgenco, Inc., 1231 Colorado Ave., Santa Monica, Calif. Bulletin EI-321A discusses a low-frequency noise generator featuring solid-state chopper and highly regulated rms level. **(379)**

ANALYTICAL POLISHING DISKS Geoscience Instruments Corp., 110 Beekman St., New York, N. Y. 10038, offers a technical report, "Polishing Semiconductors and Electronic Materials." **(380)**

TIN-LEAD RATIO CHART Alpha Metals, Inc., 56 Water St., Jersey City 4, N. J., has available a simplified tin-lead ratio chart to assist in solder selection. **(381)**

TRIMMER POTENTIOMETERS MINELCO, Miniature Electronic Components Corp., 600 South St., Holbrook, Mass., offers a bulletin describing type HR, highly reliable microminiature trimmer potentiometers. **(382)**

COAXIAL CONNECTORS Micom Electronics, Inc., Zeckendorf Blvd., Garden City, N. Y., offers its 50-page catalog 103 describing several lines of coaxial connectors. **(383)**

TRANSISTOR CIRCUITS Sylvania Electric Products Inc., 1100 Main St., Buffalo, N.Y., 14209, offers a brochure containing eight typical circuits for its *npn* germanium alloy transistors. **(384)**

R-F SHIELDING Nova Industries, Inc., 699 Castro St., San Leandro, Calif. A 4-page brochure describing the latest concept in radio-frequency shielding is now available. **(385)**

DATA TRANSMISSION SYSTEM Lenkurt Electric Co., Inc., 1105 County Road, San Carlos, Calif., has issued a pamphlet on the 25A data transmission system, which provides 200-bits-per-sec data transmission for virtually any intermediate-speed application. **(386)**

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Burroughs Combines Two Divisions

BURROUGHS CORPORATION, Detroit, Mich., as part of an overall company realignment, has announced consolidation of two divisions which manufacture electronic components used in its systems and sold commercially.

The Electronic Instrument division in Philadelphia and the Electronic Components division, Plainfield, N. J., are being combined and called the Electronic Components division. It will occupy facilities in Plainfield.

The changes will be gradual, continuing until the Fall of this year. Construction of a 75,000-square foot addition to the present building at Plainfield will start in the Spring.

Saul Kuchinsky, who has been general manager of the Electronic Components division, becomes general manager of the combined operation.

Jacob J. Mayer, formerly general manager of the Electronic Instrument division, is named manager of manufacturing at Plainfield.

Each of the units involved in the new Electronic Components division employs about 400. When consolidation is completed, there will be more than 800 employed. Total Burroughs employment is about 25,000 in the U. S. and 36,000 world-wide.

S. KUCHINSKY

J. J. MAYER

Dolan Accepts New Position

PAUL R. DOLAN has been named president of Micro Systems, Inc., a Pasadena subsidiary of Electro-Optical Systems, Inc. He succeeds William V. Wright, Jr., who has returned to the parent company as a corporate vice president.

Dolan was formerly president of Pioneer Mfg. Co., Los Angeles. At MSI, he will be responsible for all management activities including manufacturing and marketing. MSI is a producer of pressure and temperature transducers, sensors, strain gages and electronic support equipment.

GI Appoints Two Executives

TWO major appointments in the General Instrument Capacitor division have been announced by M. H. Benedek, GI board chairman:

Aniello A. DiGiacomo has been promoted to the post of vice president, R&D, of the Capacitor divi-

GE Realigns Industrial and International Groups

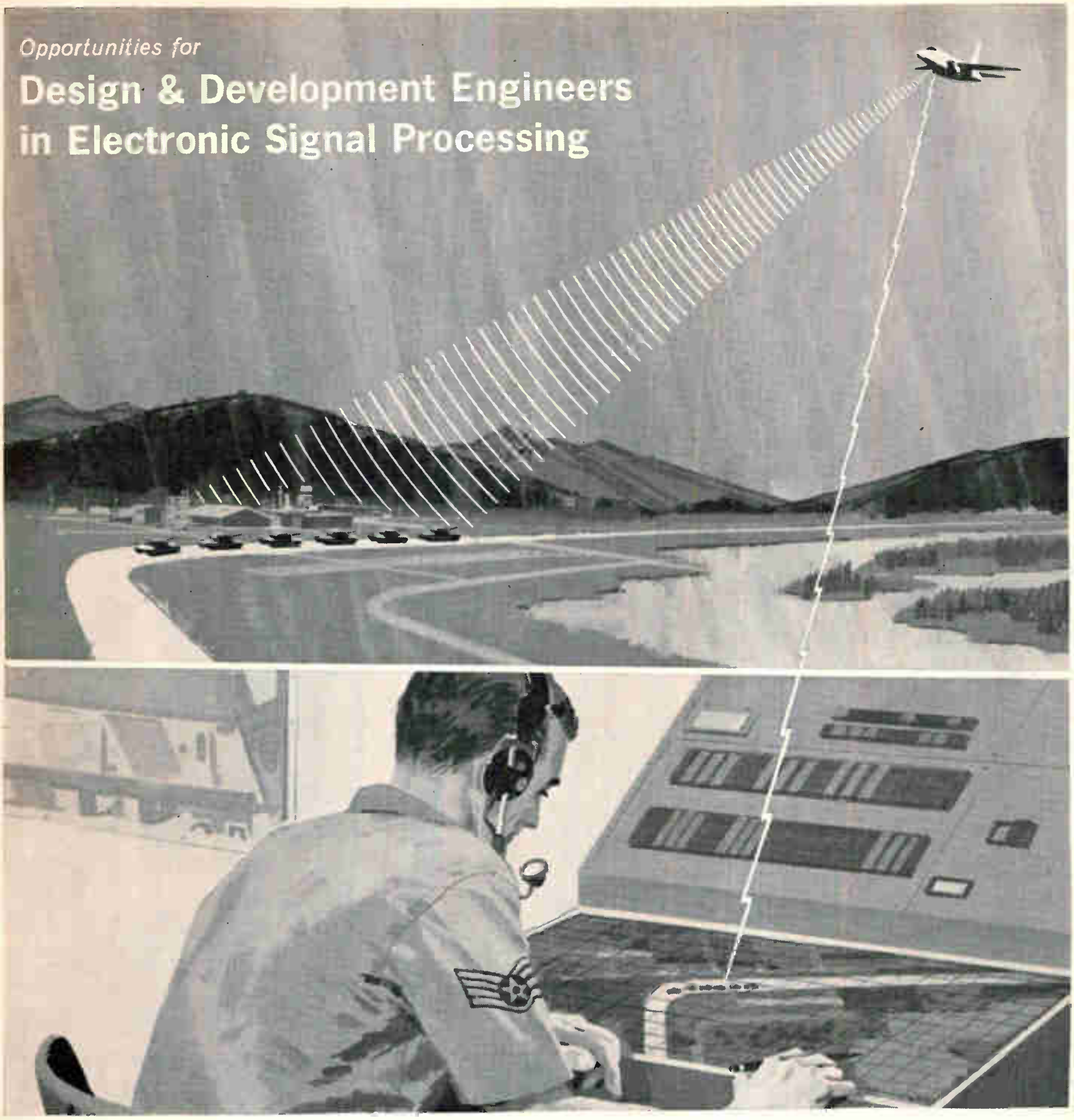
GENERAL ELECTRIC COMPANY president and chief executive officer Fred J. Borch has announced changes in the company's organizational structure "designed to align the company more closely with the markets which it serves."

The Industrial Group, under Hershner Cross as vice president and group executive, adds three divisions:

- Supply Company division (Bridgeport, Conn., Reginald H. Jones, vice president & general manager)
- Electronic Components division (Owensboro, Ky., L. Berkley Davis, vice president & general manager), formerly a part of the Aerospace and Defense Group
- Construction Industries division (Bridgeport, Conn., also headed by Jones) newly set up.

In other changes within the Industrial Group, the Industrial Sales Operation (Schenectady, N. Y., S. Wellford Corbin, vice president & general manager) becomes the Industrial Sales division; the Capacitor Department (Hudson Falls, N. Y.) is transferred from the Transformer division to the Electronic Components division; and the Industrial Heating Department is assigned to the Component Products division (Fort Wayne, Ind., Harold A. MacKinnon, vice president & general manager).

Changes within the International Group are as follows: Under vice president and group executive James H. Goss, the International Group will consist of four divisions—the IGE Export Division (formerly the International General Electric Company division, Wlliam C. Wichman, vice president and general manager), and three new Area Divisions to be known as the Area Division—Europe (Goss, acting general manager), Area Division—Far East (Wichman, acting general manager), and Area Division—Latin America R. E. Whitmyer, general manager).



Design and development activities in the field of Electronic Signal Processing are rapidly expanding today at HUGHES Aerospace Divisions.

Development of systems utilizing advanced correlation and matched filter techniques for *High-Resolution Radar, Acoustic Detection & Classification* and *Pulse Doppler Radar* is being accelerated.

Specialists in Signal Processing, Circuit Design, Mechanical Design, Packaging Design, Performance Analysis and Project Engineering will be interested in the outstanding assignments now available.

Graduate engineers with experience in wide-band video amplifiers; high-resolution cathode ray tube circuits and applications (including ultra-linear sweep, gamma correction and dynamic focus); high-voltage power supplies; low-jitter timing circuitry; high-speed analog sampling circuitry; precision film transports; ultra-high speed film development; scan conversion systems; synthetic array radar systems; imagery recording, or similar fields—are invited to submit resumes.

For immediate consideration please write:

Mr. Robert A. Martin
Head of Employment
HUGHES Aerospace Divisions
11940 W. Jefferson Blvd.
Culver City 87, Calif.

Creating a new world with electronics

HUGHES

HUGHES AIRCRAFT COMPANY
AEROSPACE DIVISIONS

An equal opportunity employer

U. S. CITIZENSHIP REQUIRED

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was general manager of the FSD Washington Systems Center in Bethesda, Md.

The Federal Systems division is developing a number of advanced information systems projects. These range from guidance computers for Saturn launch vehicles to the computing complex now being installed near Houston, Texas, for ground monitoring of Project Gemini and Project Apollo flights.

PEOPLE IN BRIEF

Don B. Hamister and **Chester J. Kawiecki** promoted to g-m and asst. g-m, respectively, of Joslyn Electronic Systems div. of Joslyn Mfg. and Supply Co. **Ernest W. Swift** moves up to exec v-p of Wilbur B. Driver Co. **George Eisler,** former president of Eisler Associates, appointed director, advanced planning and design, for Scientific Data Systems. **Elliot Ring** advances at Martin Co. to director of design and development in the Orlando div. **Thomas J. Richardson,** ex-Assembly Products, Inc., named asst. g-m of Wac-Line Meters. **Roger S. Hewett** leaves Honeywell to join the Industrial Controls div. of General Precision, Inc.'s Simulation & Controls Group as director of engineering. **Arthur S. Rosenthal,** previously with Teleregister Corp., now mgr.-systems and data processing at the Norden div. of United Aircraft Corp. **Howard D. Tindall,** from H. K. Porter Co. to International Rectifier Corp. as product mgr. for high voltage stacks. **Burnett G. Anderson** raised to mgr., special programs, RCA Electronic Data Processing. **Kennard H. Morganstern,** former associate professor of E. E. at Purdue, appointed director of research at Radiation Dynamics, Inc. **Howard C. Johnson** advances to v-p, Pacific Sales div. of The Thomas & Betts Co. **Robert M. Scarlett** promoted to director, Shockley Research Laboratories. **Conrad J. Rauch,** ex-MIT Lincoln Laboratory, joins Cryonetics Corp. as mgr. of solid state physics research.

EMPLOYMENT **electronics** OPPORTUNITIES

WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

This Qualification Form is designed to help you advance in the electronics industry. It is unique and compact. Designed with the assistance of professional personnel management, it isolates specific experience in electronics and deals only in essential background information.

The advertisers listed here are seeking professional experience. Fill in the Qualification Form below.

STRICTLY CONFIDENTIAL

Your Qualification Form will be handled as "Strictly Confidential" by ELECTRONICS. Our processing system is such that your form will be forwarded within 24 hours to the proper executives in the companies you select. You will be contacted at your home by the interested companies.

WHAT TO DO

1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
4. Circle the corresponding key number below the Qualification Form.
5. Fill out the form completely. *Please print clearly.*
6. Mail to: Classified Advertising Div., ELECTRONICS, Box 12, New York, N. Y. 10036.

COMPANY	SEE PAGE	KEY #
ACF INDUSTRIES INC. Albuquerque Division PO Box 1666 Albuquerque, New Mexico	66	1
ATOMIC PERSONNEL INC. Philadelphia, Pa.	113*	2
BENDIX CORPORATION Box 303 Kansas City, Mo.	113*	3
GENERAL MOTORS CORPORATION Delco Radio Division Kokomo, Indiana	26*	4
HONEYWELL St. Petersburg, Fla.	61	5
MELPAR INC. Sub. of Westinghouse Air Brake Co. Falls Church, Virginia	100	6
PAN AMERICAN WORLD AIRWAYS INC. Guided Missiles Range Div. Patrick Air Force Base, Fla.	67	7
P-3494	113*	8

* These advertisements appeared in the Jan. 3, 1964 issue.

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electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

(Please type or print clearly. Necessary for reproduction.)

Personal Background

NAME ....

HOME ADDRESS ....

CITY .... ZONE ...... STATE ....

HOME TELEPHONE ....

Education

PROFESSIONAL DEGREE(S) ....

MAJOR(S) ....

UNIVERSITY ....

DATE(S) ....

FIELDS OF EXPERIENCE (Please Check) 11064

☐ Aerospace	☐ Fire Control	☐ Radar
☐ Antennas	☐ Human Factors	☐ Radio—TV
☐ ASW	☐ Infrared	☐ Simulators
☐ Circuits	☐ Instrumentation	☐ Solid State
☐ Communications	☐ Medicine	☐ Telemetry
☐ Components	☐ Microwave	☐ Transformers
☐ Computers	☐ Navigation	☐ Other ....
☐ ECM	☐ Operations Research	☐ ....
☐ Electron Tubes	☐ Optics	☐ ....
☐ Engineering Writing	☐ Packaging	☐ ....

CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

	Technical Experience (Months)	Supervisory Experience (Months)
RESEARCH (pure, fundamental, basic)	....	....
RESEARCH (Applied)	....	....
SYSTEMS (New Concepts)	....	....
DEVELOPMENT (Model)	....	....
DESIGN (Product)	....	....
MANUFACTURING (Product)	....	....
FIELD (Service)	....	....
SALES (Proposals & Products)	....	....

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES

EQUIPMENT - USED or RESALE

DISPLAYED RATE

The advertising rate is $27.25 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request. AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page. EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

UNDISPLAYED RATE

$2.70 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

PROPOSALS, $2.70 a line an insertion.

BOX NUMBERS count as one line additional in undisplayed ads.

DISCOUNT OF 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

WANTED

Electronic Parts and Equipment.
May be complete or incomplete.

Writing giving quantity and description.

OLSON ELECTRONICS, INC.

Irving K. Olson   Tel. JE 5-9191

260 E. Forge St., Akron 8, Ohio

CIRCLE 950 ON READER SERVICE CARD

No-Drip

POTTING APPLICATORS

For encapsulating potting and sealing of miniature and subminiature components

6 cc
12 cc
30 cc

FEATURES
- Low Cost
- Simple Operation
- Absolutely Clean

PHILIP FISHMAN CO.

7 CAMERON ST., WELLESLEY 81, MASSACHUSETTS
PHONE: 237-0133 AREA CODE: 617

CIRCLE 951 ON READER SERVICE CARD

SMALL AD but BIG STOCK

of choice test equipment and surplus electronics

Higher Quality—Lower Costs
Get our advice on your problem

ENGINEERING ASSOCIATES

434 Patterson Road — Dayton 19, Ohio

CIRCLE 952 ON READER SERVICE CARD

TUBES & COMPONENT

FREE...CATALOG
BARRY ELECTRONICS

512 BROADWAY   212-WAlker 5-7000
NEW YORK 12, N.Y.   TWX-571-0484

CIRCLE 953 ON READER SERVICE CARD

ELECTRON TUBES

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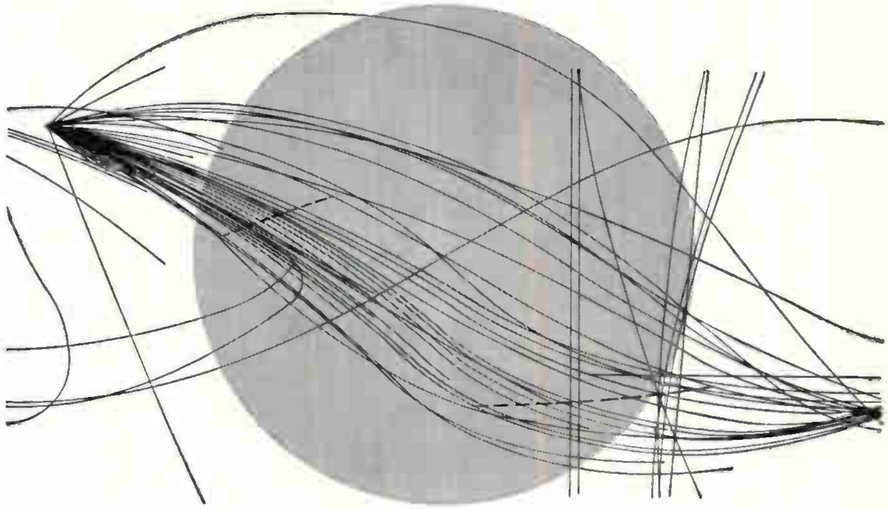

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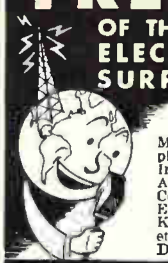

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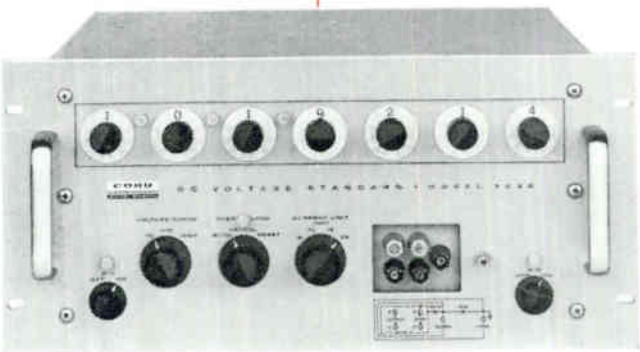

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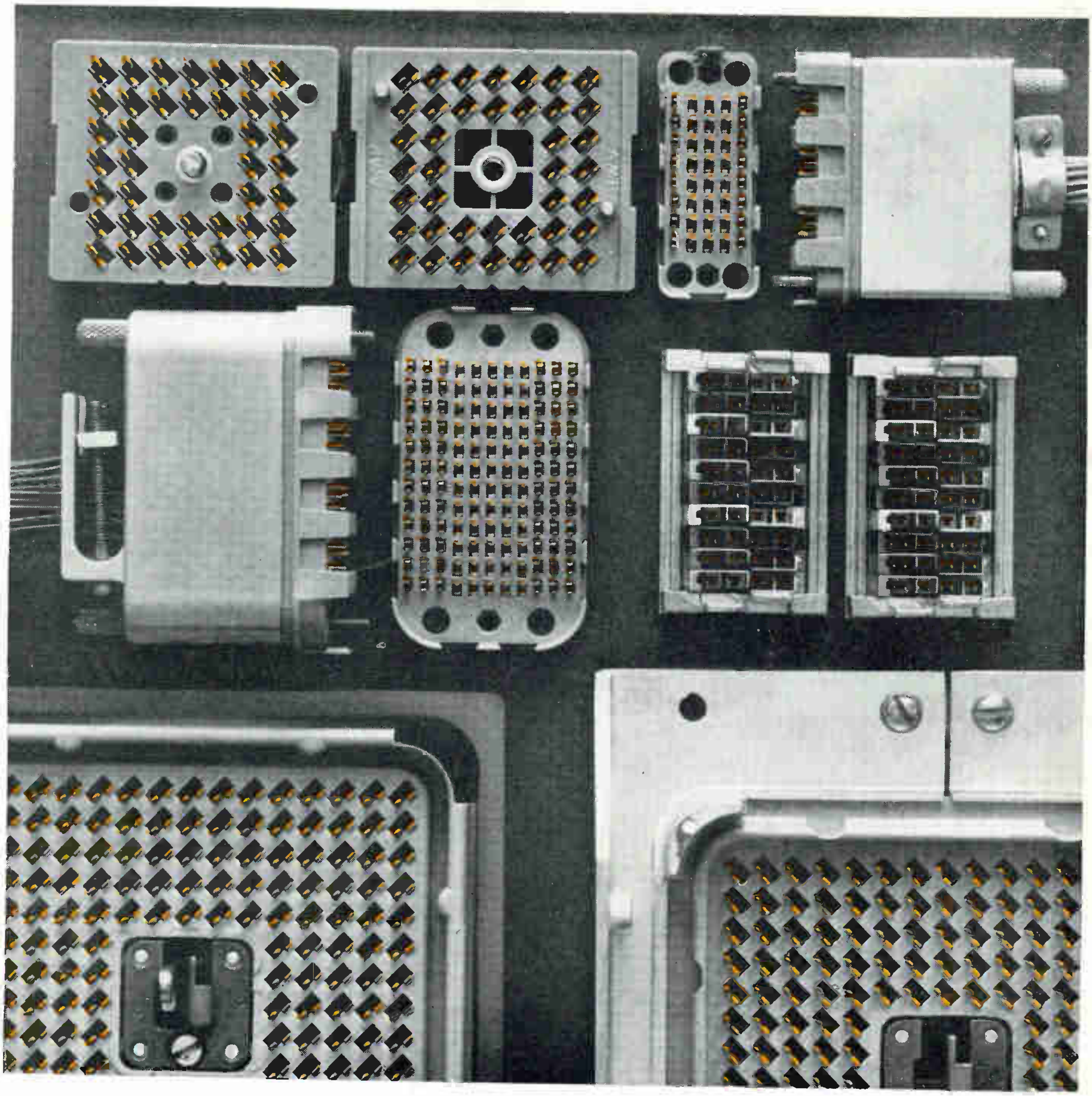

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