March 23, 1962

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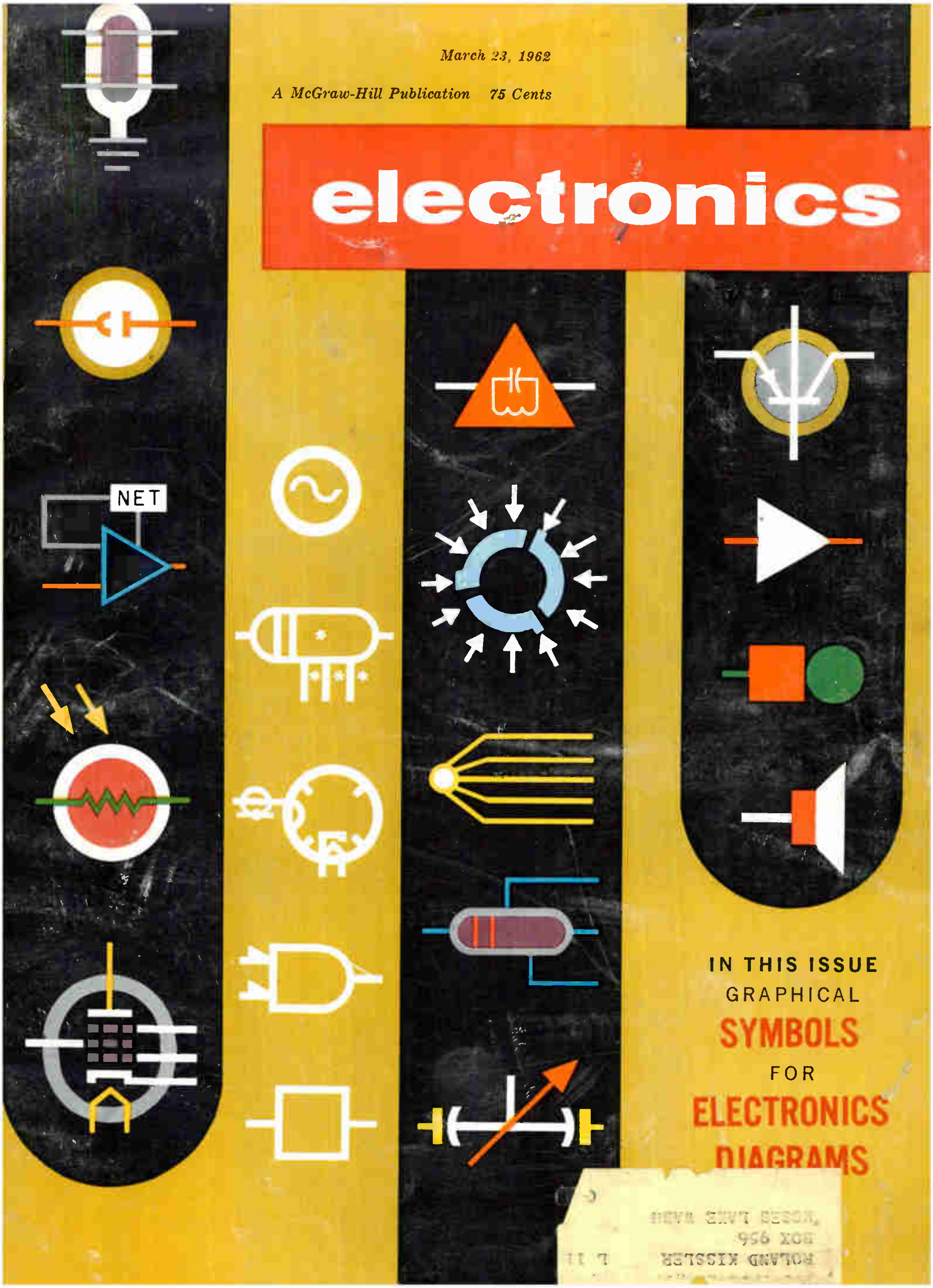
electronics



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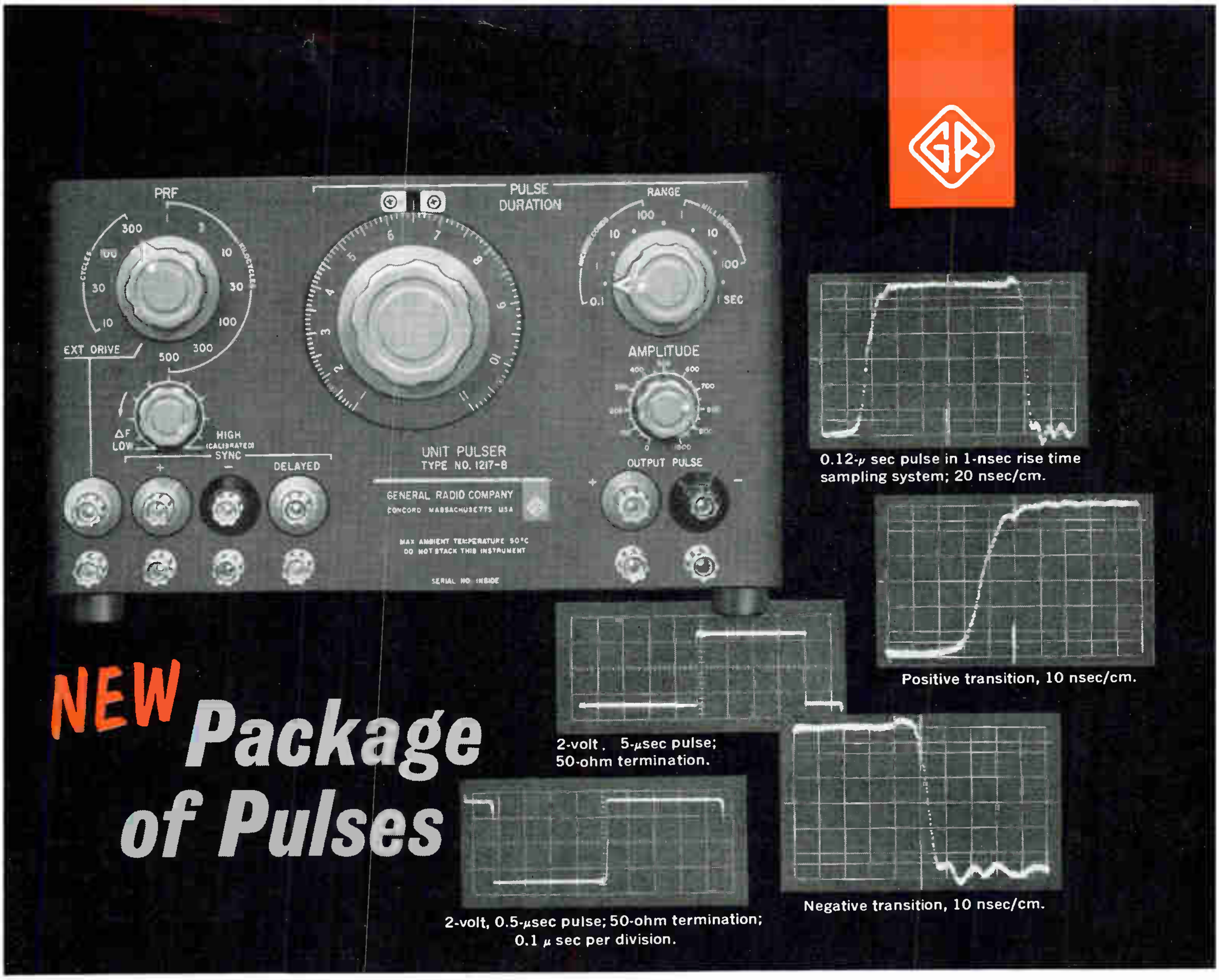
SYMBOLS
FOR
ELECTRONICS
DIAGRAMS



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electronics

A McGraw-Hill Publication *75 Cents*

W. W. MacDONALD, *Editor*

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electronics

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CONTENTS continued

DEPARTMENTS

CROSSTALK

INTEGRATION. Electronic integrator circuits connote elaboration and complexity. They call to mind chopper stabilized amplifiers, expensive high tolerance components, and power supplies —perhaps with d-c heater voltages—almost as complex and costly through voltage stabilization, as the integrator itself.

There are other approaches to integration, electromechanical, for one. The ball and disk integrator operates without time being one of the independent variables. Or, for simplicity, there is the integrating motor. Speed varies linearly with voltage, hence total rotation is an integral function of input voltage.

A relative newcomer to integration processes is the solion, an electrochemical cell. Electrochemical integrators have been used to measure the total ON time of a piece of equipment, but they usually give a readout by changing color with hours of use.

On page 46 this week, J. W. Martin and J. R. Cox, of Texas Research and Development Corp., describe how to use a solion as a current integrator. In Cox and Martin's circuit, the solion actually delivers an electrical signal that is a direct integral of the input. Adding amplifiers gives versatility and power comparable to conventional integrators. In the photo above, the authors are seen checking out an integrator developed for a chromatograph.

BREAKTHROUGHS. Many of today's logic circuits existed, at least in principle, years ago. Although the rapid development of semiconductor devices and circuits has added an infinite number of variations and combinations, it is difficult to find a new circuit that can't be traced back to a vacuum tube, saturable reactor or even relay origin.

Eccles and Jordan developed their divide-by-two circuit around 1919. In the late 1930's, the phantastron was invented. Its inventors thought the performance of this one-tube, free-running, waveform generator fantastic, hence the name. A little later, the British invented a time-base generator and called it the sanatron—their slang word for approval at the time was "sanitary."

Solid-state technology was advanced a few notches in 1958 by Esaki's tunnel diode. Logic circuits employing the tunnel diode's negative resistance characteristics are competing now with transistor circuits. Yet several early vacuum tube circuits were based on the negative resistance portion of certain tetrode characteristics.

In recent years, amalgamation of semiconductor components with magnetic amplifiers and saturable reactors have provided controls that are sensitive and trustworthy. This week, on page 43, R. E. Morgan, of GE, reports on an unusual combination of a tunnel diode and saturable reactor which gives motor controls great flexibility.

Conventionally, the semiconductor device might set the control current in a reactor's control winding. Morgan uses the control current to regulate the reactor's magnetic saturation. This, in turn, sets the frequency of the diode's relaxation oscillations. The upshot is a control circuit which can be used to adjust the speed of a three-phase motor over a 1,000:1 range.

Coming in Our March 30 Issue

BIG PULSER. Brookhaven National Laboratory is in the news for helping discover a missing nuclear particle, the anti-X-minus. The lab's basic equipment includes an alternating gradient synchrotron fed particles by a 3.5-Mev Van de Graaff generator. Next week, E. J. Rogers tells how its output is boosted with octupler power supply and 150-Kv pulser.

Another article coming up is a report by M. H. Damon and F. J. Messina, of ITT Labs, on a dual-head recording system that tapes 52 channels of wideband analog data with each channel 15 Kc wide. There will also be reports on a miniature counter using a diode array, a noise-free keying circuit, a new analog multiplier and overload protection.

COMMENT

Banana-Tube Color Television

The publication of the interesting development in coloured television, known as the "banana tube," in the January 26 issue (p 44) does not pretend to deal with the historical development of the subject, but the impression is given that the use of electronic line scanning with mechanical frame scanning is a new and significant contribution.

I thought, therefore, that students of the subject would be interested to know that a similar system was proposed by me in 1937, and published in British patents specification number 508037, 1939, which although it does not use the same shape of cathode ray tube or rotating lens, was nevertheless designed with the same objectives. The system also avoided the construction of two-dimensional display with colour selecting grids, and also provided for light from a wide area of phosphor to be collected and focuses to a narrow line, thus giving the colour reproducer a long life.

C. N. SMYTH
University College Hospital
Medical School
University of London, England

Electromagnetic Retina

I have read with great interest your series on bionics, particularly that portion relating to the mechanics of vision. The phrase "the photochemical action of the retina" appears in several places. There is no such animal as photochemical action in the retina. The retina is purely electromagnetic in action. Each cone can be regarded as a $\lambda/4$ stub with an associated rectifier and capacitor. These capacitors integrate a charge until it is picked off by the alpha rhythm acting as a scan waveform. Although the whole theoretical argument is far too long for discussion here, it results in an explanation of color vision that is:

(a) compatible with Newton;

(b) compatible with Land;

(c) compatible with existing medical knowledge except that it does not postulate any magic photochemicals. These always remind me of the exotic compounds mentioned in toothpaste ads.

(d) and compatible in terms of physical size, bandwidth requirements, etc.

Once this view of color vision is accepted, we have automatically solved 10,000 separate mysteries and replaced them by a single common process. We can answer such questions as why a grain of wheat will remain dormant for 2,000 years in Tutankhamen's tomb but yet will inevitably germinate if its moisture content is raised to 15 to 24 percent and the temperature is in the range 60 to 90 degrees.

We can account for the odd fact that small animals such as mice, to whom the gift of a 10 percent reduction in body temperature would be an invaluable boon, actually are required to operate at a temperature higher than larger animals.

In fact, by accepting the simple statement made earlier, we have discovered the fundamental process by which all living cells perform their functions.

A. J. REYNOLDS
Babylon, New York

The four-part bionics series appeared on p 37, Feb. 9; p 40, Feb. 16; p 41, Mar. 2; and p 60, Mar. 16

Tone Transceivers

I would like to comment on the article, Combined Oscillator-Amplifier for Tone Transceivers, by R. C. Carter, in the issue of Feb. 2 (p 44). I found the article quite interesting. There are three corrections that should be made, however.

(1) The coefficient of s^2 in Eq. 25 (p 46) is T_o^2, since T_o is defined as $(LC)^{\frac{1}{2}}$.

(2) Equation 27 should read $T_1T_2 = T_o^2$. There is no restriction on the magnitude of Q.

(3) The $\simeq$ in Eq. 32 should read $=$, and the expression "(for $Q>5$)" should be omitted.

The only place where the magnitude of Q is involved is in considerations such as Fig. 3, where a low Q shifts the peak from $1/T_o$.

BARRY C. DUTCHER
Huntington Station, New York

Author Carter comments: "I goofed. Equation 25 does not follow from Eq. 23. This makes Eq. 32 exact rather than approximate."

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Other materials exhibited at the Arnold Booth will include Silectron C, E and O cores; tape wound cores of Deltamax, Square Permalloy, Supermendur and other high-permeability alloys; Mo-Permalloy powder cores, iron powder cores, piezo-electric and ferro-electric ceramics; and laminations, cans and shields from our Pacific Division.

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ELECTRONICS NEWSLETTER

$52 Million Going into RS-70 Electonics

WASHINGTON—In reasserting his opposition to a stepup in the B-70 program (p 12, March 16) Secretary of Defense McNamara revealed that the new budget earmarks $52 million for development of electronic subsystems for potential use in the reconnaissance-strike (RS-70) version of the plane. This is in addition to the $171 million scheduled for three stripped-down prototypes.

The $52 million will be spent on new development contracts, after July 1, for side-view radar and for electronic processing, display and interpretation equipment.

At present, McNamara said, the $320 million added by the House Armed Services Committee would not "fruitfully" speed up electronic subsystem development.

Advance research on such systems is presumably underway independent of specific weapons systems.

However, he has asked the Air Force to "reexamine the technology" in this field and report back to him with more definitive proposed schedules for accelerating work on RS-70 electronics. The Air Force is expected to come up with its new recommendations in about a month.

McNamara's statement implies that he may be willing to modify his strong opposition to any change in the project's schedule.

If Sage is Knocked Out Will Buic Take Over?

HANSCOM FIELD, MASS.—Air Force Systems Command's Electronic Systems Division is preparing to select contractors for a new program, described as a "powerful partner" to Sage. It will be called Buic (Back-Up Interceptor Control).

Buic is termed an emergency means of controlling weapons in the NORAD inventory, providing back-up weapons control capability for Sage direction centers after an atomic attack.

A solid-state computer will be installed at sites in existing buildings, together with communications and display equipment. The installations will be made secure against atomic fallout. Facilities will enable Air Force officers to direct post-attack air battles.

The Buic program is managed by the 416L Sage System Program Office. Mitre Corp. has completed design engineering and Rome Air Development Center is responsible for equipment design engineering.

Another Airline Buys Big Reservations System

NEW YORK—IBM and Pan American World Airways last week signed a contract for a high-speed computer system that will handle passenger reservations and a number of other scheduling, business and accounting functions. Cost was not announced, but is reportedly around $25 million.

The system, called Panamac includes dual IBM 7080 computers, two 1401 computers supplementing the 7080's, three 7750 programmed transmission control units, and eight 1301 disk storages with a capacity of 400 million characters.

Overall system is called the IBM 9080 Tele-processing System and also includes remote input-output terminals, communications control equipment and a communications network linking 114 cities on six continents to the data processing center.

Ceramic Receiving Tube Warms Up in 1.3 Seconds

FEASIBILITY of developing receiving tubes with warmup time of 1.3 sec is to be reported at the IRE Convention by J. M. Connelly and D. D. Mickey, of General Electric's Receiving Tube department, Owensboro, Ky.

They say the high-speed warmup was achieved in ceramic diodes and triode tubes similar to types 7266 and 7468. Bonding the heater to the cathode to provide heat transfer by conduction while keeping them electrically isolated reduces warmup time to 2.5 sec. Adding a ballast resistor in series with the heater to provide a current surge gives a further reduction to 1.3 sec. The resistor can be built inside the tube.

Laser Moon-Bounce Experiment Planned

WASHINGTON—Plans for a laser moon-bounce experiment were outlined at the American Optical Society meeting last week.

The beam from a ruby laser will be aimed at the moon through the

"Made in Japan"... But No Label

JAPANESE TRANSISTORS and diodes are being shipped to Europe by the millions for relabeling and sale by at least one of Europe's leading electronics manufacturers, it has been reported to ELECTRONICS by a reliable source in Japan.

Other examples of sale in Europe and elsewhere of Japanese electronics products which later appear to be European-made were reported in Washington last week by members of an EIA Industrial Parts Marketing team that recently visited Europe.

In one case, antennas in European microwave systems were identified as Japanese. But the buying country insisted they were made in another European Common Market country.

Japanese have set up and staffed in Ireland a plant to supply common market countries with Japanese-designed products made in Ireland

University of Michigan's 37-in. reflecting telescope, said Peter A. Franken. While the light is on its 2.5-sec round-trip, a prism will be placed in the telescope to deflect the return echo into a sensitive light-measuring device. Scattering is expected to reduce return light to 15 photons.

Purpose of the experiment is to gather data for a satellite-bounce try, to be undertaken with Conductron Corp. and Trion Instruments (NASA support is being sought). A radio signal will be transmitted simultaneously, to determine if radio and light waves really do travel at the same speed in a vacuum.

A reflector on the satellite would enhance echo strength.

Heavy-Duty Laser to Bow at the IRE Show

WESTINGHOUSE ELECTRIC'S electronic tube division is entering the laser field with a heavy-duty, pulse-type laser it will introduce next week at the IRE Show. The laser is designed for experimental use in micromachining and welding.

It has an 800 to 8,000-v power supply. Maximum energy storage capacity is 25.6 kilojoules, switched into the load with an ignitron. Pulse rate can be varied from 0.25 to 12 a minute. Maximum power output of the supply is 10 Kw.

The laser head assembly directs radiation down through a liquid nitrogen-filled Dewar flask containing optical windows. The flash lamp portion of the head is cooled by compressed air. Price is $25,000.

Sage System Completed, But Not the Accountants

WASHINGTON—General Accounting Office charges that the Air Force "unnecessarily" spent $10.8 million in equipping the Sage system. The agency said the Air Force failed to cancel a contract to buy manual control equipment "after it became apparent that the equipment was not needed," prematurely bought gap-filler radars, and "failed to reduce" procurement of consoles, generators, air-conditioning and boiler equipment at sites "to actual needs when operation experience became available."

Will Show Germanium Planar Microdiode

BOSTON—Transitron will announce a germanium planar microdiode at the IRE Show in New York next week. Silicon dioxide—presumably deposited—is used for surface passivation.

Junctions are diffused in lots of 1,000. Batch process also lends itself to manufacture of several common-anode diodes on a single germanium substrate. Available sample lots include three diodes in a TO-18 header and five in a TO-5 header.

The company says computer makers need a germanium planar device, since it provides appreciable currents at low voltage, in the range of 0.35 v. Transitron claims the diode has better reliability and is lower in cost than gold-bonded diodes. Tests indicate the possibility of significant improvements in forward characteristic and pulse recovery, the company says.

Pentagon Puts Tighter Reins on Consultants

WASHINGTON—A new Pentagon directive tightens up conflict-of-interest policies for 2,000 part-time industrial and scientific consultants serving the military.

Rules now require consultants to file a detailed statement of employment and financial interests by April 30. Specialists spending more than 40 percent of their time as government consultants are forbidden to deal with military agencies on behalf of companies for whom they work regularly or in which they have financial interests. Those who serve the government less than 40 percent of their time are not allowed while on government status, to deal with projects involving their regular employer.

Consultants are also prohibited from using inside information for private benefit or, as a Pentagon spokesman says, "engaging in activities which give the appearance of using such information for private gain."

In Brief . . .

PERKIN-ELMER and Spectra-Physics, Inc., will sell commercially a 13-lb, helium-neon, c-w gas laser for $7,500. Coherent light output is 1 mw at 11,530 angstroms.

FOLLOW-ON missile contracts include $27 million to General Dynamics for continued production of Tartar and Advanced Terrier, and $10.2 million to Ford Motor, for continued development of Shillelagh.

SONAR contracts include $6 million to Sangamo Electric for 24 sonar sets, and $4.4 million to Raytheon for transducers.

OTHER major military contracts are $4 million to RCA for classified gear; $3.2 million to Bendix for aircraft system components, and 3.5 million to Ryan Electronics for doppler navigators.

DEVELOPMENT contracts include $1.2 million to Sylvania for a miniature security system for Minuteman; $1 million to General Electronic Labs; $600,000 to Martin, for advanced submarine detection techniques; $76,782 to Dresser Research for a nuclear speedometer for submarines; $185,683 to Electronic Communications for filter and radar array studies.

CRYOGENIC Engineering Co. will supply CERN, European Organization for Nuclear Research, with a hydrogen liquifier, is building others for Brookhaven National Laboratory and Midwest University Research Assoc.

PITNEY-BOWES and National Cash Register have jointly developed a document sorter which reads and sorts 1,620 checks a minute.

AIR FORCE Electronic Systems Division has invited eight companies to bid on procurement of 35 AN/TPQ-11 weather radars.

BURROUGH'S booth at the IRE show will include a remote stock market display allowing conventioneers to dial for data on 2,000 stocks via a telephone-computer system.

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Powering bench setups

hp 711A Laboratory Power Supply, 0 to 500 v, 100 ma. This general purpose regulated dc supply for lab and field use is an exceptional value. Output changes less than 0.5% or 1.0 v (whichever is greater) for a 10% line voltage change or no load to full load. hp 711A (cabinet), $250.00; hp 711AR (rack mount), $255.00.

Testing radar, pulsed systems

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WASHINGTON OUTLOOK

NIKE ZEUS FUTURE LOOKS DIM

DEFENSE SECRETARY McNAMARA has put the kibosh on Army proposals to produce and deploy Western Electric's Nike Zeus anti-ICBM system. In closed-door testimony to Congress, to be publicly released shortly, he said Zeus, as now conceived, could not cope with a massive ICBM attack.

He is believed to have said that the project is being kept alive primarily because development work is generating technical data of potential value to more advanced anti-ICBM systems and of use in designing and improving U. S. strategic weapon systems. Success in this year's operational-type Zeus tests in the Pacific, McNamara believes, will have no bearing on possible production of the system and its components as now designed.

Harold Brown, director of Defense Research & Engineering, believes that a terminal defense system still poses the most practical type of anti-ICBM defense. He believes Zeus R&D should be continued because "it's the only game in town; the consequences of ICBM defense are so great, we can't afford to drop it."

NO STOCK SALES FOR SATELLITE SYSTEM?

THE ADMINISTRATION'S bid to gain congressional support for its ownership plan for a communications satellite system is stymied. Meeting strong opposition in the Senate, the White House hoped to spark support in the House. E. G. Welsh, executive secretary of the National Aeronautics and Space Council, and Attorney General Robert F. Kennedy tried hard.

However, criticism in hearings held by the House Interstate and Foreign Commerce Committee closely followed that leveled by the Senate Aeronautical and Space Sciences Committee a week earlier. Primary objection is the unwieldy corporate structure proposed by the administration.

The administration is clearly seeking to prevent the satellite system from being dominated by AT&T. Welsh told the House committee, "so far as financing is concerned, the basic alternatives seemed to be government ownership, financial domination by one company, or private broad-based ownership," the latter as proposed by the administration.

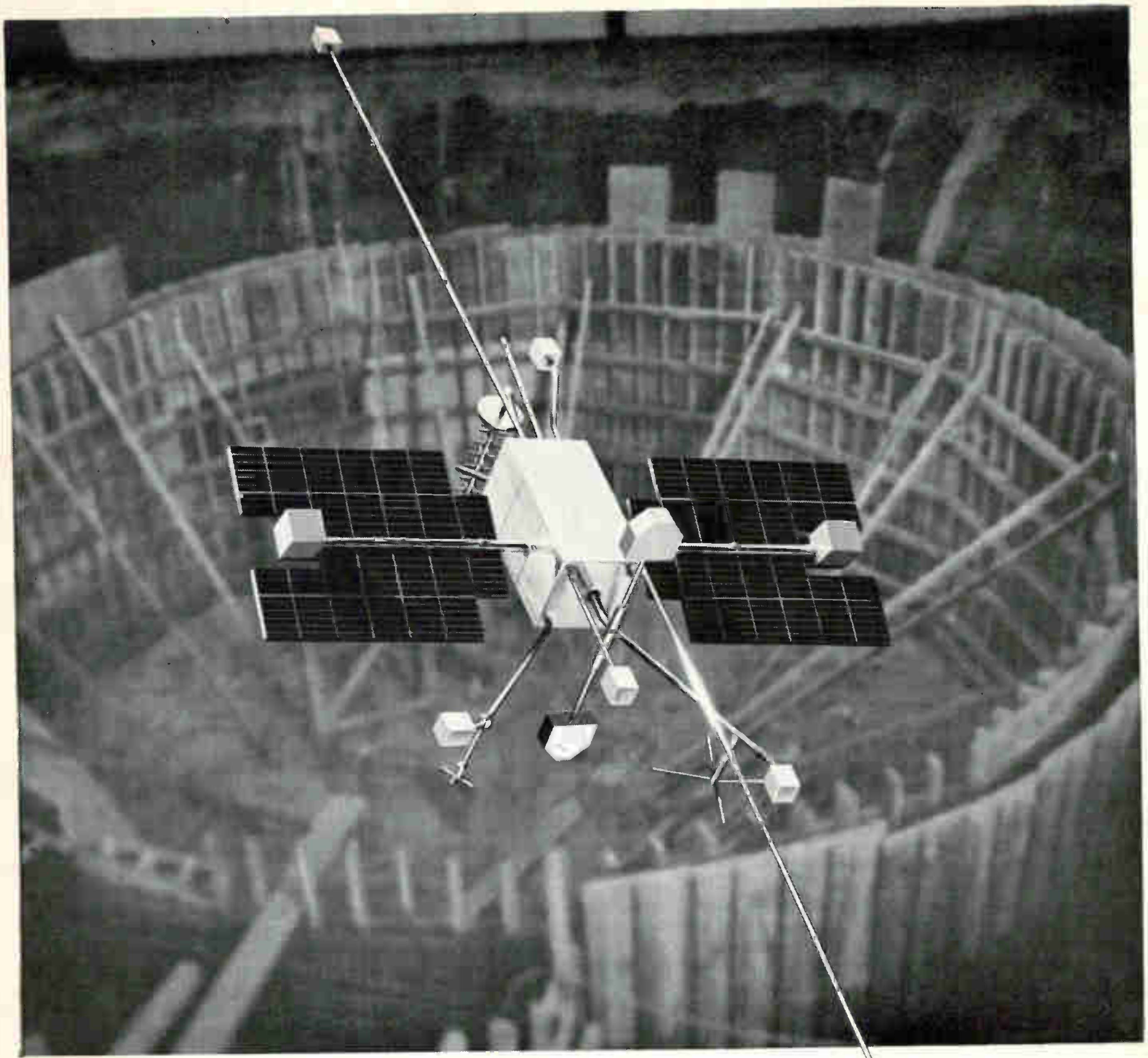
In spite of administration arguments, final congressional approval of an ownership plan is expected to be lodged mainly with common carriers.

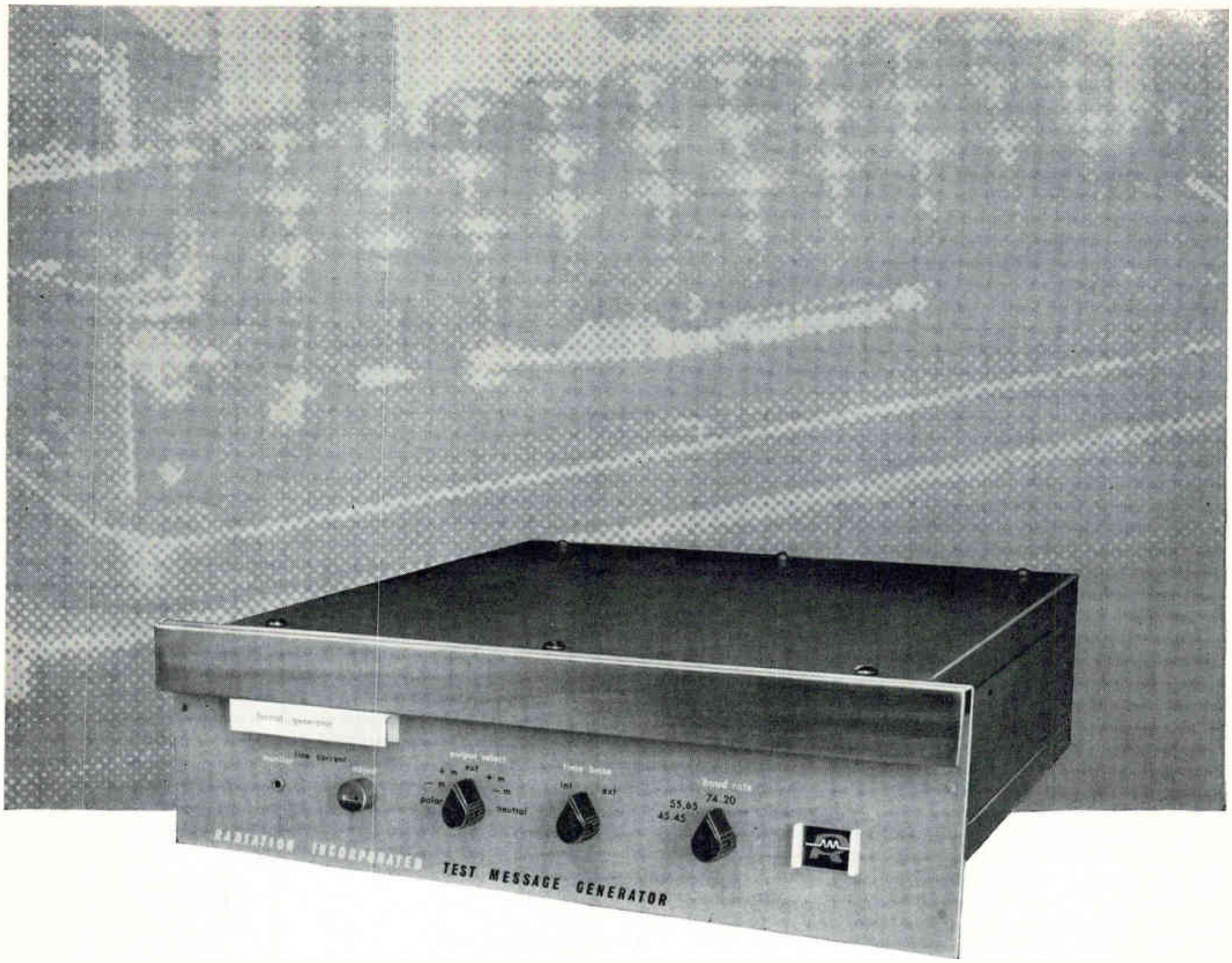
FCC AHEAD IN FIGHT FOR ALL-CHANNEL TV

FEDERAL COMMUNICATIONS COMMISSION may pull off a piece of legislative wizardry this year: passage of its long-sought bill to require the manufacture of all-channel tv sets. A year ago, most FCC officials agreed the bill would solve the allocations logjam that has had broadcasters fighting for 12 vhf channels, while 70 uhf channels go begging. It was also recognized a miracle was needed to get the bill through Congress. Chairman Newton N. Minow and former chairman Frederick W. Ford maneuvered to divide and mollify the opposition. Today, the bill is perking along in Congress with an even chance of passage this year, helped by Kennedy's support last week.

The three tv networks, hoping FCC will drop its demand for direct regulation of network broadcasting, have lined up behind the bill. Broadcasters support it, hoping FCC will end plans to "deintermix" key markets—deleting existing vhf stations to give weaker uhf stations a chance. Such major firms as GE, Zenith and RCA now support the bill, leaving the Electronic Industries Association badly undercut in its fight to block it.

The issue now boils down to what compromise FCC is willing to make on deintermixture. Congressmen opposed to deintermixture will support the all-channel bill as a substitute. FCC is willing to agree to a moratorium on deintermixture plans for eight cities, but doesn't want its hands tied by law.





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AUTOMATIC TELEGRAPH TEST MESSAGE TRANSMISSION WITH HIGHEST RELIABILITY

The use of test message transmission over telegraph circuits to assure efficient and reliable operation is a well-known technique. Radiation's new transistorized Test Message Generator, Model 7411, provides an 80-character message with speed accuracy of 0.02%. Readily switched standard telegraph speeds with a maximum rate of 150 bauds (600 bauds on special order) are offered by this unit. Reliability and long life are assured through the use of solid-state circuitry. Perfect transmission is assured since test message information is stored on magnetic cores.

The unit is also designed for ease of operation. Such variables as message format, speed, stop and information pulse length are controlled with convenient plug-in circuits. Provided with the generator is a standard plug-in message with station identifying numerals and letters to fit your requirements. Other formats are available on special order.

Radiation's Model 7411 Test Message Generator is packaged for rack mounting, and is powered with 105-125 v ac, 50-60 cps. When extreme accuracy is required, Model 7710 Time Base Generator may be used to supply a timing signal with a stability of one part per million per day. Write Dept. EL-32T for complete information on this time-saving test equipment. Radiation at Orlando, 5800 McCoy Road, Orlando, Florida.

Radiation's advanced research and development of systems for aero/space result in the finest equipment for commercial communications. These include: test signal generators, distortion and data analyzers, high-speed strip and page printers and solid-state relays.

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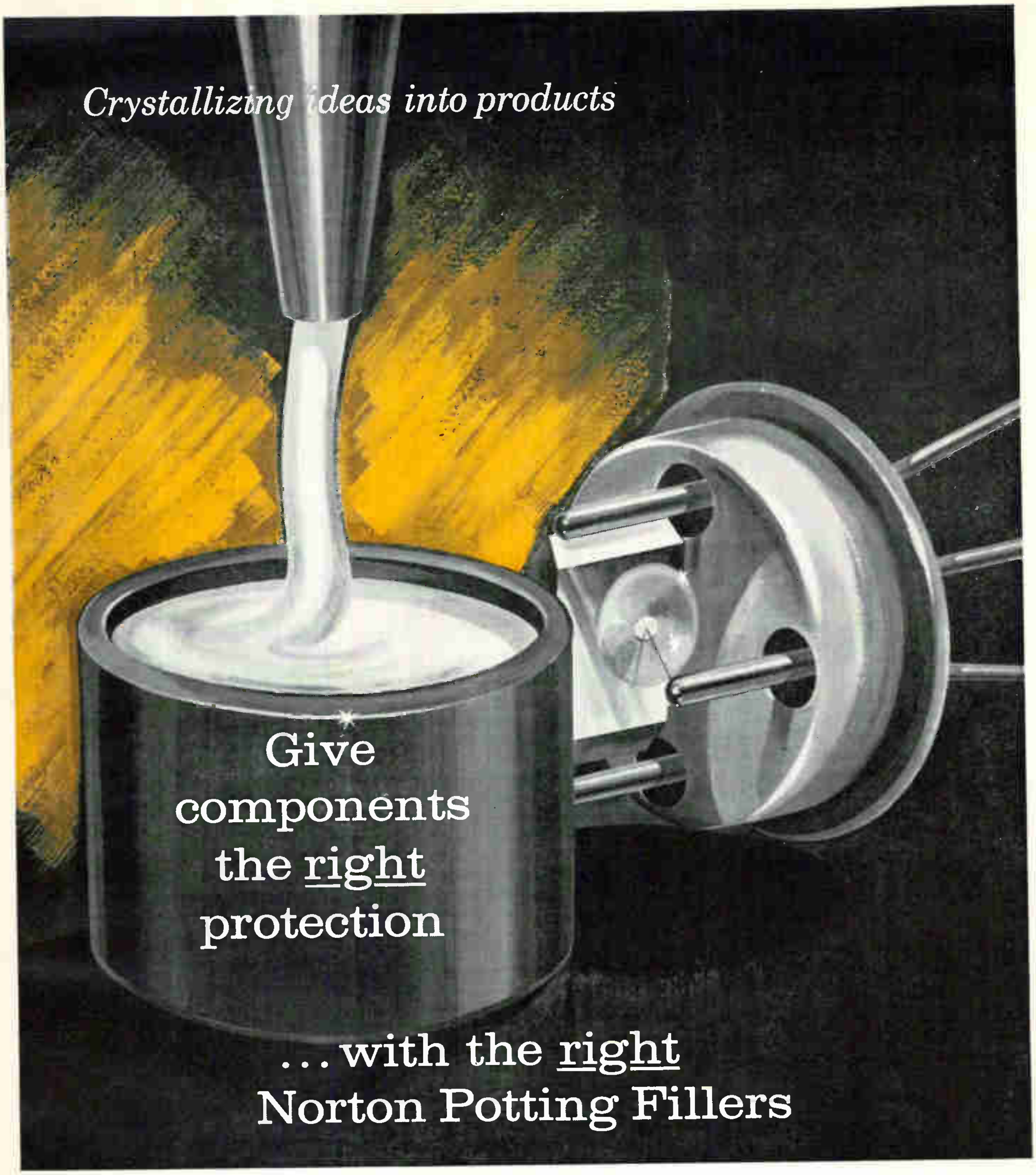

Norton ALUNDUM* fused alumina and MAGNORITE* fused magnesia have proved outstanding as fillers in potting compounds for electronic components — including transistors, resistors, capacitors, coils, small power and pulse transformers. Engineered to provide high, even heat dissipation, high dielectric strength and low leakage current, these Norton materials provide a chemically and physically stable addition to unfilled compounds to improve component performance.

For increased filler versatility, ALUNDUM fused alumina is available in four fine powder sizes (average particle size: 3½, 5, 12, 20 microns) as well as coarser. MAGNORITE fused magnesia is obtainable in an average particle size of 10 microns as well as coarser. These materials enable potted components to operate at a lower temperature or higher ratings, with increased reliability and longer life.

For details on how ALUNDUM Al_2O_3 or MAGNORITE MgO assure important benefits that ordinary fillers cannot provide, write to NORTON COMPANY, 682 New Bond Street, Worcester 6, Massachusetts.

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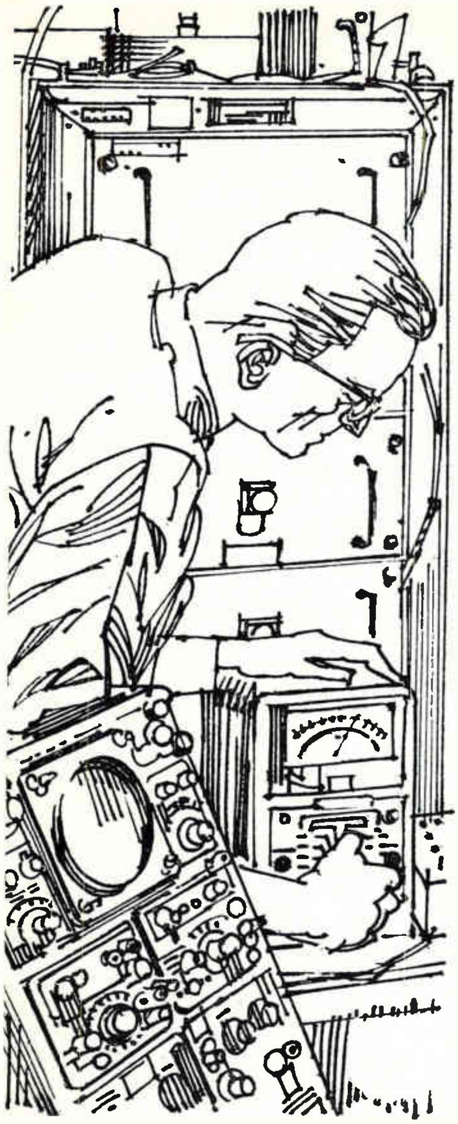
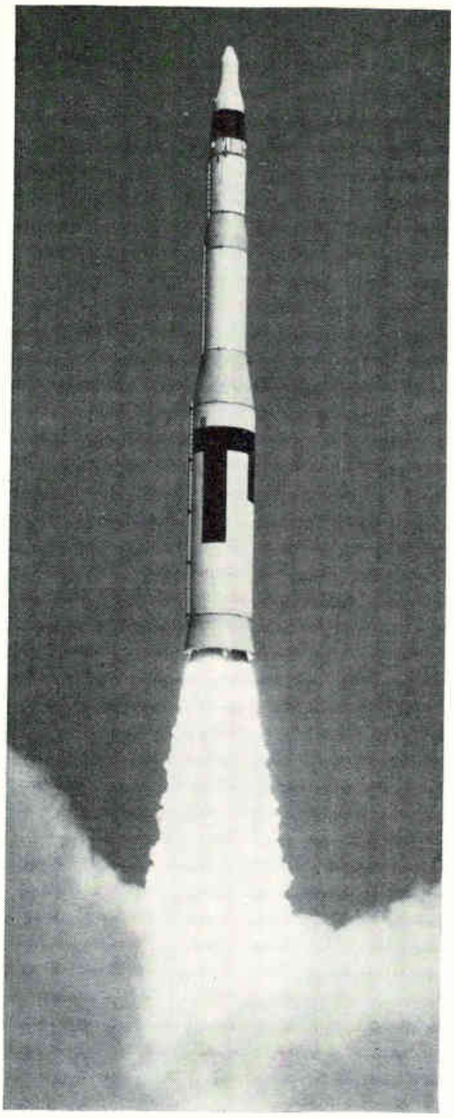
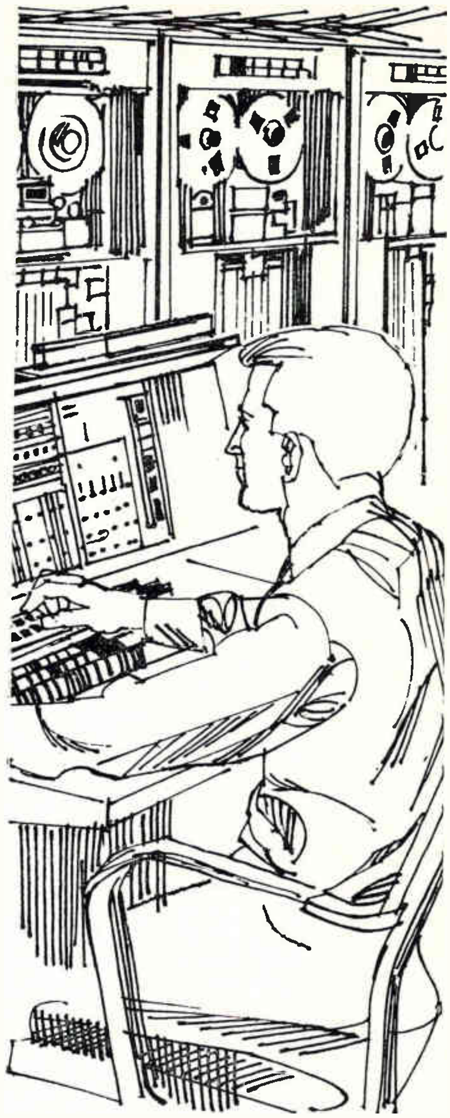
CIRCLE 15 ON READER SERVICE CARD

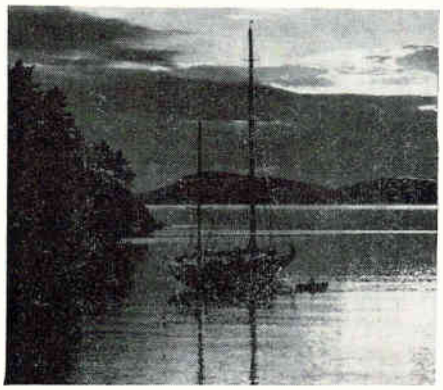






Advanced-program openings at Boeing for
TEST INSTRUMENTATION AND DATA SYSTEM ENGINEERS

Boeing's Aero-Space Division, holder of major contracts on such advanced programs as Minuteman, Dyna-Soar and Saturn, has a number of immediate, long-range openings offering professional challenge, and in many instances, unique ground-floor opportunities in newly-formed divisional organizations.



Test Instrumentation assignments are available on advanced missile and space programs. Requirements include background in transducer, signal conditioning, as well as airborne-ground telemetry systems development, design and application utilizing the latest state-of-the-art concepts, including PCM/FM techniques.

Data Systems engineering openings involve the application of digital techniques to the processing of test data.

Salaries are commensurate with experience and educational background. Minimum requirements include a B.S. degree in EE, ME or Physics, with three years applicable experience. Most of the assignments are in the uncongested Pacific Northwest, offering outstanding family living and recreational advantages.

Send your resume, today, to Mr. Carl Anderson, The Boeing Company, P. O. Box 3707 - ECF, Seattle 24, Washington. The Boeing Company is an equal opportunity employer.

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CIRCLE 17 ON READER SERVICE CARD

Minnesota Educators Strive to Keep Up with

University and Twin Cities manufacturers celebrate growth of electronics industry with R&D progress reports. Goal: to become "Detroit of electronics"

By CLETUS M. WILEY
Midwest Editor

MINNEAPOLIS-ST. PAUL—The Twin Cities, now the fourth largest U. S. electronics center, is working to become the "Detroit of the electronics industry," according to Minnesota's Governor Elmer L. Andersen.

He announced that goal this month at the conclusion of the first annual Minnesota Electronics Recognition Week. Other goals: beefing up the University of Minnesota's output of electrical engineers and a long-range effort to establish an Upper Midwest Research Institute.

The University is unable to supply all local needs for engineering talent, the governor pointed out. Electrical engineering accounts for 400 of the Institute of Technology's 2,248 enrollment and 186 of its graduate students.

Last year, five of the state's electronic companies hired three times as many engineers as the university graduated. This year, one company alone will hire the equivalent of all the EE's graduated. Industry-supported evening graduate courses are helping fill part of the needs. The state's electronics potential is also attracting more applicants for faculty positions, reports W. G. Shepherd, head of the electrical engineering department.

Facility Dedicated

During the week, the university dedicated a new facility that will increase its research space by one-fourth, easing some of the pressure on graduate training. It was built with a grant from the National Science Foundation, matched by a gift from Minneapolis-Honeywell. Future plans call for building on a structure originally designed to support two radio antennas.

Research already underway in the new facility includes studies of primary electron sources, including thin-film laminar devices, headed up by Shepherd. In another project, a superconductor near absolute zero emits a near-noiseless beam with an extremely high current density.

Study of semiconductors at frequencies between microwave and far infrared shows that electrical characteristics change and semiconductor properties are lost. Keith Champlin, associate professor, says that this may indicate a fundamental upper limit to semiconductor usefulness.

Among recent plasma investigations are determining the influence of nuclear explosions on radio communications, converting thermionic energy into electricity and development of new energy sources. Di Chen is completing equipment to check feasibility of using a rotating d-c magnetic field and pumping to achieve microwave amplification in solids.

Developments Displayed

As businesses in the Twin Cities displayed local electronics products, Governor Anderson led 50 businessmen and educators on a tour of electronics plants and laboratories in the area.

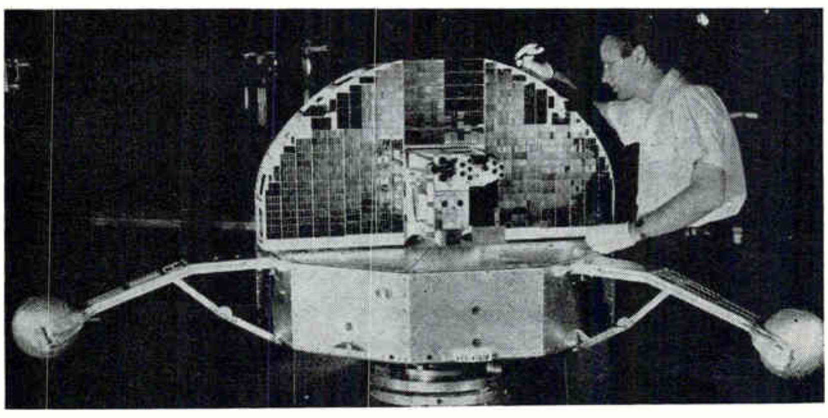
Here are some of the developments they saw:

• Control Data is working on a wide-angle camera device to measure relative angle and distance of selected planets. Readings are transmitted to a 0.1-cu-ft airborne computer which charts a course. A magnetic drum which stores 50,000 binary digits has a diameter of 1.5 in. and length of 3 in.

Control Data's 180 source data collector automates payrolls, inventory, scheduling and other office and production chores. A microwave control system under test processes 2.5 million bits a second, bidirectionally over a two-mile span.

• Telex showed a high-speed random access disk file that stores 22 million characters in concentric rings on 31-in. disks coated with

Orbiting Solar Observatory



Engineer at Ball Brothers Research Corp. gives Orbiting Solar Observatory (ELECTRONICS, p 8, March 2) final check before launch earlier this month. Sun-pointing instruments and solar cells are on sail. Base, which rotates independently, acts as gyroscope. The 440-lb satellite uses an Alcoa aluminum frame

Industry Gain

iron oxide. The file is a prototype of a 64-disk unit which will store 100 million characters.

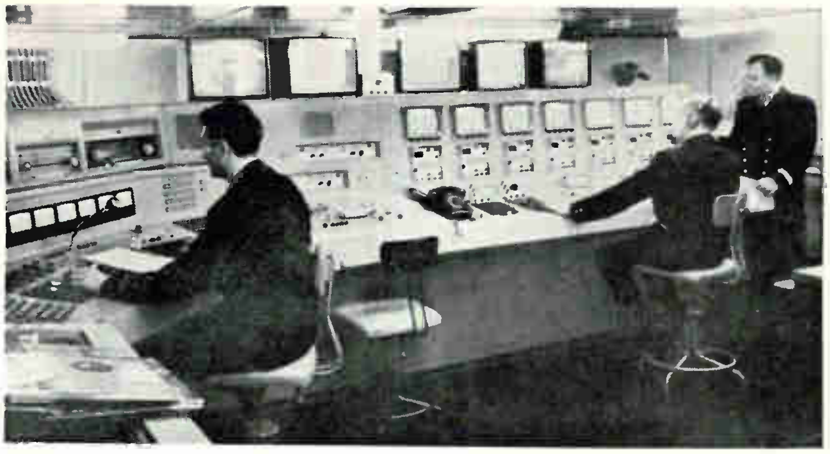
• Univac reported on third-generation, nanosecond, real-time, thin-film memories. One memory stores 166,000 binary digits in one-third cu ft.

Production will be upped this year from two a month to 10 a month. The memory will be used in a missile-borne computer. Development to achieve a cycle time of 50 nsec is underway.

• Data Display has a high-speed character generator for information retrieval and message composition.

A five-console system is being completed for the Ohio State aviation psychology lab. It will display letters, numbers, lines and dots for group tactical decisions aimed at improving man-machine communications.

• Medtronic demonstrated a half-pound implantable heart pacemaker with a five to 10-year battery supply. It is fitted with a projecting needle than can be tuned to adjust the heart beat speed. The company is also adapting its hospital monitoring system to include temperature, brainwave and other functions.



Tv control room on S.S. France handles European and American broadcasts, movies and live programs

Liner Carries Elaborate Tv System

S.S. FRANCE, which made its maiden voyage to New York last month, carries an all-transistor, closed-circuit tv system designed by Philips. A passive r-f cable distribution system supplies 450 North American Philip's receivers with signals between 2 and 5 mv at 160 to 210 Mc.

Receivers can operate on French 819-line, European 625-line or American 525-line standards. Each program has three channels: 625 lines at 25 frames; 525 lines at 30 frames; and 819 lines at 25 frames.

Signals are picked up by three rotatable Yagi antennas mounted on the ship's aft funnel. Four special receivers supply the system with video and audio from American or European transmitters.

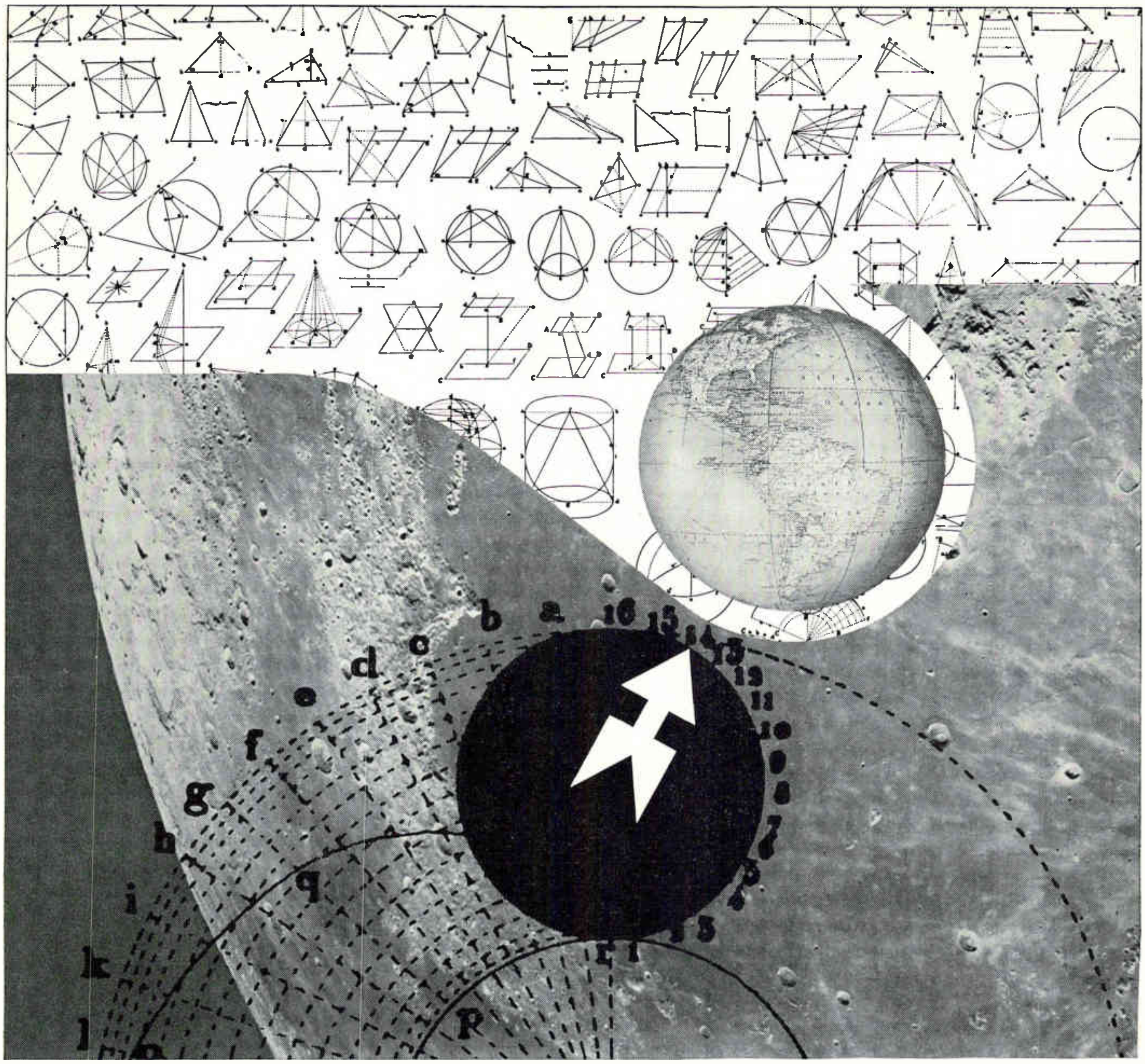
Internal programs, such as live shows and interviews, originate from two studios. Vidicon cameras can take live shots from any of ten fixed key locations and two compact cameras can originate programs from eight other locations. Two more vidicon cameras are coupled to two 16-mm film projectors and two 16-mm tape recorders. A pair of vidicon cameras are also coupled to the ship's 35/70-mm movie projectors.

Tv-Computer Microscope Reported by Russians

MOSCOW—USSR Institute of Biophysics has designed an electron microscope which Tass says does not show the object of study but nevertheless gives a comprehensive picture of it. The news agency says an image of a biological object magnified by an ordinary microscope is broken down by a tv system into series of electronic impulses. A computer sorts and counts impulses and the instrument produces data about number of particles in microscope's field of vision grouped according to size or other indices.

Planning Hospital Data Processing

IBM and The Children's Hospital of Akron, Ohio, have started a joint study aimed at developing hospital information systems. One patient may generate as much as 50 documents requiring clerical work by nurses. Beginning in July, the hospital will use an IBM Ramac 305 computer to schedule nursing care



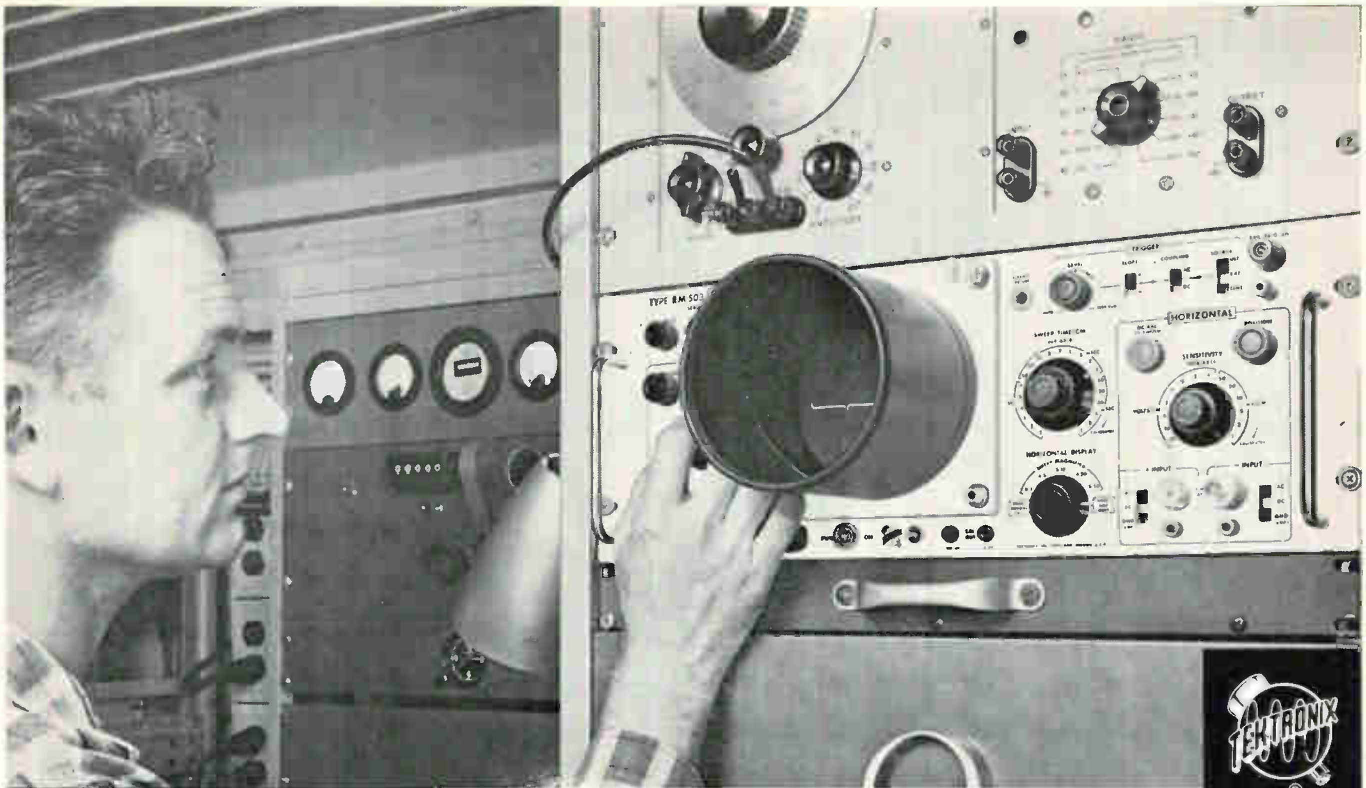


Photo courtesy of Shell Development Laboratory, Houston, Texas

PROBING UNDERGROUND FORMATIONS WITH THE AID OF A TEKTRONIX RACK-MOUNT OSCILLOSCOPE

TEKTRONIX TYPE RM503 DC-to-450 KC DIFFERENTIAL-INPUT X-Y OSCILLOSCOPE

At Shell Development Laboratory, Houston, Texas, a field crew relies upon waveform displays from a Tektronix Type RM503 Oscilloscope to monitor equipment performance accuracy while evaluating underground formations.

Rack-mounted in their truck, the Type RM503 serves to insure accuracy of tool operation while below the surface, since instruments used may be positioned at substantial depths in the bore holes. The operator uses the Type RM503 to display the signals before they are applied to an electronic counter. By observing the quality of these signals appearing on the 5-inch crt—to determine that they are of sufficient amplitude and free of noise and distortion so that the accuracy of the count can be relied upon—the operator thus establishes an effective monitoring system at the surface.

Note the polarizing viewer. Even with the truck door open, this polarizing viewer enables the operator to observe the trace free from reflections and glare.

CHARACTERISTICS

Vertical and Horizontal Amplifiers: Frequency Response—dc to 450 kc (at 3 db down). Sensitivity—1 mv/cm to 20 v/cm in 14 calibrated steps, variable uncalibrated from 1 mv/cm to 50 v/cm. *Differential input and constant input impedance at all attenuator settings.*

Sweep Range and Magnification: Linear Sweeps—1 μsec/cm to 5 sec/cm in 21 calibrated rates, variable uncalibrated from 1 μsec/cm to 12 sec/cm. Sweep Magnification—2, 5, 10, 20, or 50 times.

Triggering Facilities: Fully automatic, recurrent, or amplitude-level selection on rising or falling slope of signal, with AC or DC coupling, internal, external, or line.

Tektronix Cathode-Ray Tube: 5-inch crt at 3 KV accelerating potential provides bright trace on 8-cm by 10-cm viewing area.

Amplitude Calibrator: 500 mv and 5 mv peak-to-peak square-wave voltages available.

Regulated Power Supplies: All critical dc voltages—and the input-stage heaters of both amplifiers—are electronically regulated.

Small Size and Light Weight: Dimensions—7" high x 19" wide x 16½" deep. Weight—27 pounds.

Tektronix Type RM503 Oscilloscope	$655.00
Polarizing Viewer	10.00

U. S. Sales Prices f.o.b. Beaverton, Oregon

For a demonstration of this laboratory oscilloscope that occupies only 7 inches of standard rack height, please call your Tektronix Field Engineer.

Tektronix, Inc. *P. O. BOX 500 · BEAVERTON, OREGON / Mitchell 4-0161 · TWX—BEAV 311 · Cable: TEKTRONIX*

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CIRCLE 21 ON READER SERVICE CARD

Japanese Plan to Join Private Communications Satellite Net

Telstar ground station to be built near Tokyo will have sectionally-inflated radome. Transmitter and receiver will ride on rotating antenna mount

By CHARLES COHEN
McGraw-Hill World News

TOKYO—Kokusai Denshin Denwa Corp., Japan's overseas radio and cable system, plans to build a station to transmit and receive via the Telstar communications satellite that AT&T will orbit this Spring (ELECTRONICS, p 26, Feb. 16). The station will be used to study the feasibility of relaying telephone and television signals by satellite.

Frequencies will be compatible with equipment carried aboard the satellite. However, the station will be completely engineered in Japan and many details will differ from the American station.

The radome will consist of two thin layers of Vinylon plastic, separated by about 30 cm at the center and joined by webs of the same material to produce thirteen wedge-shaped sections. Each section will be pressurized; that is, inflated like a balloon. The space between the antenna and the radome will not be pressurized. This differs from American practice in which the entire radome is supported by pressurizing the region between it and the reflector. Advantages claimed for the Japanese radome are ease in making adjustments and continuity of operation even though the radome is punctured. The radome will withstand 60-meter gusts of wind.

One cassegranian antenna will be used for transmitting and receiving. Both transmitter and receiver will be mounted on the horizontally rotating portion of the antenna mount. Tracking equipment will be installed here later if it proves feasible to use the transmitting-receiving antenna for tracking also.

The receiver's first stage will be a parametric amplifier cooled with liquid nitrogen. This f-m receiver will use negative feedback to lower the threshold level. Transmitter output will be approximately 3 Kw. Experiments now being conducted will determine whether a twt or klystron output tube will be used. Work on the vhf command control equipment has not been started, because exact satellite requirements are not known.

Kenichi Miya, director of the KDD research laboratory's space communications branch, says exact frequencies and code have not been made public by AT&T to prevent jeopardizing the mission of the satellite (whose power supply life is limited) by unauthorized operation. But he says commercial vhf equipment can be modified for this project and the program will not be delayed. A representative of KDD has gone to the U. S. to confer with AT&T officials in the U. S. about the vhf equipment.

The tracking antenna will receive the 4.8-Gc beacon transmitted from

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JANANESE STATION WOULD BE EIGHTH IN TELSTAR NET

NEW YORK—Spokesmen for AT&T and NASA said last week that plans for Japanese participation in the Telstar and Relay communications satellite projects have not yet firmed up. The KKD station could not participate in experiments with satellites launched this year because the station will not be built in time.

AT&T said one problem is that Telstar will not be visible to Japan and U.S. stations at the same time. Japan could not employ point-to-point transmissions by Telstar, but would have to use round-trip transmissions, from the station, to the satellite and back to the station.

However, AT&T said Japanese participation would be welcomed, since about 90 percent of the experimental data gathered in round-trip transmissions would be useful.

American and European stations being readied for satellite communications tests are:

United States: Bell Telephone Laboratories' main station at Andover, Me., and the facility at Holmdel, N. J. Also, ITT in Nutley, N. J.

Britain: a Post Office station at Goonhilly Downs, near Falmouth, England, to be completed Aug. 1, with an 85-ft dish antenna.

France: a station with a horn antenna like the one at Andover, being built near Lannion, in Brittany, by the Centre National des Etudes Telecommunications.

Germany: the Bundespost is building a horn antenna station at Raisting, 30 mi southwest of Munich.

Italy: Telespazio is building a 30-foot receive-only antenna and station at Fucino, 80 mi east of Rome in the Appenine Mountains.

Brazil: Radional, a Brazilian subsidiary of ITT is building a station with a 40-ft parabolic antenna, near Rio de Janiero. It would make telephone and telegraph transmissions to ITT in Nutley, but not tv. NASA says this station will be transportable

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SPECIFICATIONS FOR JAPANESE STATION

Transmitter and receiver

transmitter frequency: 6.39 Gc
receiver frequency: 4.17 Gc
communications system: one-way transmission of one tv channel or two-way transmission of 60 telephone channels (carrier separation is 10 Mc)
baseband: tv, 5 Mc; 60 telephone channels, 0.3 Mc
modulation: f-m—deviation, television, 7 Mc; deviation, 60 telephone channels, 1.5 Mc; r-f band, approximately 25 Mc receiver and transmitter bandwidth: 25 Mc (50 Mc is ultimate aim, but is difficult to obtain with parametric amplifier)
transmitter output: 3 Kw
receiver equivalent noise temperature: 84 K

Vhf command control and telemetering

transmitter frequency: in range of 121 to 125 Mc
receiver frequency: in range of 136 to 137 Mc
transmitter output: 200 to 500 watts cw
bandwidth: 5 Kc
antenna gain: 17 to 19 db for both transmitting and receiving
polarization: right-hand circular polarized
telemetering: pcm/f-m/f-m
control instructions: special code

Station control equipment

control method: stored program (interruption possihle)
logical device: parametron (approximately 3,000)
word length: decimal 7 digits + sign
memory device: magnetic core, 512 words
operation speed: addition, subtraction—1 ms

Transmitting—receiving antenna

parabolic cassegranian mirror antenna; 20 m in diameter
gain, transmitting: 59 db
gain, receiving: 55 db
front—back ratio: more than 60 db
drive mechanism: hydraulic drive
rotational range: azimuth, ± 400 deg; elevation, to 90 deg
maximum angular velocity: azimuth, 3 deg/sec; elevation, 1 deg/sec

Tracking antenna

parabola, 6m in diameter
maximum tracking angulra velocity: azimuth 8 deg/sec, elevation, 1 deg/sec
drive mechanism: hydraulic drive
error sensing method: amplitude comparison simultaneous lobing
tracking frequency: 4.08 Gc

the satellite. Angular information will be read digitally and used to control the main antenna.

A time-division system will be used in the station control equipment to enable it to control both tracking and main antennas. Inputs to control equipment for decision making include: orbit information from orbit computer, antenna angle information, and receiver output. The following modes of operation will be programmed: control by data tape containing orbit information from the U. S.; satellite search according to a predetermined pattern; following another antenna, and manual operation. Antenna positions will be shown on the control panel. Remote operation will also be possible.

The satellite receiving and transmitting frequencies are both in use for common carrier communications in Japan. The problem of interference between the satellite communications equipment and services already in operation is especially difficult in Japan because most microwave relay stations are located on mountain tops.

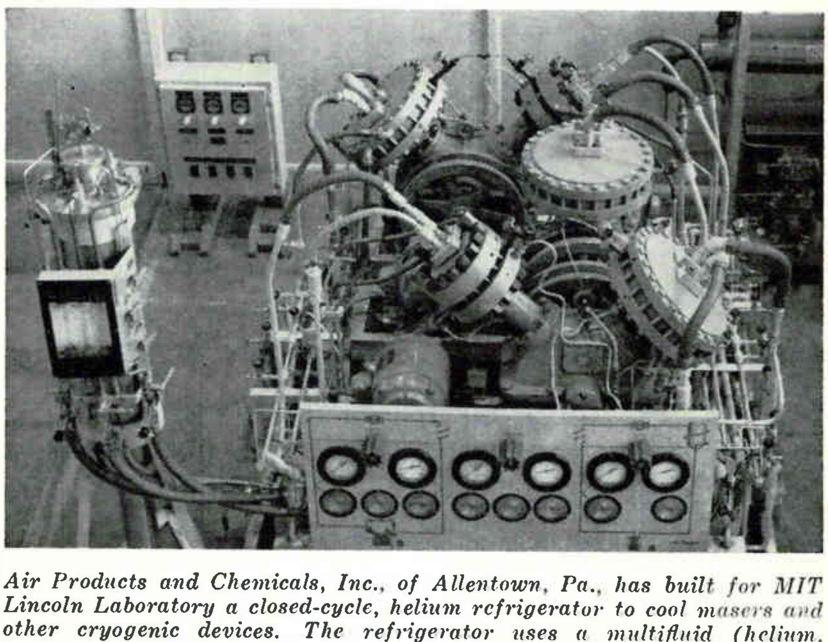
Present plans calls for the station to be located in Kamisumura, Ibaraki-ken, about 80 Km east of Tokyo (direction of station from Tokyo is 80 deg, location is 35° 53′ 53″ N, 140° 39′ 26″ E). Preliminary tests show that diffraction by mountains affords sufficient isolation for tests with AT&T satellites. But if the domestic telephone company installs additional routes in the area, or uses fully all frequencies alloted to it in stations already in the neighborhood, or if a wider bandwidth is used in future satellite communications programs, serious interference will result. Future plans for the domestic microwave network will be considered when locations of actual operational stations are determined.

Although final details for all equipment to be used in this experiment have not been completely settled, fabrication contracts have been let. Completion of the station is expected by April, 1963. Contracts are for concurrent research, development and production. Hiroshi Shinkawa, deputy director of the KDD research laboratory, said that the suppliers were chosen for their technical ability. He said that this was somewhat more expensive than competitive bidding, but would enable KDD to obtain finished equipment more quickly.

Cost of the completed station will be less than $1.4 million. Miya says he cannot give the cost of individual items, because KDD expects to renegotiate the contracts, whose total cost has exceeded the amount budgeted for the station. Disclosure of individual prices would cause great embarrassment, he said.

Toshiba will supply the transmitter, on the basis of its ability in fabricating high-power microwave tubes. The receiver will be supplied by Nippon Electric Co., experienced in parametric amplifiers and negative feedback f-m receivers. Antennas and associated drive and control equipment will be fabricated by Mitsubishi Electric Co., chosen for its servomechanism experience.

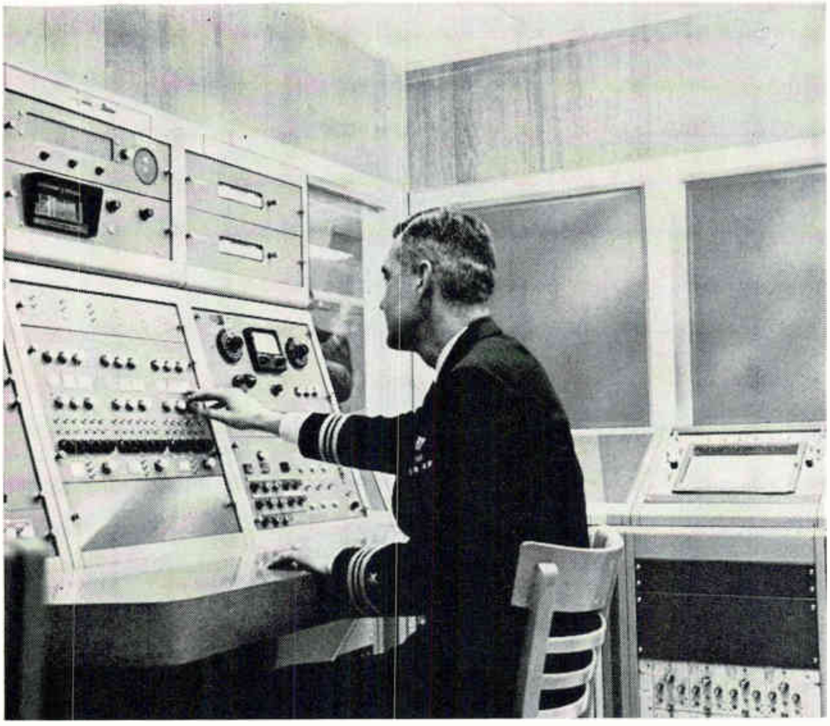
Liquid Helium Closed-Cycle Refrigerator



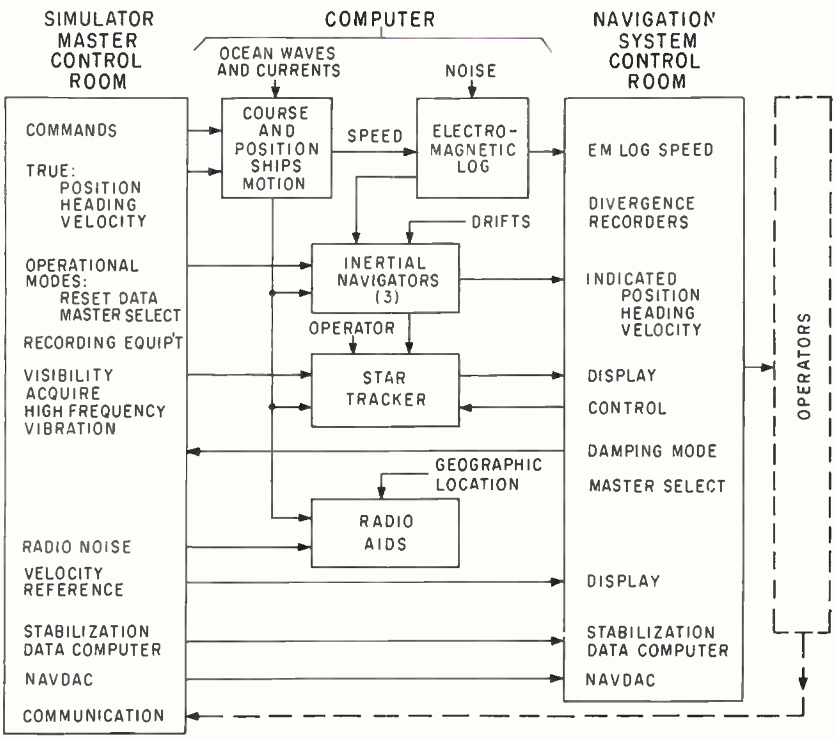
Air Products and Chemicals, Inc., of Allentown, Pa., has built for MIT Lincoln Laboratory a closed-cycle, helium refrigerator to cool masers and other cryogenic devices. The refrigerator uses a multifluid (helium, hydrogen and nitrogen) cascade cycle, to maintain a temperature of 4.4 K (−452 F) in the 6-ft-high cryostat at left. The cryostat can be remotely connected by tubing

Dynamic Simulator Speeds Navigation

By LEON H. DULBERGER, Assistant Editor



Control console of dynamic simulator designed to test complete Polaris submarine navigation system under controlled sea conditions



Signal flow of the analog computer operated, Sperry Gyroscope Co. simulator; which uses dynamic outputs of navigational aids

CREATION OF AT-SEA conditions in a computer-operated dynamic simulator allows laboratory evaluation of nuclear submarine navigation systems. Next generation designs of navigational aids and system components can be accurately tested before sea trials.

Missile launching submarines require precise position information at time of launch. The navigation system on these undersea craft locates position with extreme accuracy. Equipment carried includes the ship's inertial navigation system, SINS, (ELECTRONICS, p 28, Mar. 7, 1958) for constant position information.

Long-term system drift is corrected by data obtained from other navigational aids. Among them are: optical and radio star sighting devices, loran, speed and course measurement and recording. A digital computer handles the mass of data produced and automates the application of corrective adjustments (ELECTRONICS, p 40, Jan. 6, 1961).

The dynamic simulator, built by Sperry Gyroscope Co., Syosset, N. Y., duplicates important system components. Mathematical models of the dynamics of various navigational aids are simulated electrically on analog computers. Changes of computer programming are readily achieved to reflect design changes of new equipment.

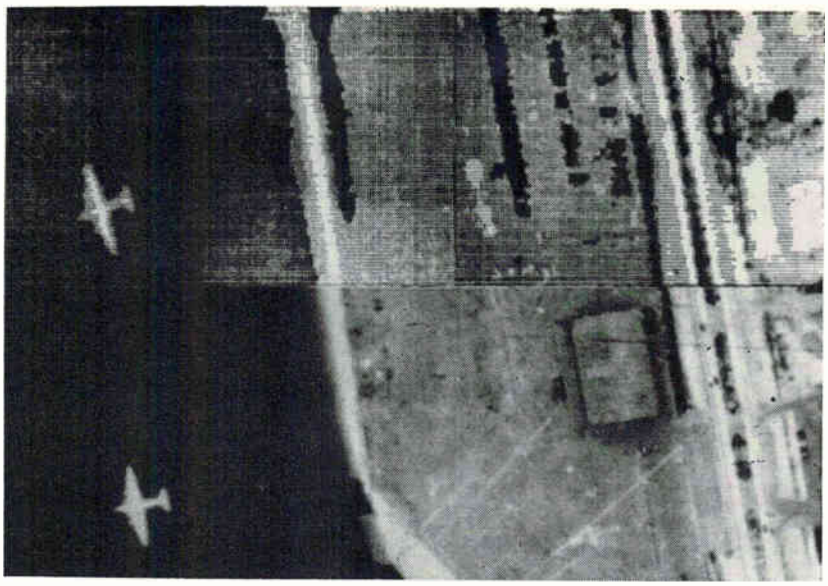
A director controls the simulated outputs obtained from a model of each navigation element. He follows a program of the tests desired. A "navigation crew" in a navigation control center—a replica of that section of a submarine—attempts to solve simulated navigation problems in a realistic environment. Human-factor studies using simulated displays, such as the efficiency of a navigator, may be run. One example where human performance is evaluated, is in a star tracking test. Using a periscope

System Design

employing a reversed lens system, a "crew" member sights on an arc lamp, of an intensity calibrated for a given star's magnitude. Wave motion of the submarine is simulated by moving the arc lamp randomly. Cloud-cover effects are produced by a revolving, variable density disk between periscope and lamp. Background illumination may be varied to reproduce daylight or darkness star sighting conditions. Human performance is thus also measured in checking out system operation.

Other submarine performance conditions such as course, speed and depth, are all simulated accurately when testing the system. Navigational errors during a test run are displayed on several Brush Instruments chart recorders, and also on digital displays. Information may be stored on magnetic tape for later analysis. Evaluation of a single navigation component or the entire complex can be made. Those tests which do not include a human operating a component are speeded up twenty times against real time. This allows days of at-sea time to be reduced to hours in the simulator.

Three analog computers, supplied by Electronic Associates, Inc., Long Branch, N. J., are used in the simulater. Special amplifiers and networks are employed in these otherwise standard equipments. Simulator running time is often as long as several hours. To reduce drift during integration and summing operations, operational amplifiers with reduced drift specifications were designed and hand wired. A total of 280 of these chopper stabilized amplifiers simulate outputs and functions of the complete navigation system. To achieve maximum utility from each amplifier, multifunction networks were designed for many of them, using high-accuracy components in temperature-controlled ovens.



Seaplanes in San Diego Bay. Upper portion of photo has been sampled, quantized, stored on tape and retrieved from computer

Computer to Analyze Photos

FACSIMILE TRANSMITTER has been modified by Cornell Aeronautical Laboratory to serve as a photographic input to a digital computer.

Photo details go into the computer, an IBM 704, on a cell-by-cell basis so the computer will be able to perform cognitive processes. Built under a Navy contract, the input will be used for automatic photo interpretation, character recognition and other cognitive systems research.

The facsimile transmitter has a resolution of slightly less than 100 lines an inch. Modifications included isolation and control circuits and an analog-digital sampler and converter.

Ninety seconds are required to insert a 5 by 5-in. photo, which is broken down into some 250,000 individual elements each having 16 levels of gray intensity. Storage on tape provides a library of photos.

Color Film Printer Uses Simple Analog Computer

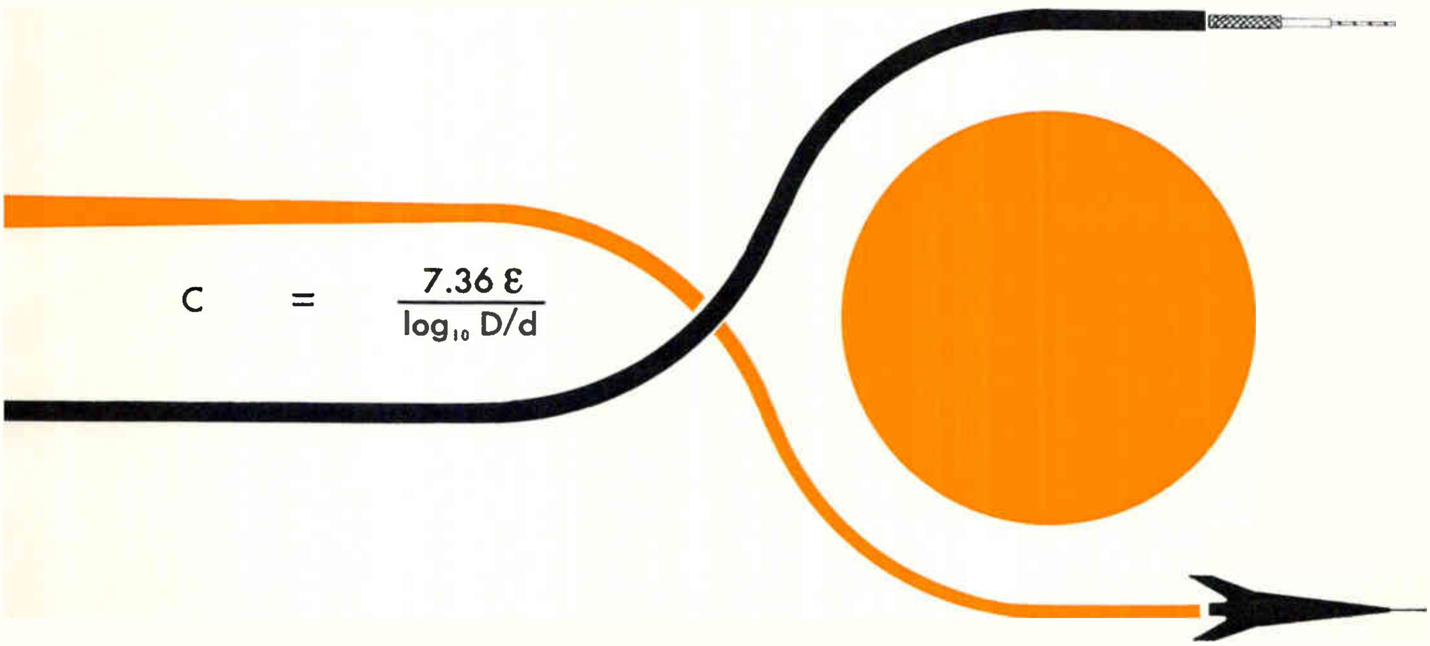
NEW YORK—Low-cost analog computer is used in an automatic, daylight, color-printer processor for amateur photographers. The computer determines color balance in the film negative while the processor turns out a print in three minutes. Pavelle Corp. will put the unit on the market this fall at a price of $150 to $200.

According to the designers, Alex Dreyfoos, Jr., and George Mergens, the computer has two cadmium sulfide photo cells in a modified bridge circuit with a null meter to evaluate the color of the integrated transmission of the negative and printing filters.

One cell is filtered to analog the spectral sensitivity of the green-sensitive layer of the color print material. The second cell has a two-position filter that trims cell sensitivity to analog blue or red layers.

A fixed and a variable resistor, the other two legs of the bridge, are set to give a null reading when blue-green balance is proper. When the red filter is in place, another variable resistor is switched in to the circuit to give a null when red-green ratios are correct. The red-blue ratio is then also correct. Color balance is obtained with any negative by moving the proper amount of filtration into the light path.

In a third mode, the bridge makes a overall light intensity measurement to determine print exposure time. The unit also includes the chemical process.



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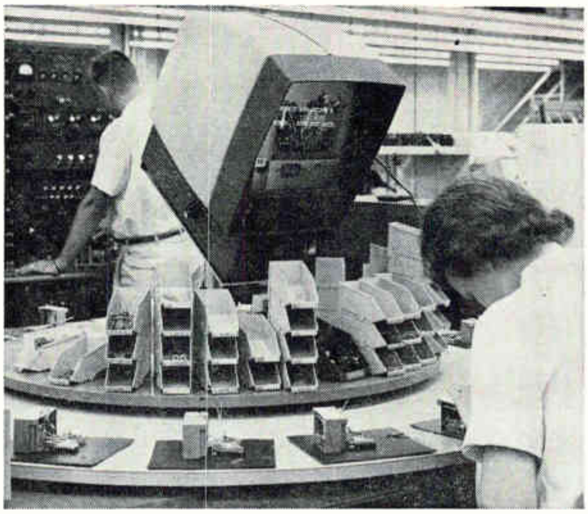
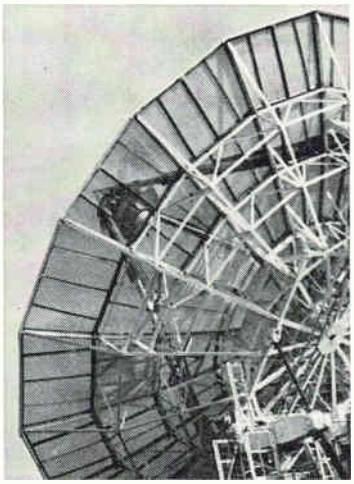
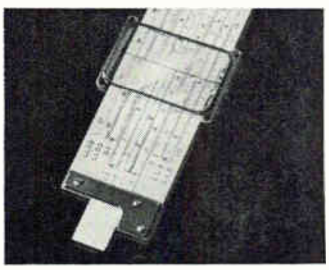


MEETINGS AHEAD

IRE INTERNATIONAL CONVENTION, Coliseum & Waldorf Astoria Hotel, New York City, Mar. 26-29.

QUALITY CONTROL CLINIC, Rochester Society for Quality Control; University of Rochester, Rochester, N. Y., Mar. 27.

ENGINEERING ASPECTS OF MAGNETOHYDRODYNAMICS, AIEE, IAS, IRE, University of Rochester; University of Rochester, N. Y., Mar. 28-29.

QUALITY CONTROL ADMINISTRATIVE APPLICATIONS CONFERENCE, American Society for Quality Control; University of Montreal, Canada, Mar. 29-30.

READ-ONLY DIGITAL COMPUTER MEMORIES DESIGN & APPLICATION DISCUSSION, Institution of Electrical Engineers (British); Savoy Pl., London, April 3.

ELECTRONIC & ELECTRICAL INDUSTRIAL-COMMERCIAL EQUIPMENT SHOW, Electrical Manufacturers Representatives Assoc. of Michigan; Artillery Armory, Detroit, April 4-6.

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

NONDESTRUCTIVE TESTING CONVENTION, Society for Nondestructive Testing; Pick-Carter Hotel, Cleveland, Ohio, April 9-13.

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

SOUTHWEST IRE CONFERENCE AND SHOW; Rich Hotel, Houston, Texas, April 11-13.

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

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

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

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

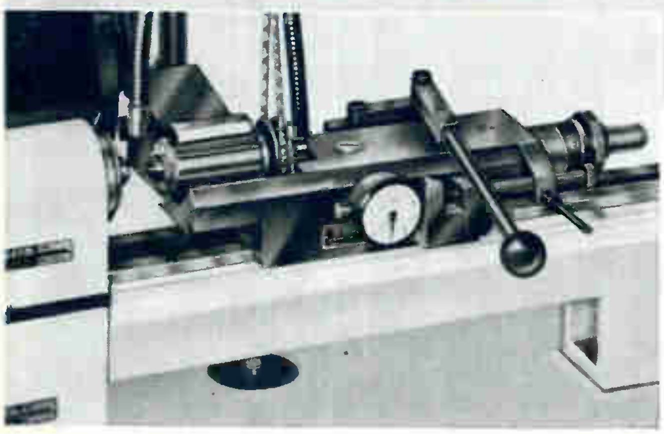
SELF-ORGANIZING INFORMATION SYSTEMS CONFERENCE, Office of Naval Research, Armour Research Foundation, Museum of Science and Industry, Chicago, May 22-24.

AERO-SPACE INSTRUMENTATION SYMPOSIUM, Instrument Soc. of America; Marriott Motor Hotel, Washington, D. C., May 21-23.

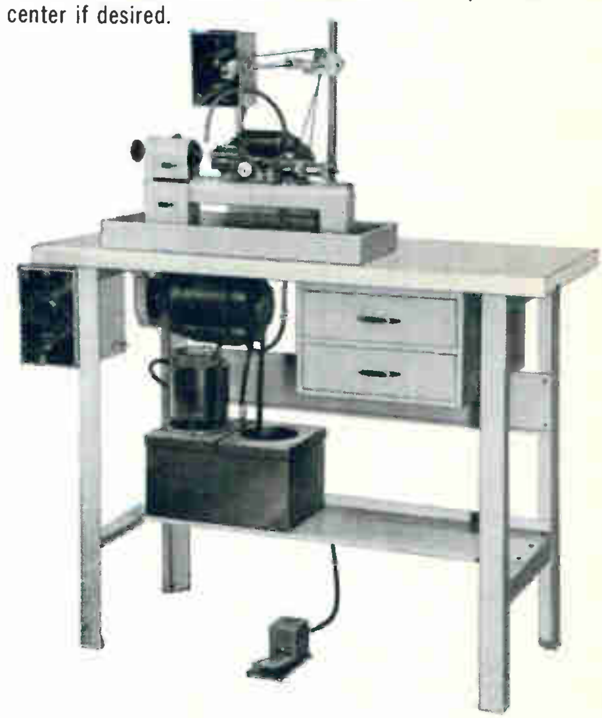
ELECTRONICS PARTS DISTRIBUTORS SHOW, Electronic Industry Show Corp; Conrad Hilton Hotel, Chicago, May 21-24.

MICROWAVE THEORY & TECHNIQUES NATIONAL SYMPOSIUM, IRE-PGMTT; Boulder, Colo., May 22-24.

MICRO-DRILLING PROBLEMS?



LEVIN micro-drilling machines are the best answer for precision drilling of orifices, bushings, and similar devices, with hole diameters in the range from 0.001″ to 0.125″. The drilling spindle can be shifted to drill up to ¼″ off center if desired.



Shown above, an ACDO micro-drilling machine set up for drilling the miniature bushing illustrated, with a 0.0114″ hole 0.250″ long. Maximum run out on either end of the hole does not exceed 0.00020″ T.I.R. separate motors and controls are used on the headstock and drilling spindles. Both are continuously variable from 0 to 4000 RPM with dynamic braking on each and IR drop compensation on the headstock spindle motor. The headstock is driven by a ¼ HP motor and the drilling spindle by a ⅛ HP motor.

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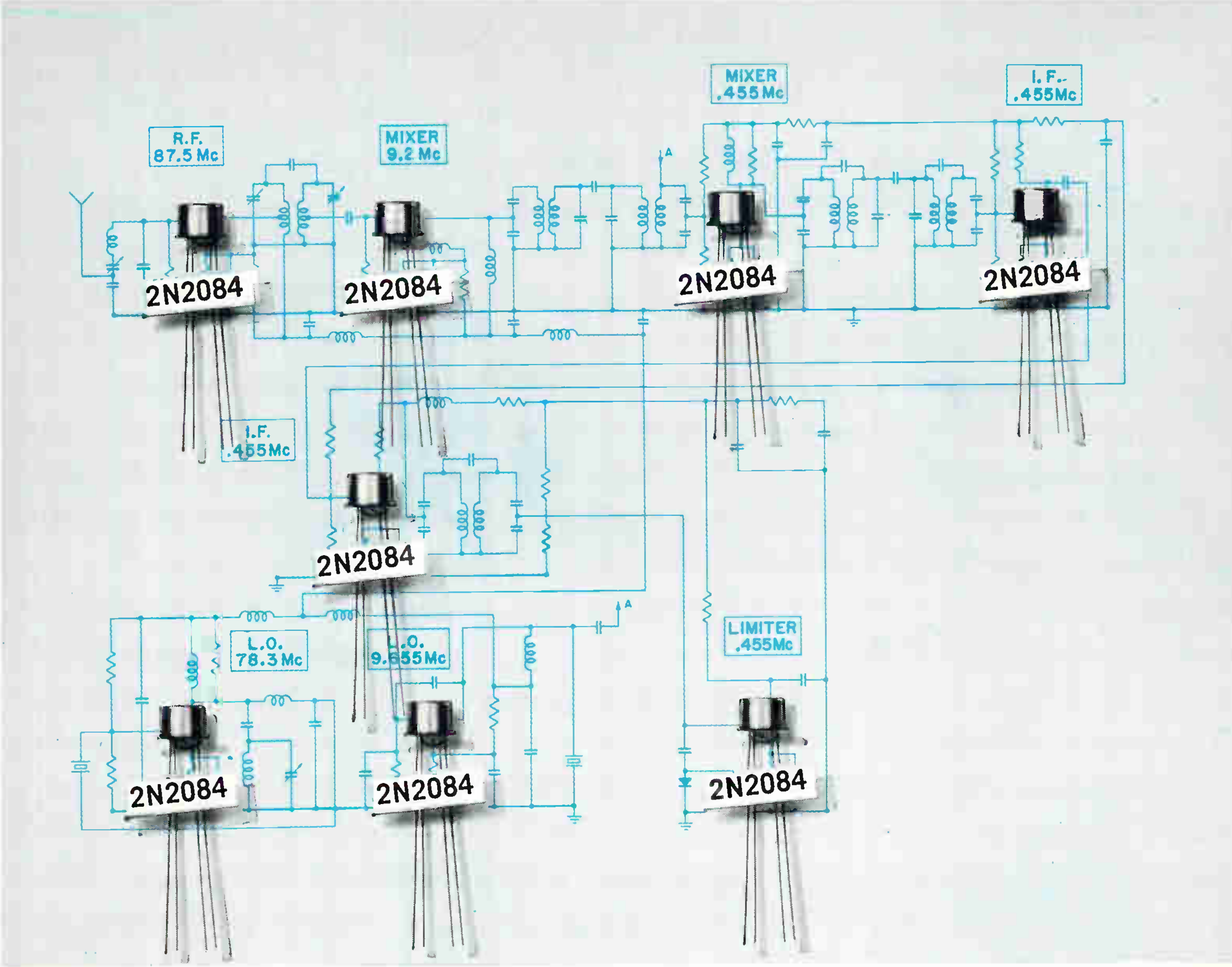
CIRCLE 31 ON READER SERVICE CARD



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Combining the best features—high voltage, high beta and high frequency —of many specialized front end and IF types, this new PADT germanium-alloy-mesa transistor will obsolete and replace such types* as 2N1224, 2N1225, 2N1226, 2N1395, 2N1396 and 2N1397 for HF and VHF mobile, aircraft and radar applications.

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1. Lower procurement costs: only one type to order—with a better price break through volume purchasing.
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TYPE 2N2084
SPECIFICATIONS AND FEATURES

Gain Bandwidth Product	$f_T = 100$ mc
Typical Beta	$h_{FE} = 140$
Breakdown Voltage	$BV_{CBO} = 40$ V
Typical Power Gain	14 db (at 100 mc) 27 db (at 30 mc)
Output Capacitance	$C_{ob} = 2\ \mu\mu f$
Case	JEDEC TO-33

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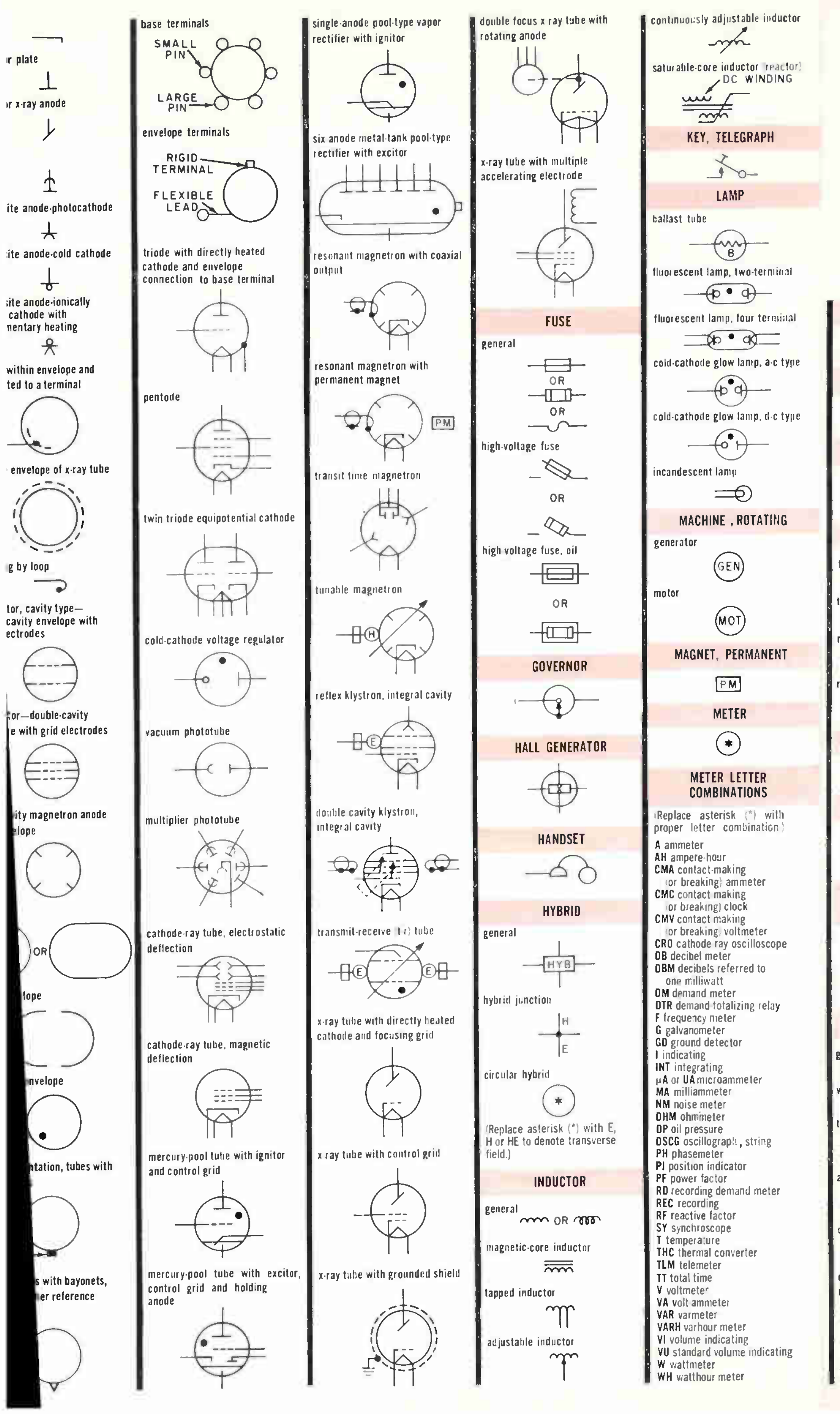
GRAPHICAL SYMBOLS FOR ELECTRONICS DIAGRAMS

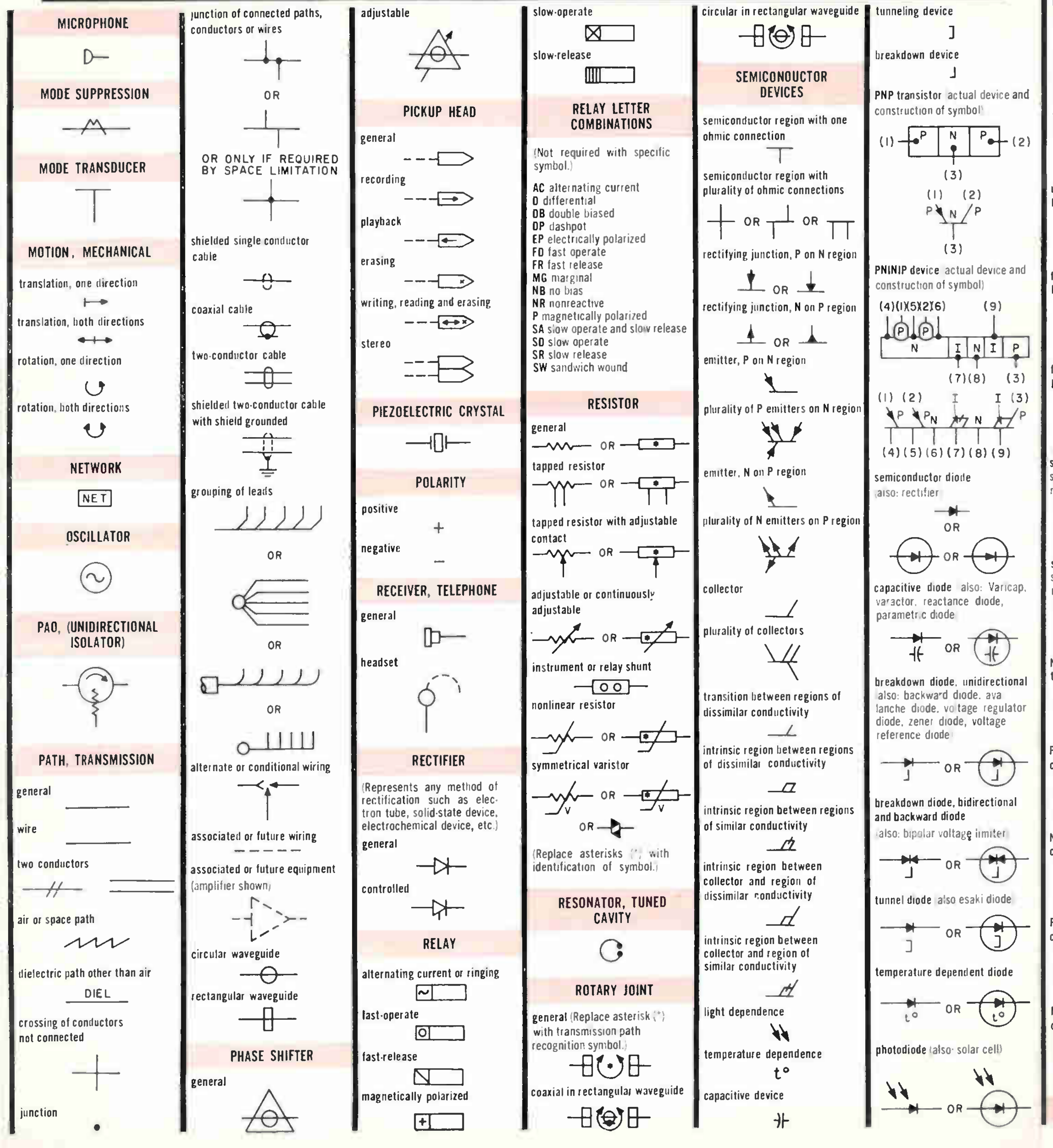
THIS CHART is abridged from proposed American Standard Y32.2-1962, **Graphical Symbols for Electrical and Electronic Diagrams,** which is identical to MIL-STD 15-1 dated October 30, 1961 and proposed IRE Standard 62IRE21.S1. Symbols for use on logic diagrams are abridged from proposed American Standard Y32.14-1962 **Logic Symbols for Digital Computers.**

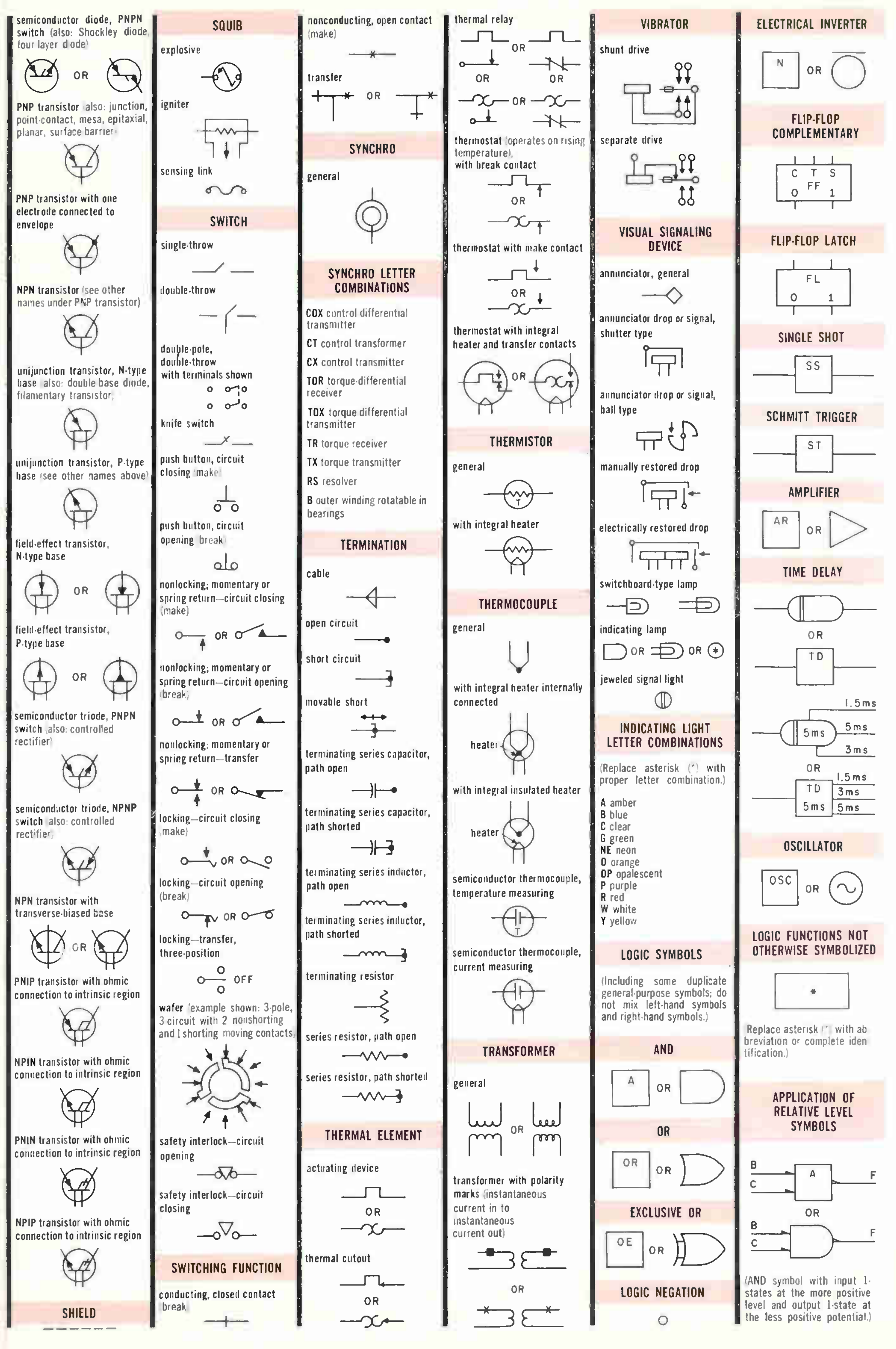
The chart does not include symbols used primarily in electric power distribution, electrical machinery and telephone systems. Certain specialized build-up applications of basic symbols are omitted. Where the basic American Standard shows both single-line and complete symbol equivalents, this chart shows only the single-line symbol. Consult the basic Standard for complete symbols in these cases.

MARCH 23, 1962

Reprints of this chart available for $1.00 from: Reprint Mgr. electronics, McGraw-Hill Publishing Company 330 W. 42nd St. New York 36, N. Y.







SEMICONDUCTORS for RADIO & TV

Ge PNP Alloy Type for HF Use

2SA52 For BC Band Converter Service
2SA49 For 455Kc IF Amplifier Service
2SA53 For 455Kc IF Amplifier Service

Ge PNP Drift Type for HF Use

2SA60 For Short Wave Converter Service (12Mc)
2SA72 For High Frequency Amplifier Service (3Mc)
2SA73 For BC Band Converter Service
2SA92 For Short Wave Local Oscillator Service (18Mc)
2SA93 For Short Wave Mixer Service and 10.7Mc IF Amplifier Service

Ge PNP Mesa Type for VHP Use

2SA229 For VHF Mixer and Local Oscillator Service
2SA230 For VHF Amplifier Service (TV Tuner)
2SA239 For VHF Converter Service (VHF-FM)
2SA240 For VHF Amplifier Service

Ge PNP Alloy Type for LF Use

2SB54 For Audio Frequency Voltage Amplifier Service
2SB56 For 200mW (Class B) Power Output Amplifier Service
2SB189 For 350mW (Class B) Power Output Amplifier Service
2SB202 For 1W (Class B) Power Output Amplifier Service
2SB26 For 10W (Class B) Power Output Amplifier Service

Ge PNP Drift Type Power Transistor

2SB69 For 10W Hi-Fi Amplifier Power Output Use
2SB231 For 8" TV Horiz. Deflection Output Use
2SB258 For 40W Hi-Fi Amplifier Power Output Use
2SB296 For 10" — 14" TV Horiz. Deflection Output Use

Ge Point Contact Diode

1N60 For FM-AM Radio Detector Service
1N87A For FM-AM Radio & TV Video Detector Service
1S34 (Similarity 1N34A) For General Service

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Toshiba's new 75PC11, a 3" camera tube for black and white TV, can be operated with target voltage of up to 4 volts above cut-off which deletes black border and clouding. The picture quality of 75PC11, which is suitable for both studio and outdoor use, is greatly improved because it is equipped with a specially designed field-mesh device. Outstanding features of this tube include high resolution capability, uniform picture quality and high signal-to-noise ratio.

This is another example of the superiority of Toshiba products. From semiconductors to giant transformers, each Toshiba product is backed by the company's advanced research, great technical resources and most modernized facilities.

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Using 75PC11

Toshiba Image Orthicon Camera Tube 75PC11

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1N3152

1N3153

3 TIMES ACTUAL SIZE

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Applications for these microwave diodes include parametric amplifiers, second-stage protectors, and harmonic generators at ambient temperatures up to 200°C. The capacitance of these devices is closely controlled. The extremely low equivalent series resistance and inductance (approx. 0.4 nhy) makes them ideal for ultra high and super high frequency applications.

JEDEC NUMBER	BV Minimum @ I_R=10 mAdc	I_S Maximum @ V_R=2 Vdc	V_F Maximum @ I_F=100 mAdc	Q Typical @ f=9 kmc, V=0	R_S Maximum @ f=9 kmc, V=0	Total Capacitance f_0=500 mc, V=0	
						Minimum	Maximum
1N3152 & 1N3153*	5.5 Vdc	1.0 μAdc**	1.1 Vdc	4	2Ω	3.55 pf	4.45 pf

*1N3152 and 1N3153 have opposite polarities

**10 μAdc for 1N3152

These environmentally tested high reliability diodes may be purchased in quantity from Western Electric's Laureldale Plant. For technical information, price and delivery, please address your request to Sales Department, Room 102, Western Electric Company, Incorporated, Laureldale, Pa. Telephone: Area Code 215—WAlker 9-9411.

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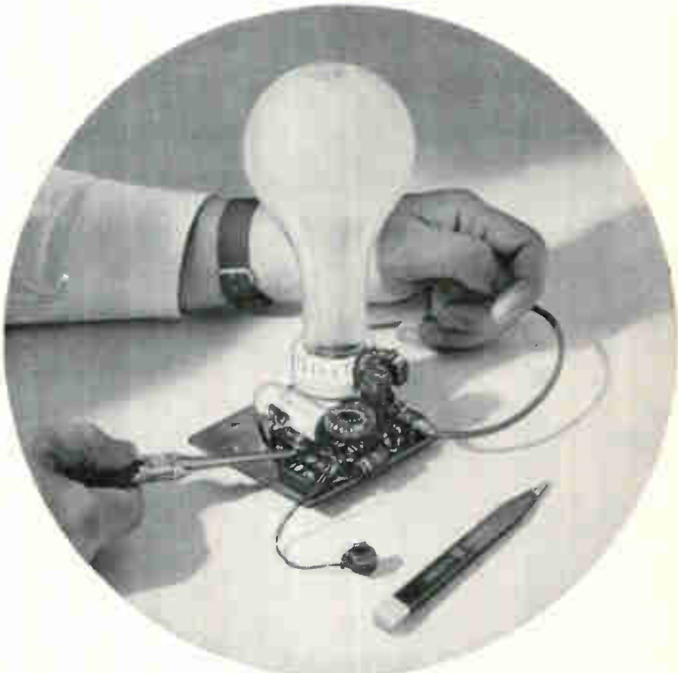
electronics

March 23, 1962

Tunnel-Diode Saturable-Reactor Amplifier as a Control Element

The saturable reactor, with its control winding insulated from other circuits, controls the frequency of tunnel-diode relaxation oscillations. Range of frequencies to 1,000:1 is obtainable for triggering power circuits



Adjusting the balance of a lamp control circuit

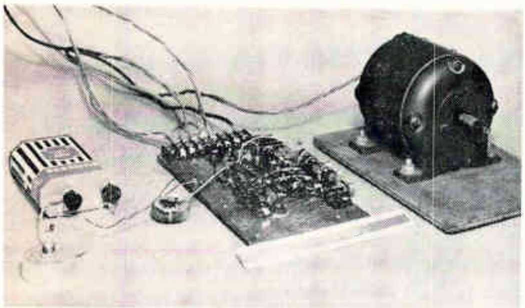
By RAY E. MORGAN
General Electric Company,
Schenectady, New York

THE TUNNEL DIODE[1] and saturable-reactor control method combines many of the advantages of semiconductor circuits with an amplifier having isolated input. The circuit is compact, economical, fast responding, versatile and in many applications provides a wider range of control than other available control elements. The combination is an oscillator with the oscillating frequency controlled by the d-c signal applied to an insulated winding on the saturable reactor. Frequency is controlled over a range of 100:1 and in some applications 1,000:1. The unit is ideal for operating with controlled rectifiers[4,5] or switching transistors[6] to provide wide range time-ratio control and variable frequency or controlled frequency power inverters and function generators for control systems or computers.

The theory of oscillation has previously been described,[7] nevertheless a brief description is presented for convenience.

The basic tunnel-diode-saturable reactor circuit is shown in Fig. 1 together with the volt-ampere characteristic of the tunnel diode. The sequence of oscillation *ABCDEFA* and relative positions of the supply voltage E_{S1} and bias current I_B are shown. Consider operation with control current $I_C = 0$. Application of bias current I_B places tunnel diode D_1 at position *A*. Application of supply voltage E_S does not disturb D_1 at first (D_1 remains between *A* and *B*) because saturable reactor *SR* is unsaturated. While *SR* is unsaturated the exciting current $i_S < (i_{TDB} - i_{TDA})$ where i_{TDA} and i_{TDB} are tunnel diode currents at positions *A* and *B* respectively. After *SR* saturates (position *A* of Fig. 2B) supply current i_S flows through D_1 adding to bias current I_B and raising tunnel diode current i_{TD} to position *B*. Once D_1 is at position *C*, voltage $e_{TD} > E_S$, voltage e_{SR} again reverses, *SR* becomes unsaturated (i_S negligible) and D_1 moves to position *A* and the oscillation continues.

Application of control current I_C (Fig. 1) increases the frequency of oscillation according to Fig. 2A. Figures 2B and 2C trace the B-H



Tunnel diode saturable reactor unit gives 1,000:1 speed control of 3-phase motor

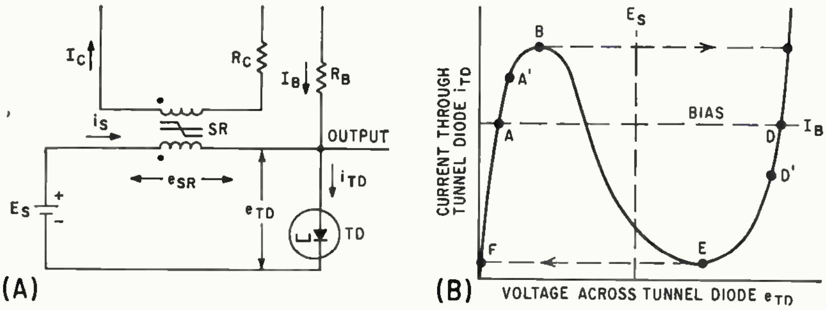


FIG. 1—Control current in saturable reactor sets oscillation frequency of tunnel diode (A); sequence of operation is traced out by characteristic curve (B)

loop of the saturable reactor for two conditions: Fig. 2B with no control current I_c flowing and Fig. 2C having 3 ma control current and increased frequency f_o of relaxation oscillations. Current I_c reacts on *SR* just as control current reacts on a non-self saturating magnetic amplifier[2, 3]. Control current I_c provides ampere-turns to *SR* in opposition to the ampere-turns produced by supply current i_S. Position *A* is shifted to the left of the B-H loop as shown in Fig. 2C. This forces i_S to increase between position *A* and *A'*; the tunnel diode reaches position *B* and switches to position *C* before *SR* saturates (position *B*, Fig. 2C), reversing e_{SR} so that *SR* traces a minor B-H loop. The reduced swing of flux brings an increase in the oscillation frequency.

As control current I_c is further increased, the flux swing decreases with smaller B-H loops as shown in Fig. 2D. The magnetomotive force *H* of Fig. 2D is proportional to $(i_S - I_c)$ assuming a turns ratio of 1:1 for *SR*. The peak-to-peak swing of current i_S during oscillation is $i_S = i_{TDB} - i_{TDE}$, where i_{TDB} and i_{TDE} are tunnel diode currents at positions *B* and *E* respectively. The peak-to-peak swing of i_S is determined by the tunnel diode and is held constant. Likewise the swing of *H* of Fig. 2B, 2C and 2D is held constant. As I_c increases in Fig. 2D the sequence of oscillation and relative position of *B* and *H* to i_{DT} and e_{DT} of Fig. 1 are shown by *ABCDEFA* for $I_c = 0$, by $A_1B_1C_1D_1E_1F_1A_1$ for $I_c = 20$ ma and by $A_2B_2C_2D_2E_2F_2A_2$ for $I_c = 50$ ma. The tunnel diode is a 1N2941, with $i_{TDB} = 5$ ma; *SR* has a 1:1 turns ratio and a Hi-Mu 80 core. The transfer curve is shown in Fig. 3 relating output to input current for the circuit shown. Waveforms are illustrated in Fig. 4. A transistor added to the tunnel-diode saturable-reactor circuit as shown in Fig. 5A increases the load voltage and load power over the circuit of Fig. 1. The limit of load voltage of Fig. 1 is too low for many control and computer applications ($e_{TD} < 0.5$ volt for germanium and $e_{TD} < 1.2$ volts for gallium arsenide). Transistor Q_1 raises the load voltage to $e_L = 20$ volts or in some cases $e_L = 75$ volts.

Transistor Q_1 also provides current gain. The tunnel diode is frequently a low current type, such as 1N2941 ($i_{TD} = 4.7$ ma $\pm$ 0.3 ma at position *B*) to match the desired design parameters of the saturable reactor.

The design parameters of *SR* (Fig. 5A) is extended by use of Q_1. During the interval that Q_1 is turned on (e_{TD} between positions *C* and *E* and $e_Q = 3$ volts) supply voltage E_{S1} drops to less than 20 percent of the voltage for Q_1 turned off. The action of Q_1 (Fig. 5A) upon E_{S1} permits E_{S1} to be much larger (such as five times) than E_{S1} of Fig. 1 when the tunnel diode

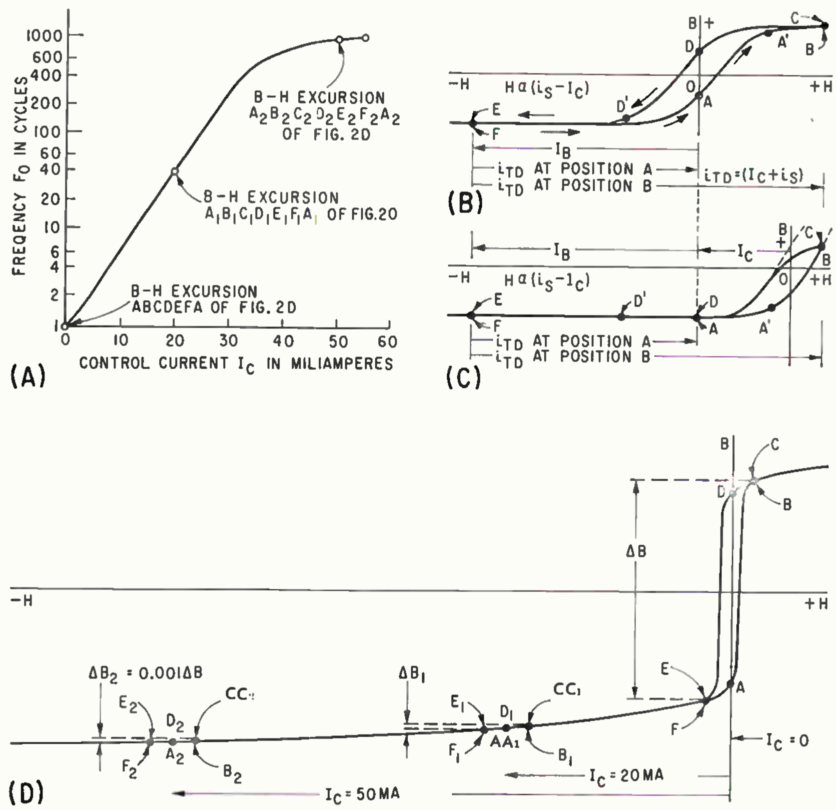


FIG. 2—Control current of 55 ma raises frequency to 1,000 cycles (A); hysteresis loops relate to saturable reactor with zero (B) and 3 ma (C) control current. Curve (D) shows the B-H excursion for 3 conditions of operation pinpointed on curve (A)

is operating between F and E. With the tunnel diode operating between C and E, voltage E_{S1} of Fig. 5A is about the same as E_{S1} of Fig. 1 This action of Q_1 permits the saturable reactor resistance to be much larger (five times or more) than for *SR* of Fig. 1. The operating requirement for Fig. 5A is that $(E_{S1} - i_S R_{SR1}) > e_{TD}$ for D_1 at position B, and $E_{S1} < e_{TD}$ when D_1 is at position E; R_{SR} is the resistance of the saturable reactor and the supply voltage is E_{S1}.

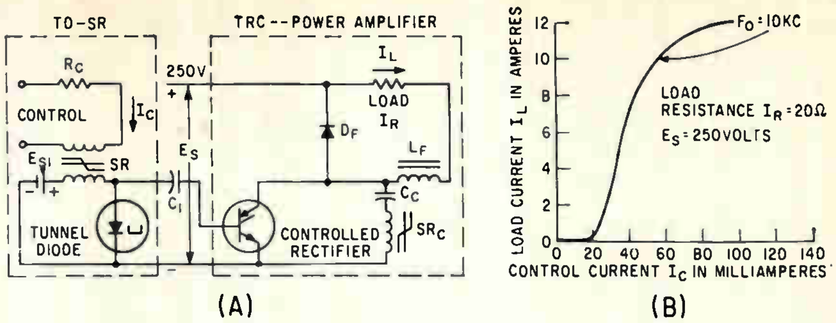


FIG. 3—Variable frequency control circuit feeds silicon controlled rectifier amplifier (A); transfer characteristic shows that 100 ma control current gives 12-amp output (B)

The tunnel diode-saturable reactor is an excellent control element for time-ratio control circuits in controlled rectifier[4, 5] and transistor[6] techniques.

The tunnel-diode saturable-reactor circuit controls a silicon controlled rectifier (scr) in Fig. 5B. The power circuit stays on for a fixed length of time and the tunnel diode-saturable reactor controls the frequency, and in turn, the load voltage.[4, 5] The power supply voltage E_{S1} comes from the power circuit to synchronize the time ratio control and tunnel diode-saturable reactor circuits at maximum frequency. Transistor circuit Fig. 5C uses the tunnel diode-saturable reactor in the same way[6] as the *SCR* circuits. The tunnel diode-saturable reactor triggers the power circuit with a pulse during each oscillation. Voltage E_{S1} in both Fig. 5B and 5C is obtained by an attenuator consisting of resistor R_1 and diode D_1. The forward dynamic resistance of D_1 is much lower than the static resistance, allowing D_1 to be a good attentuator element. When the tunnel diode is germanium (such as 1N2941) D_1 is a 1N91.

The tunnel-diode saturable-reactor control unit can generate a frequency controllable for more than 1,000:1 range for time-ratio control, converters and function generators, and is excellent for combining with controlled rectifiers or switching transistors for power control. The tunnel diode saturable reactor provides a preamplifier or function generator for control or computer systems.

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(1) I. A. Lesk, N. Holonyak, Jr., U. S. Davidsohn, and M. W. Aarons. Germanium and Silicon Tunnel Diodes-Design, operation and Application, *Wescon Con. Rec.* 3, EC441, p 9, 1959

(2) W. A. Geyger, "Magnetic-Amplifier Circuits," McGraw-Hill Book Company, Inc., New York 36, N. Y., 3, p 29, 1954

(3) H. F. Storm, "Magnetic Amplifiers" John Wiley & Sons, New York, N. Y. p 62

(4) R. E. Morgan, A New Magnetic-Controlled Rectifier Power Amplifier *AIEE Transaction* 80, I, p 152, May 1961.

(5) F. W. Gutzwiller, "Controlled Rectifier Manual", Semiconductor Products Dept., General Electric Co., 2, p 173, 1960.

(6) R. E. Morgna, A New Control Amplifier Using a Saturable Current Transformer and a Switching Transistor, *AIEE Transaction* 77, p 557

(7) H. F. Storm and D. P. Shattuck, Tunnel Diode D-C Power Converter, *AIEE* Transaction 80, Part I, paper # 61-149

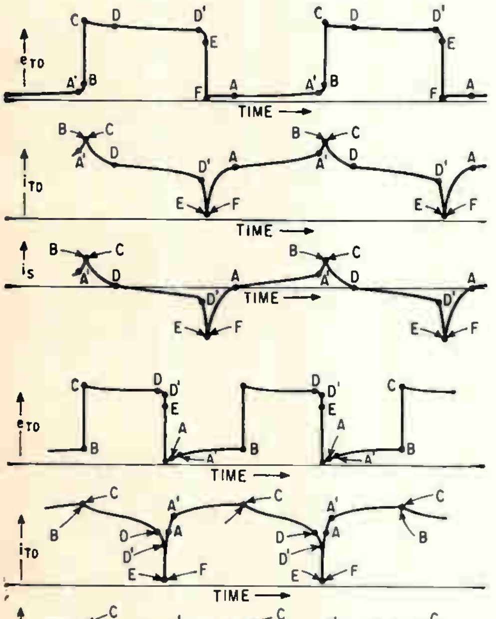

FIG. 4—Upper 3 waveforms are plotted for zero control current, lower for $I_c = 3$ ma

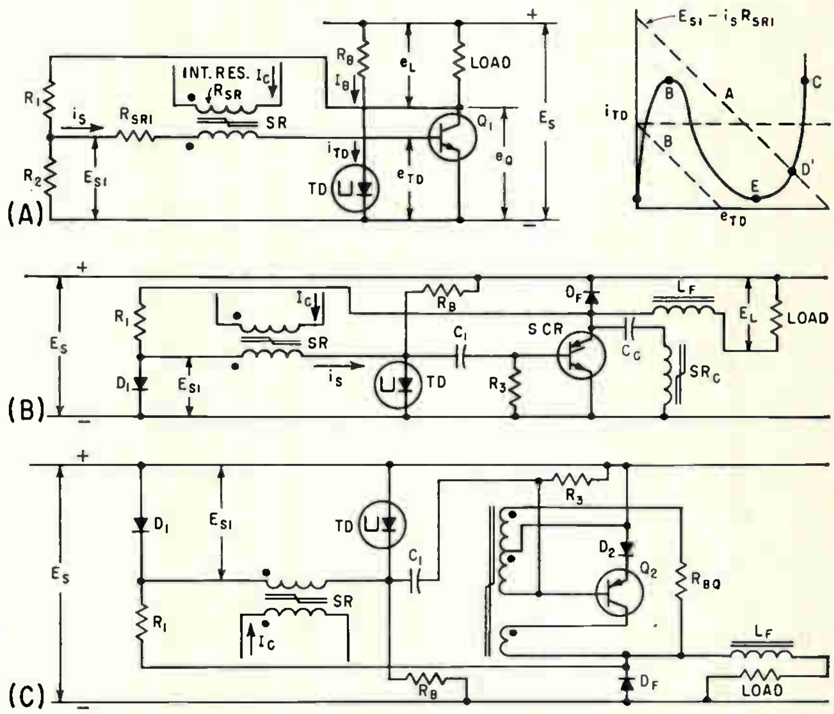

FIG. 5—Transistor increases control circuit gain and output voltage (A); control circuit feeds scr amplifier (B); control circuit triggers blocking-oscillator-type output amplifier (C)

Solion Tetrode Integrates

Signals ranging from slowly varying d-c to frequencies beyond 10 Kc can be integrated using the low-power solion tetrode in simple, inexpensive circuits

By JAMES W. MARTIN, JAMES R. COX
Texas Research and Electronic Corp., Dallas, Tex.

SOLION TETRODE enables time-integration to be performed accurately using simple, reliable and inexpensive circuits. Integration of electrical signals has required complicated mechanical equipment or complex, costly electronic circuits.

The commercially available SE 110 solion tetrode is smaller than a miniature tube and requires less than 1 mw of d-c power. This device has been used in circuits to integrate signals with frequencies above 10 Kc, as well as slowly varying d-c signals such as those encountered in meteorological measurements.

The circuit in Fig. 1 is designed to integrate signals from a gas chromatograph recorder. Accuracy of the integrator is better than 1 percent, drift is negligible for this application, and the integrator can be operated from batteries.

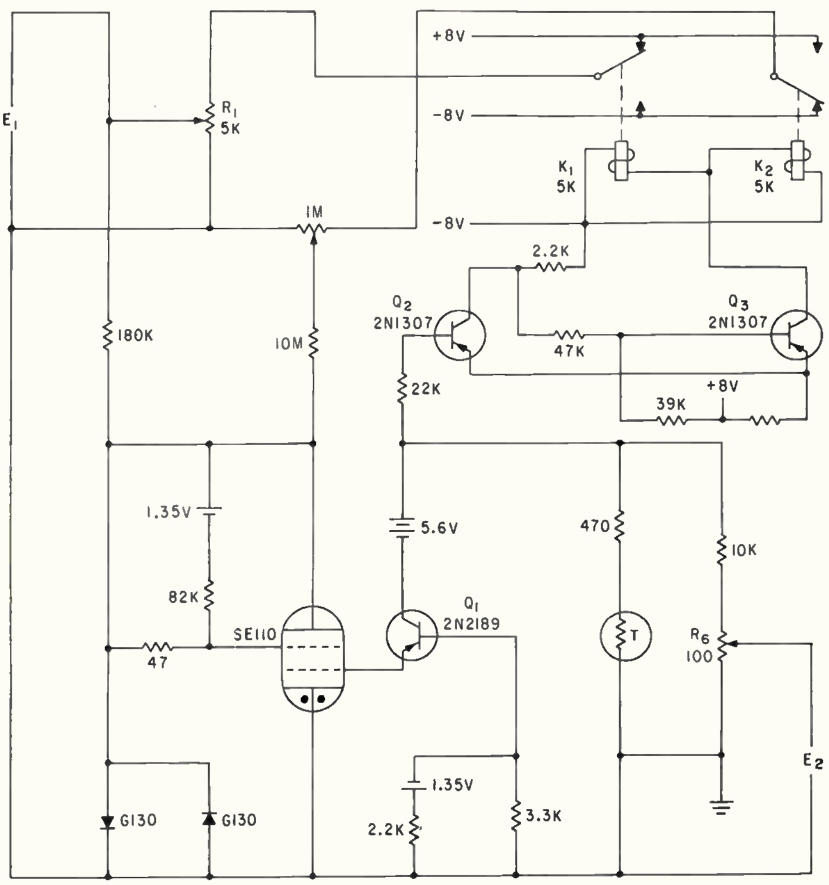

FIG. 1—Solion integrating circuit provides accuracy better than one percent and is battery-powered

Input E_1 to the solion tetrode is taken from retransmitting potentiometer R_1, which is driven by the chromatograph recorder. Output E_2 drives a second recorder channel. Typical input and output signals are shown as a function of time in Fig. 2A.

Common base amplifier Q_1 provides voltage gain to the integrator output circuit. The Schmitt trigger consisting of Q_2 and Q_3 and of relays K_1 and K_2 reverses polarity of the input current to the solion. Reversing input current polarity at predetermined output current levels folds the integral as shown in Fig. 2A, which provides an unlimited output range of the integral.

The thermistor in the output circuit in Fig. 1 compensates the increase in output current of about 2.5 percent per degree centrigrade. Accuracy using thermistor compensation is better than 1 percent. Where greater accuracies are required of the integrator, component ovens are used.

Operating power for the solion is provided by 1.35-volt mercury cells and voltage dividers. Maximum voltage from the 1.35-volt cells is limited by the dividers to 0.7 volt to avoid damaging the low-power solion.

The integrating component in the circuit in Fig. 1 is the SE 110 solion tetrode. The term solion, a contraction for solution of ions, applies to a family of devices that function by controlling and monitoring a reversible electrochemical reaction.

The aqueous solution contained in the SE 110 is potassium iodide (KI), with a small quantity of the element iodine (I_2). Although in the solution the iodine actually exists primarily as the tri-iodide ion (I_3^-), it will be referred to as iodine for simplicity.

The four electrodes and two functional compartments of the tetrode are identified in Fig. 2B. Current through the device in the direction shown effectively transfers a quantity of iodine from the reservoir

Chromatograph Signals

compartment into the integral or output compartment. Actually a reversible oxidation-reduction type of chemical reaction occurs at the two electrodes. The reactions occur at the same rate, causing the effective transfer of iodine, although no iodine actually moves through the solution. This effective transfer of iodine can be reversed by changing the polarity at the two electrodes.

Based on Faraday's law, the quantity of iodine transferred is proportional to the input charge, which is the time integral of input current. Thus the quantity of iodine transferred is proportional to Q_i, where Q_i is input charge in microcoulombs, and

$$Q_i = \int I_i(t)dt, \qquad (1)$$

where $I_i(t)$ is input current in microamperes as a function of time.

The output current that flows between the readout and common electrodes is directly proportional to the quantity of iodine in the integral compartment. This quantity, as shown in Eq. 2 and 3, is proportional to the integral of input current:

$$I_o = K Q_i \text{ or} \qquad (2)$$

$$I_o = K \int I_i(t)dt, \qquad (3)$$

where I_o is output current in microamperes and K is integrator sensitivity in microamperes output per microcoulomb input.

Bias supply E_s between the input and shield electrodes prevents iodine from diffusing from the reservoir into the integral compartment.

Simple integrator circuits such as that in Fig. 1 can be designed with the aid of the equivalent circuit of the solion tetrode in Fig. 2C. The input circuit, between the input and common electrodes, can be represented by resistor R_i in series with the nonlinear voltage generator E_c. In the input characteristics shown in Fig. 2D, voltage at the input terminals is plotted as a function of charge Q_i for several values of constant input

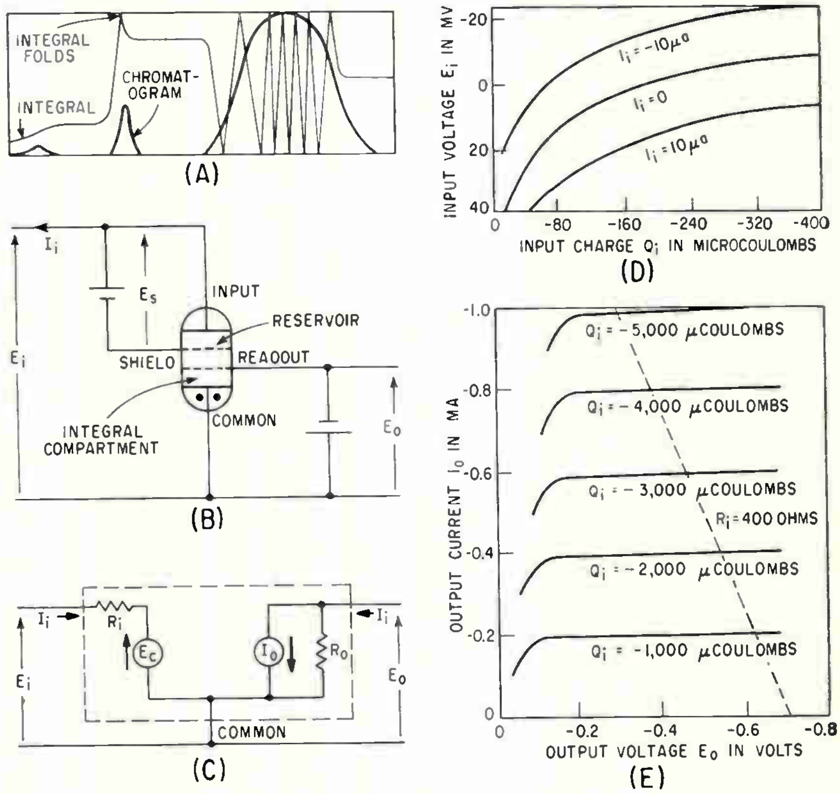

FIG. 2—Folding integral above preset level (A) permits unlimited output range. Current effectively transfers iodine from reservoir (B) to integral compartment, while nonlinear voltage source in input part of equivalent circuit (C) results from different iodine concentrations. Input voltage is compared to charge (D) at several levels of input current, and typical output characteristics (E) show linear relationship between input charge and output voltage

current. Voltage source E_c in the equivalent circuit results from a difference in iodine concentration at the input and common electrodes. This voltage is a function of input charge Q_i and is represented by the curve for I_i equal zero in Fig. 2D.

The output portion of the equivalent circuit in Fig. 2C includes the readout and common electrodes. This circuit is similar to the equivalent output circuit of a vacuum-tube pentode. It contains current generator I_o and output resistance R_o. The output characteristics shown in Fig. 2E indicate a high value of output resistance R_o and show the linear relationship between output current and input charge indicated by Eq. 2. A load line for a 400-ohm resistor and a 0.7-volt supply is also shown.

Simple circuits using solions have been designed to integrate many parameters for which obtaining integrals had been impractical. The low drift rate of solions has led to their use as integrators of long-period signals, such as those proportional to sunlight and temperature. The high frequency response has been used to integrate pulses above 10 Kc proportional to sound power level.

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THREE-PHASE INVERTER

Three-phase 400-cps solid-state inverter uses servo loops to control output voltages and phase angles in spite of unbalanced loads. Output voltage- and phase-sensing circuits tell control logic circuits how much to shift time positions of the two square waves that comprise the quasi-square wave of each phase

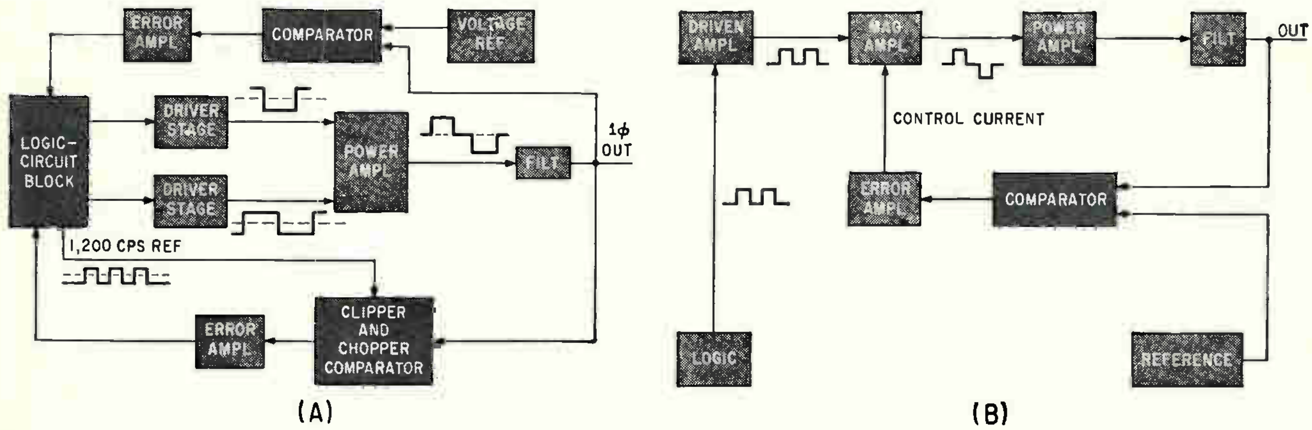

FIG. 1—Simplified block of 3-phase inverter (A) that is discussed in the article shows only one of its three-phase sections. Compare it with other inverter type shown in (B)

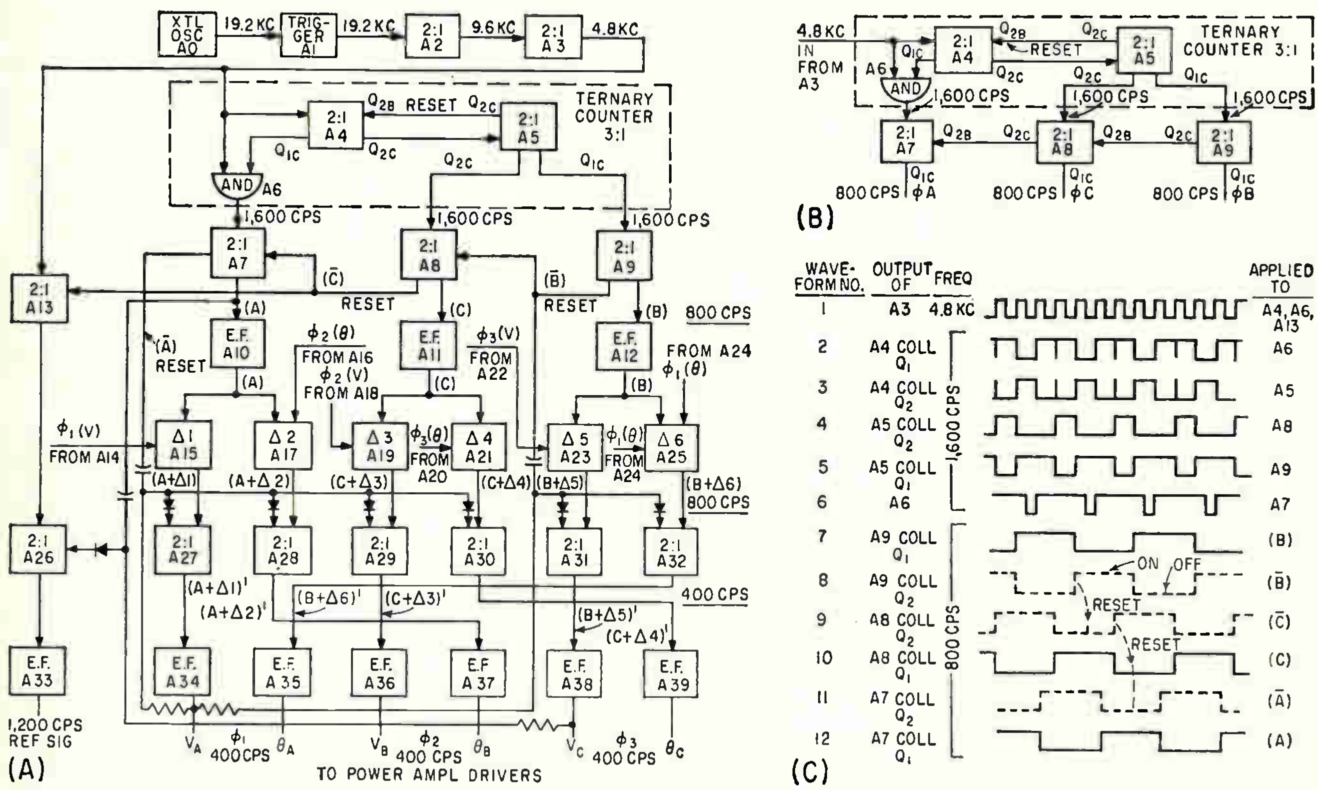

FIG. 2—Logic circuits (A) of inverter produce a pair of square waves for each phase, one wave being controlled by an amplitude sensitive feedback signal, the other by a phase-sensitive feedback signal. Ternary counter and 2:1 divider (B) of logic circuits produce and receive waveshapes shown in (C)

WITH FEEDBACK LOOPS

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THIS SOLID-STATE INVERTER has a high conversion efficiency, is tightly regulated, and maintains near 120-deg separation between its three phases under heavily unbalanced load conditions.

Solid-state digital logic circuits in the inverter (Fig. 1A) generate a precise low-level three-phase squarewave signal. Each of these low-level squarewave signals is then amplified by a highly efficient switching amplifier. Band pass filters at the outputs of these amplifiers produce the final 3-phase sinusoidal output. Each phase contains two servo loops; one loop regulates voltage variations for load and line changes and the other loop maintain a fixed phase relationship with the other two phases in spite of unbalanced load conditions. The output of each inverter phase, before filtering, is a quasi-squarewave. The leading edge of the quasi-squarewave is shifted to obtain voltage control, and the trailing edge of the waveform is shifted to maintain the correct phase relationship, under varying load.

Compare Fig. 1A to Fig. 1B, which shows another method of generating a quasi-squarewave. In Fig. 1B, the driver stage drives the magnetic amplifier, which drives the power stage and the filter network. The comparator samples the output and compares it to a reference voltage. Any error signal is amplified, and current is applied to the control winding of the magnetic amplifier. This control current determines the firing angle of the magnetic amplifier. The push-pull output of the magnetic amplifier is a quasi-squarewave, whose dwell time is a function of the control current. One serious problem arises when this circuit is employed. During the dwell time of the quasi-squarewave, there is no drive signal for the output transistors of the power stage; therefore, the primary of the output transformer is terminated into a relatively high impedance. Since no drive signal is applied to the filters during the dwell time, the energy stored in the filters is reflected through the secondary into the primary of the output transformer. This energy is in the form of spikes and hash, and is superimposed on the quasi-squarewaves during the dwell time. This problem can be eliminated with relatively complex circuits and special biasing networks. The price of these circuits is paid in lowered efficiency and increased weight, cost and complexity.

The method indicated in Fig. 1A uses a different approach to eliminate the problem of unwanted reflected energy from the filters. Logic circuits generate two squarewaves for each of the three phases. Delay circuits within the logic-circuit block, which are controlled by amplitude and phase-reference feedback signals, vary the time delay of these squarewaves. Figure 1A shows a pair of square waves produced by the logic circuits and going to one phase section of the static inverter. The squarewaves are amplified and then added in the power amplifier stage. Adding these variable-delay squarewaves at the transformer secondary output produces a quasi-squarewave with a varying dwell time.

At no time are all the output power transistors turned off simultaneously. Therefore, the power transformer always presents a low impedance to the filter. There is no reflected energy from the filter, because there is no dwell time, as in Fig. 1B, when energy is not being delivered to the filters.

The other two phase sections are similar to the one shown in Fig. 1A. Note that the servo feedback loops of each phase are independent of the other two phases.

The logic circuits generate two 400-cps squarewaves having a defined phase relationship to drive each phase of the static inverter. These squarewaves are amplified by driver amplifiers to obtain sufficient power to drive the output power stage. The two squarewaves are added in the power amplifier so as to give a quasi-squarewave at the output. Varying the delay of each of these squarewaves varies the dwell time of the quasi-squarewave. One edge of the quasi-squarewave controls the output voltage amplitude, while the other maintains phase control under varying load. The quasi-squarewave goes to a filter, whose output yields a sinewave of less than 3-percent distortion.

The output of each phase is sampled by a voltage-referenced and a phase-referenced comparator. Any error in output voltage or phase is then detected, amplified and applied to the delay circuits in the logic-circuit block. These circuits delay the two 400-cps squarewave signals to the power amplifier so that when added, they yield the correct phase and voltage relationship.

Figure 2A shows a block diagram of the logic circuits that drive the static inverter. A 19.2-Kc crystal oscillator (A_0) is a frequency standard. After squaring this signal with Schmitt trigger A_1 and dividing this signal down, a 4,800-cps squarewave signal is obtained. This is the frequency used to drive the logic circuits. Note that if the frequency specification requirements of the inverter were not too stringent the 19.2-Kc oscillator would not be required. It might be possible to use a 4,800-cps mechanical resonator or a relaxation oscillator to drive the logic circuits. The 4,800-cps signal drives the ternary counter (Fig. 2B), which divides by three.

Figure 2C illustrates the waveforms of the ternary counter. Also shown is the manner in which three 800-cps square waves with the proper phase relations are generated. Three nonsymmetrical 1,600-cps output signals of A_5 and A_6 (Fig. 2B) of the ternary counter and go to binary counters A_7, A_8 and A_9. Waveforms 4, 5 and 6 of Fig. 2C show these 1,600-cps signals, which go to A_8, A_9 and A_7.

By reset signals, as shown in the block diagrams and also in the waveforms by the vertical dotted lines, three symmetrical 800-cps signals are obtained (phases A, B, and C, in waveforms 12, 7 and 10, of Fig. 2C). These 800-cps squarewaves are displaced 120 degrees in phase with respect to each other. Phase rotation is AB, BC, CA.

Each of these signals is then coupled through an emitter follower (A_{10}, A_{11} and A_{12} of Fig. 2A) to two separate delay circuits, one of which is controlled by amplitude control circuits (the ϕ (V) inputs), while the other is controlled by phase control circuits (ϕ (θ) inputs). Each delay circuit consists of a one-shot multivibrator and a delay network. An amplifier inverts this signal to obtain the proper output signal polarity.

Take phase 1 for example. The 800-cps squarewave signal derived from A_7 is fed through emitter follower A_{10} to a delay multivibrator (A_{15}). This 800-cps signal is delayed as shown in Fig. 3A (upper group of waveshapes). The delay of the multivibrator is determined by a voltage-sensing servo loop that monitors the output of phase 1 of the static inverter (Fig. 1A and Fig. 2A). The delay is a function of the phase 1 output voltage. The output of delay network A_{15} drives binary counter A_{27}, whose output frequency is 400 cps. This 400-cps signal (V_A) drives phase 1 (ϕ_1) of the static inverter as shown in Fig. 2A and 3A. This 400-cps drive signal is a function of the delayed 800-cps signal, which in turn is a function ϕ_1 (V) of the output voltage of phase 1. Feedback signal ϕ_1 (V) comes from the voltage-sensing servo loop (A_{14} of Fig. 2A).

Figure 3A also shows how the other 400-cps drive signal is obtained for phase 1. The delay of A_{35} is a function of output phase relationship. The bottom drawing of Fig. 3B shows the quasi-square wave formed by adding drive signals V_A and θ_A in the power amplifier output stage.

Figure 3B shows how drive signals are derived for the three phases. It also shows the 1,200-cps signal that corrects output phase. This 1,200-cps signal is the common reference for all three phases. As shown in Fig. 3B, the output of each power amplifier is a quasi-squarewave. When the dwell period is 60 deg, the third harmonic and multiples are cancelled. The total harmonic distortion is approximately 30 percent. (A square wave contains approximately 47 percent distortion.) The waveforms shown in Fig. 3B are precisely maintained 120 deg apart by the logic circuits.

Filtering is necessary to reduce the harmonic distortion below the 5-percent distortion required for most applications. The output filters have to be closely matched to meet the requirements of 120 deg ±2 deg required in most specifications. As long as the loads of the three phases are matched, no problem is encountered in meeting the ±2 deg limits. However, when unbalanced loads are applied at the output of the static inverter, phase shift will occur in the output filters. One method of eliminating this problem is to use a three-phase auto transformer at the output of the filters.[1] This method, however, does not use an auto transformer but uses a servo loop in each phase that corrects for any phase shift through the filters.

The 1,200-cps signal required for the phase-sensing circuits comes from A_{33}, Fig. 2A and goes to the clipper and chopper comparators of each phase (Fig. 1A). The sinewave output of each phase of the static inverter is sampled and applied to the clipper circuit of the comparator. This clipped 400-cps signal is then applied to a transistor chopper and compared to the 1,200-cps reference signal as shown in Fig. 3C. Waveform 1 shows the quasi-square wave (broken lines) applied to the filter. It also shows the sinewave output of the filter. Waveform 2 shows the clipped sinewave (ideal) that is applied to the phase-correcting loop. A 1,200-cps signal turns the chopper on and off (waveform 3). When the 1,200-cps signal is negative, the 400-cps signal appears at the output of the

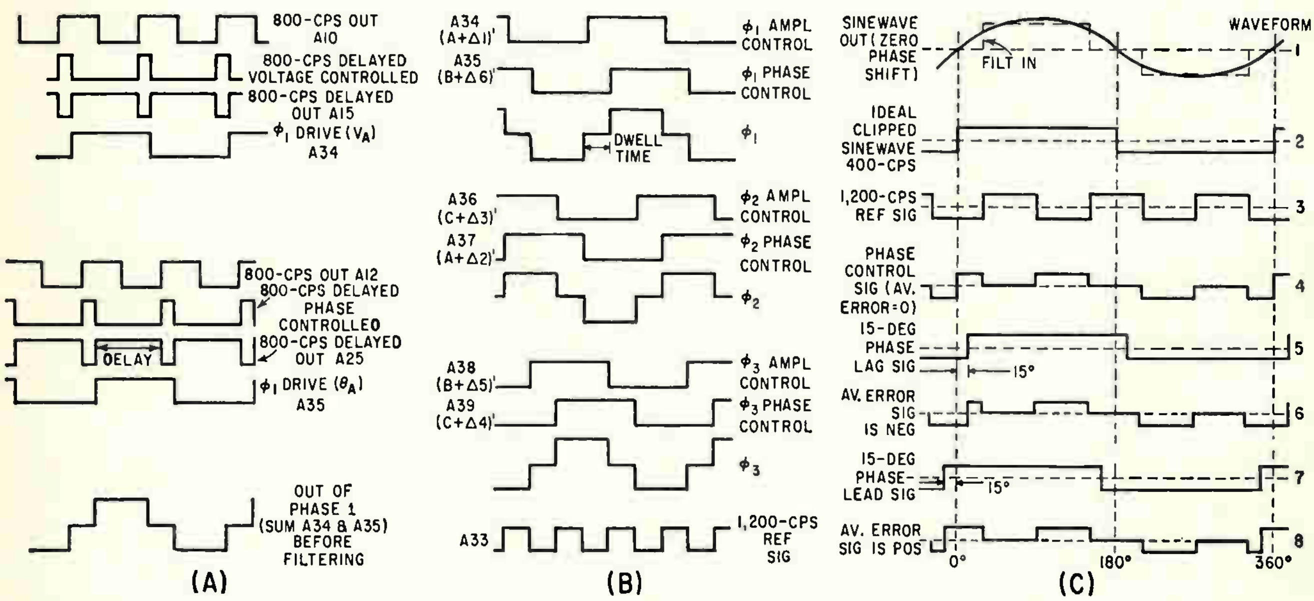

FIG. 3—Waveshapes in (A) show effect of voltage- and phase-controlled delays on formation of quasi-square wave of single phase; (B) shows relationships of the three quasi-square waves and the 1,200-cps reference signal. Waves in (C) show how out-of-phase outputs develop a phase-correction feedback signal

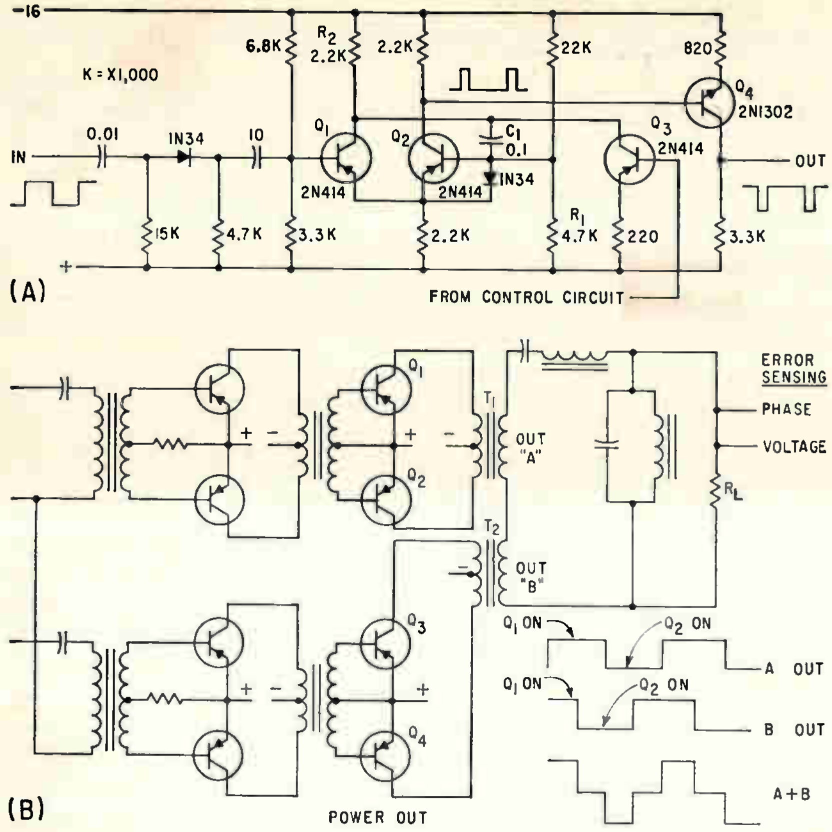

FIG. 4—Delay circuit (A) is one of the six delays shown in Fig. 2A. Power amplifier section of a single phase and its square and quasi-square waves (B)

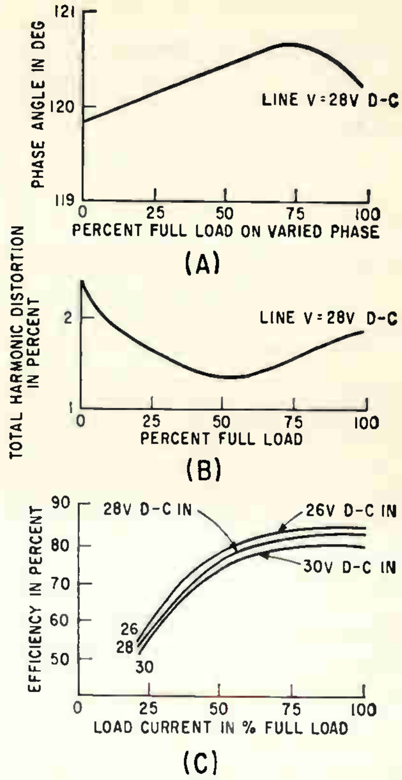

FIG. 5—Phase angle versus unbalanced load between 2 phases (A). Harmonic distortion versus loading (B). Efficiency versus load current for various supplies (C)

comparator switch. When the 1,200-cps signal is positive the 400-cps signal will not pass through the switch.

If there is no phase shift, the output of the chopper is that shown by waveform 4. Close observation of this waveform shows the average value to be zero. Hence, no error signal would appear at the output.

Assume that a varying load causes the phase shift to lag by 15 deg, as shown by waveform 5. The output of the chopper would appear as shown by waveform 6 and a negative error signal would be detected.

If the varying load caused a 15-deg advance in phase shift, the clipper output would appear as shown by waveform 8, and a positive error signal would be detected.

The error signal is applied to the logic circuit, as shown in Fig. 1A. The logic circuit then corrects for the error by adjusting the delay circuits that drive the binary counters.

The delay circuit (Fig. 4A) comprises a one-shot multivibrator with Q_1 conducting and Q_2 nonconducting. The input signal is differentiated, with only the positive pulses going to Q_1. Transistor Q_1 is triggered to the nonconducting state and its collector becomes negative. This makes the base of Q_2 negative and Q_2 starts conducting, making the collector of Q_2 positive. Capacitor C_1 then charges through the path R_1, C_1 and R_2. After a time, determined by R-C time constant $(R_1 + R_2)\ C_1$, the base voltage level reaches the point that shuts off Q_2, and Q_1 conducts. Since the R-C time constant and the level at which Q_2 is turned off are fixed, the conducting time of Q_2 depends on how far negative the base voltage of Q_2 (collector voltage of Q_1) can swing. The negative swing of Q_1's collector depends on the conducting state of Q_3, which is controlled by the base voltage applied to Q_3. The base voltage of Q_3 is controlled by the error-detecting signals at the output of the static inverter. This base voltage controls the collector current of Q_3 and establishes a voltage drop across R_3 that determines the collector voltage swing of Q_1. Thus the delay is controlled by the sensing circuits.

Drive signals from the logic circuits are amplified by driver stages to drive the power stage. Here they are amplified and added to the desired power levels. The circuit shown in Fig. 4B uses two power output stages in push-pull. The outputs are added at the secondaries of output transformers T_1 and T_2. As indicated by the waveshapes, there is no period of time in which all output power transistors of a phase are off.

Figure 5 shows some of the results obtained with the 250-va inverter. Figure 5A shows the effect of unbalanced loads on phase shift. Here, one phase has a constant full load while the load of the other phase is varied; the ordinate shows the phase angle between these phases. Figure 5B shows the effects of loading on total harmonic distortion at the output of the filters. The variation in distortion is caused by loading and by the varying dwell time of the quasi-square wave. Figure 5C shows conversion efficiency.

The author thanks S. Schwartz and others for their assistance.

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MAGNETIC-CORE RING

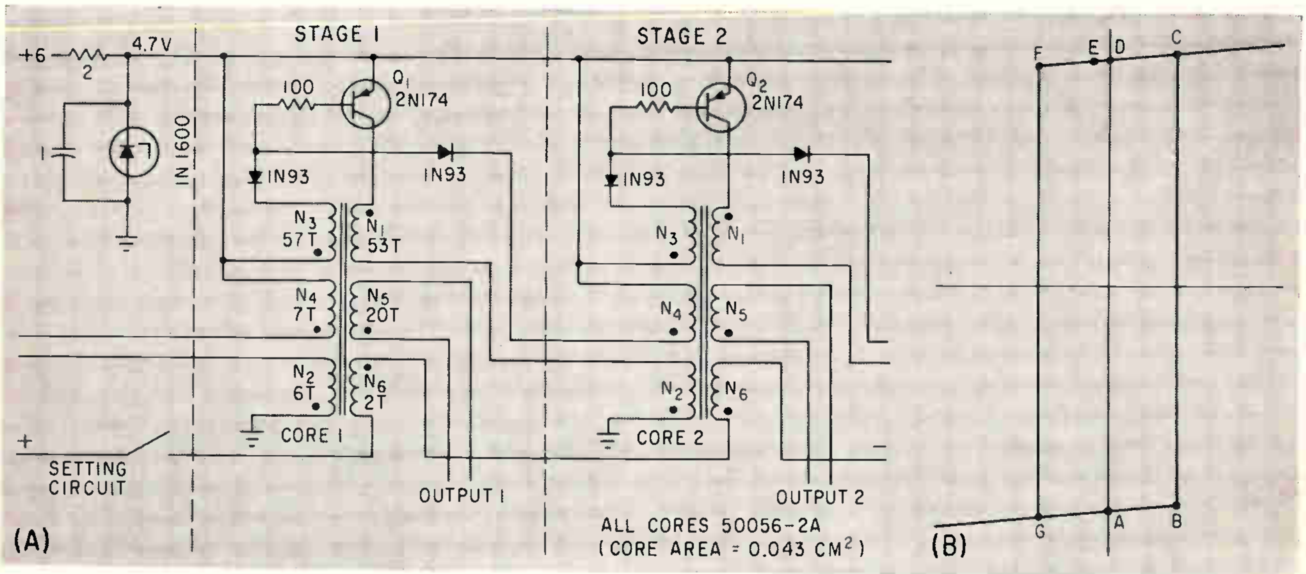

FIG. 1—Output 2 follows output 1 after a delay that is a function primarily of input voltage and core size (A). Delays from 100 μsec to 3 seconds can be obtained relatively easily. Magnetic excursions of cores (B) are explained in text

A RING-TYPE oscillator using transistors and square-loop magnetic cores can provide relatively high-power output pulses from each of a string of stages, with each output completely isolated electrically from the remainder of the circuit. It differs from a ring-counter circuit in that no oscillator (and amplifier) is needed for drive.

The circuit, Fig. 1A, shows two successive stages of any number of identical stages that can be connected in series before the loop is closed.

Assume the cores are initially set by a current through the N_6 coils such that core 1 is saturated negatively and all the other cores are saturated positively.

As soon as the setting current is removed, Q_1 starts conducting. This is initiated by either or both of two causes. Any small leakage current through Q_1 and N_1 will generate a voltage in N_3, causing Q_1 to conduct. Also, the removal of the setting current causes the operating point of core 1 to drop from a high negative value, beyond point G, Fig. 1B, to point A. The slight slope of this part of the curve causes a small voltage to be generated in N_3 of core 1, which drives Q_1 further into conduction. These effects are cumulative and the current increases until Q_1 is fully conducting.

Collector current passing through N_1 of core 1 causes the flux to change from point A to B to C. During this period the voltage generated in N_3 supplies base current to maintain Q_1 saturated while collector current is limited by N_1, since for a given core the abscissa of point B in Fig. 1B is a function of the ampere turns in magnetizing coil N_1. The current is therefore limited to this value until positive saturation (point C) is reached, after which it will increase until limited by other elements in the circuit.

This same current also passes through N_2 of core 2. Although this current is in the right direction to drive core 2 from positive to negative saturation, it is insufficient in magnitude, since both cores are identical and N_1 has a much larger number of turns than N_2. Thus the operating point of core 2 shifts from D to E but remains positively saturated.

After core 1 reaches positive saturation (point C), N_1 no longer limits the current, which will increase until limited by coil N_2 of core 2 in the same manner that N_1 previously limited it. Core 2 can now be driven from positive to negative saturation (point F to G in Fig. 1B) by the current in N_2. During this interval the voltage generated in N_3 of core 1 will disappear because core 1 is saturated and the flux is not changing. However, the changing flux in core 2 generates a voltage in N_4 of core 2 to supply base current to Q_1, which is thus maintained in the conducting condition.

When core 2 reaches negative saturation (point G), the voltage generated by N_4 on core 2 disappears, and Q_1 cuts off. At the same time, since core 2 has now been driven to negative saturation by N_2, Q_2 starts to conduct; collector current through N_1 of core 2 drives core 2 from negative to positive saturation. Coil N_3 of core 2 sup-

COUNTER NEEDS NO DRIVE

Each stage of pulse generator develops an electrically isolated pulse. Delays from one pulse output to the next can range from less than 100 μsec to more than 3 seconds

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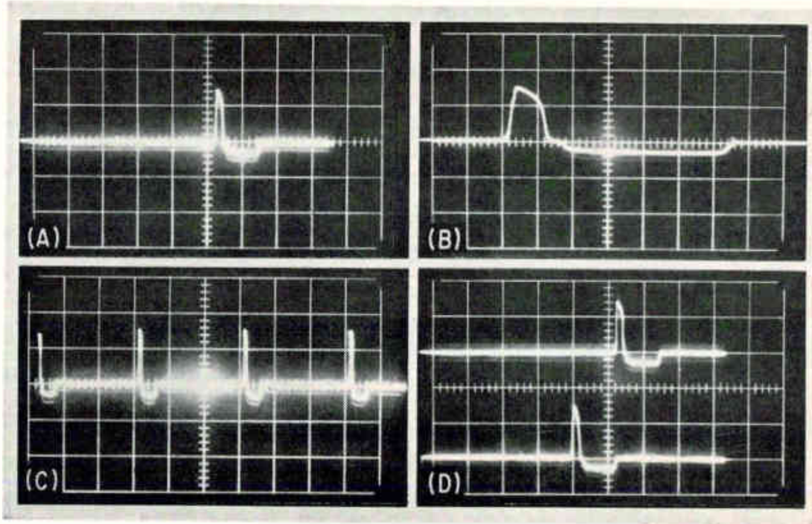


FIG. 2—Waveforms at various sweep speeds show high-peak, short-duration pulse and low level, longer duration tail. Single pulse trace at upper left was taken with a sweep of 200 μsec per cm

plies base current for Q_2.

A similar cycle now takes place for cores 2 and 3. Coil N_5 on each core provides an output pulse each time its associated core changes magnetic state. The output is a short, high-amplitude pulse followed by a long, low-amplitude pulse of opposite polarity.

The output from a single stage circuit is shown in Fig. 2A and 2B; Fig. 2C shows four successive pulses. During the intervals between the cut-off of a negative pulse and the initiation of the following positive pulse, the other stages operate in succession. The outputs from two successive stages are shown in Fig. 2D. The waveforms of Fig. 2 were obtained from a six-stage circuit having the specifications given in Fig. 1.

The time durations of the pulses can be varied by changing the size of the cores, the number of turns, or the input voltage. The equation is

$$E = 2NBA10^{-8}/t$$

where E is the voltage across the coil, N is the number of turns on the coil, B is the maximum flux density for the given core material in gauss, A is the cross-sectional area of the core in sq cm, and t is the duration of the pulse in seconds.

Positive and negative portions of the cycle do not have the same duration. The number of turns on N_2 determines the positive portion and N_1 determines the negative portion. The equation is exact for the given core, but if the input voltage is maintained constant (which is the function of zener diode 1N1600 in Fig. 1A) the actual voltage across the coils will depend slightly upon the voltage drop across the transistors and miscellaneous circuit resistances. By adjusting the number of turns on the cores, pulse durations sufficiently accurate for nearly all applications may be obtained. If more precise intervals are required, series resistances may be inserted to give the necessary adjustment.

Transistors with high voltage ratings must be used, with the required value depending on the ratio of turns between N_1 and N_2 and also on the input voltage. During the interval when N_2 is driving its core, a high voltage is generated in N_1 on the same core. This voltage is impressed across its transistor, which is cut-off. The transistor must be able to withstand this voltage without breaking down. Thus 2N174 transistors were used, since they were the cheapest readily available transistor with the required voltage rating.

The circuit is useful where successive pulses at fixed intervals are needed as in synchronizing a multiphase static inverter.

This circuit can also provide pulses separated by a relatively long time interval. This is difficult to obtain electronically, but by varying the input voltage, number of stages, size of cores and number of turns, any reasonable time delay between pulses may be obtained. That is, a pulse might be given at every Nth count.

The circuit can be used in place of a ring-counter driven by a fixed oscillator, with the advantage of high power and separated output circuits, and it does not require drive.

Sweep Circuits Using Two

Design of phantastron circuits using two three-terminal active elements instead of three is discussed. Both vacuum tube and transistor versions are described

IN THE classical pentode-phantastron circuit, two distinct feedback loops can be distinguished. The first is a negative-feedback loop which enables Miller integration action; the second is positive-feedback loop through which a gating waveform at the suppressor is obtained. In this way, a phantastron effect is brought about by using both inputs (grid and suppressor), and both outputs (screen and plate), of a single pentode.

It is possible to obtain the same phantastron effect with two three-terminal active elements having two inputs and two outputs, that is, with the same number of useful terminals as a single pentode.

A circuit of this type using two triodes is shown in Fig. 1. Before triggering, the plate of V_1 is at such a low potential that V_2 is cut off. Immediately after application of the trigger, the plate voltage of V_1 rises until V_2 conducts. The resulting voltage drop at the plate of V_2 prevents, through Miller capacitor, C, further rise at the plate of V_1, and thus, Miller action begins. At the same time, the linear waveform at the plate of V_2 is differentiated by the C_1R_1 time constant, and the resulting negative square-wave at the grid of V_1 keeps this tube cut off as long as Miller rundown continues to take place.

The negative-feedback loop is from the plate to the grid of V_2, and the positive feedback is obtained through the differentiating network C_1R_1 from the plate of V_2 to the grid of V_1. To achieve good sweep linearity, a triode with amplification factor of 100 is used. An auxiliary diode, V_3, is provided to disconnect the low output impedance of the pulse generator from the circuit immediately after the triggering.

As shown in Fig. 2, the waveform at the plate of V_2 is fairly linear during the voltage drop, including the initial jump. Of course, other techniques, such as catching diodes and buffer cathode-followers, widely employed in other pulse circuits, can be used here.

This dual-feedback approach affords the possibility of designing simple phantastron circuits with transistors, which are inherently three-terminal active elements.

In Fig. 3, transistor Q_2, is saturated before the triggering, and Q_1 is practically cut off. After the application of a narrow positive trigger, collector voltage V_{c1} rises linearly, Fig. 4, during the time $t_1 = (R_c + R)C$.[1] In this period, base voltage V_{b2}, after a negligible positive jump, rises to the voltage $-V_{cc}[(R_{b1}C_1)/C(R+R_c)-1]$ with the time constant R_bC_1, and the voltage V_{b1} decreases slightly due to the increase of the base current of Q_1. After t_1, when transistor Q_1 has reached saturation, there is no more reaction from the collector to the base, and the base current increases to its saturation value, producing a further fall of the base voltage V_{b1}. During this interval there is no rise of V_{c1} and the discharge of C_1 slows down and proceeds with the time constant R_bC_1. Thus, base voltage V_{b2} changes from the value which can be evaluated from the equation for the previous time interval by substituting $t = t_1$ toward V_{cc} with the same time constant. When the discharge of C_1 is completed, Q_2 conducts, (its base current being partly supplied through C_1), and both C and C_1 recharge through R_c. Thus the collector voltage V_{c1} falls toward V_{cc} with the time constant R_c $(C+C_1)$. The recovery time can be shortened by choosing a smaller value for R_c, but this decreases the voltage gain of Q_1 and sweep linearity suffers.

As in the vacuum-tube circuit, both the positive and negative-feedback loops are readily distinguished. The former consists of C_1R_b combination which keeps Q_2 cut off during the sweep and the latter is the usual Miller-integrator capacitor C.

It is possible to minimize the time during which Q_1 is saturated by making R_bC_1 smaller. By inserting an emitter-follower after the collector of Q_1, a sweep with short recovery time can be obtained.

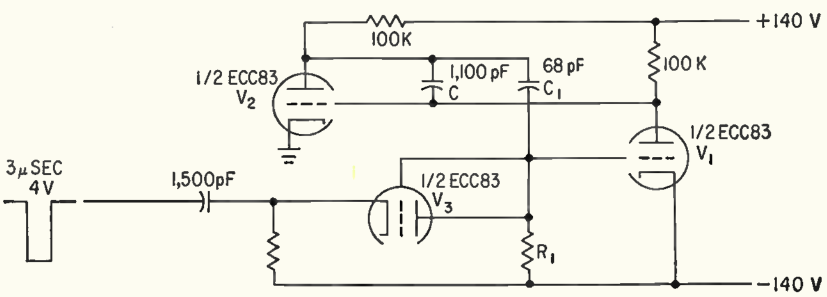


FIG. 1—Vacuum-tube phantastron circuit uses two active elements (V_1 and V_2). Tube V_3 is an isolation diode

REFERENCE

(1) L. Strauss, Wave Generation and Shaping, McGraw-Hill Book Co., 1960, Eq. (7-19)

Three-Terminal Active Elements

By A. S. KISLOVSKY
Electrotechnical Faculty,
Grcica Milenka 19, Belgrade,
Yugoslavia

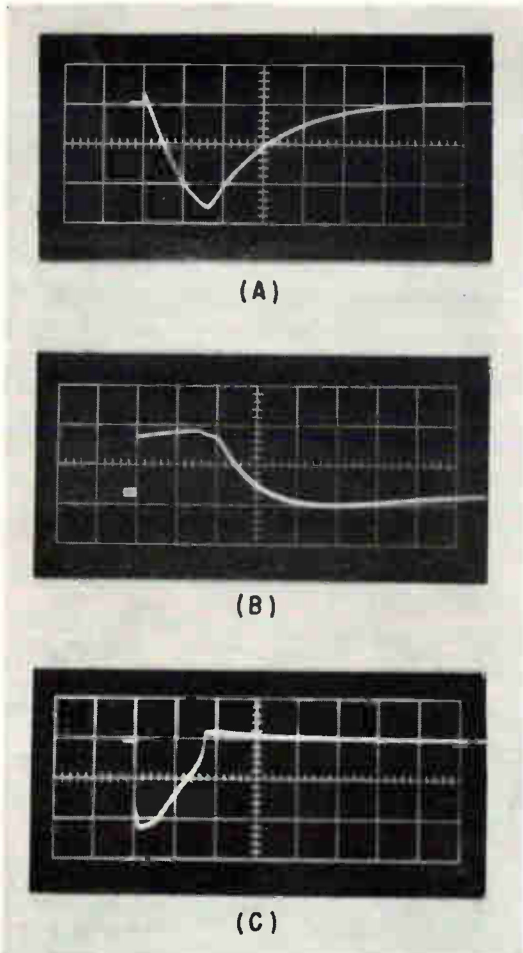


FIG. 2—Typical waveforms at plate of V_2 (A), at grid of V_2 (B), and at grid of V_1 (C)

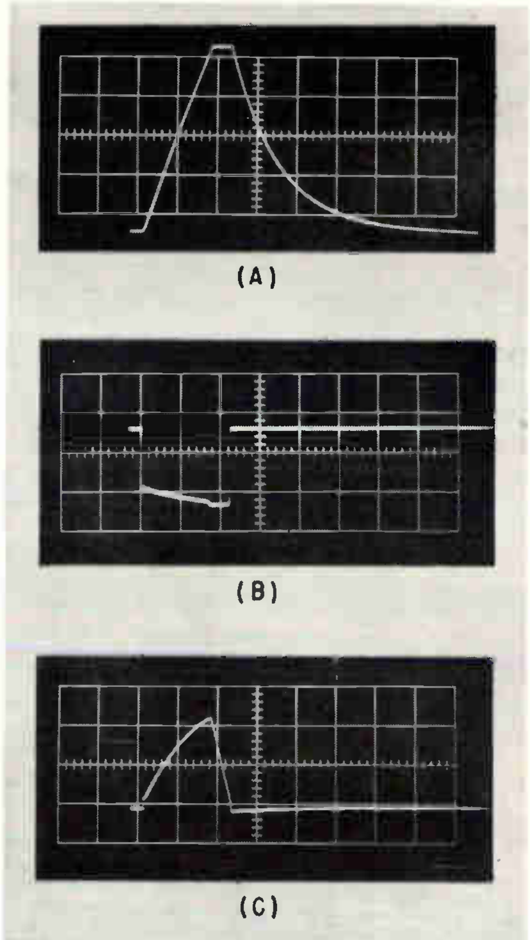
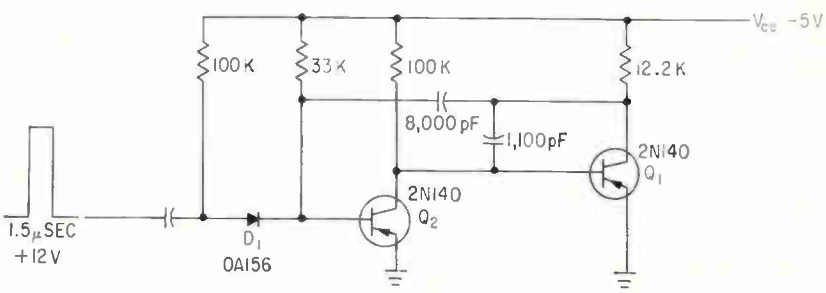


FIG. 4—Typical waveforms of voltages at collector of Q_1 (A), base of Q_1 (B) and base of Q_2 (C)

FIG. 3—Two transistor version of the phantastron sweep circuit



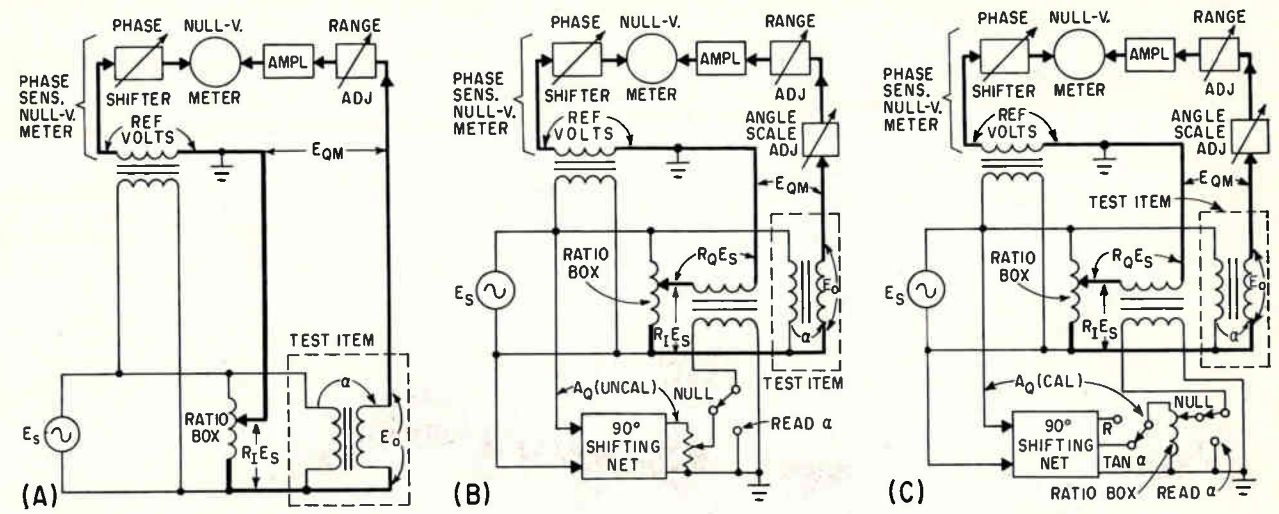


FIG. 1—There are two variations of measuring circuit shown in (A): one that is shown has phase shifter, other circuit has none. Circuit (B) injects quadrature-balancing voltage from 90-deg network, as does (C), which also has a quadrature ratio box. Heavy lines depict voltage-bucking action in null-voltmeter circuit

RATIOMETRIC MEASUREMENTS:

Techniques and Accuracies

By MALCOLM D. WIDENOR
SIDNEY HERMON
North Atlantic Industries, Inc., Plainview, N. Y.

TABLE I — DEFINITION OF SYMBOLS

E_S	= Excitation or source voltage
E_O	= Test item output voltage
E_I	= In-phase component of E_O
E_Q	= Quadrature component of E_O
E_{QM}	= $R_Q E_S$ = Measured E_Q
α	= Phase angle of E_O (E_S, ref), rad
δ	= Orthogonality error, rad
γ	= In-phase Ratio Box phase shift, rad
n	= Null-V Meter resolution factor
n_O	= Null-V Meter overload factor
m	= Meter accuracy in % full scale
R_I	= In-phase ratio reading
R_Q	= Quadrature ratio reading
$\Delta R/R$	= Rated Ratio Box error
A_Q	= Quadrature amplitude scale factor
ΔA_Q	= Quadrature amplitude scale stability[a] (with freq., exc. amplitude, time, etc.)
T.R.[b]	= E_O/E_S
Z_D	= $R_D + jX_D$ = Null Detector input Z[c]
Z_L	= $R_L + jX_L$ = Test Item output Z
Φ	= Null Circuit Transfer Angle

$$K \angle \Phi = \frac{Z_D}{Z_D + Z_L}, \text{ Null Circuit transfer function}$$

$$\cong 1 - Z_L/Z_D \text{ for } Z_L/Z_D << 1$$

(a) With freq., excitation amplitude, time, etc.; (b) Transformation Ratio; (c) Impedance

THIS ARTICLE shows basic circuit arrangements for making various voltage-ratio measurements and lists formulas that compare their accuracies.

Consider Fig. 1. In each of these circuits, a precision ratio divider compares output E_O of the device under test with the input to the device (E_S). The test item can be any 3- or 4-terminal device, such as a resolver, amplifier, computer, or a transformer (as shown in the figures). These illustrations do not show actual measuring setups. Table I explains the symbols used in Fig. 1; Fig. 2 shows the vector relationships.

In Fig. 1A to 1C, the phase shifter is used to shift the phase of a reference voltage that compensates for Φ, the null-circuit transfer angle.

In obtaining a null for Fig. 1A, the output voltage of the ratio box ($R_I E_S$) is adjusted so that it equals the in-phase component (E_I) of E_O. This adjustment is made with the phase-sensitive null-voltmeter set so that it senses in-phase voltages. A function switch (not shown in Fig. 1A) permits rapid switching of the phase-sensitive null-voltmeter from the in-phase to the quadrature-sensing mode. The ratio-box reading shows the in-phase ratio R_I. Turning the function switch to the quadrature mode causes the meter to indicate E_Q, thus allowing α (phase shift) to be computed.

The errors introduced are (see Table II): a small ratio box error, ΔR; the resolution error of the test setup, which, in Fig. 1A, results from the presence of quadrature and orthogonality (δ) errors. The δ error is the error of the test circuit in sensing the true perpendicularity between

TABLE II — PARAMETER-MEASUREMENT ERRORS OF SETUPS SHOWN IN FIG. 1[a]

PARAMETER MEASURED	PARAMETER SYMBOL	ERROR FACTORS	ERROR CONTRIBUTING FACTOR[b]	ERROR EQUATION	REALIZABLE ERROR VALUES[c] FIG. 1A(1)	FIG. 1A(2)	FIG. 1B	FIG. 1C
In Phase Ratio	R_I	Orthogonality	δ	$(\delta\alpha \times 100)$, % of R_I	n.a.[d]	$0.3\,\alpha$ %	$0.01\,\alpha$ %	$0.01\,\alpha$ %
			δ, Φ [only 1A (1)]	$(\delta\alpha + \Phi\alpha)100$, % of R_I	$(0.3\alpha + 100\Phi\alpha)$ %	n.a.	n.a.	n.a.
		Resolution	n, no / n, no, Φ [1A(1) only]	$\frac{n}{no}\,\alpha \times 100$% of R_I	$\left(\frac{0.05\,\alpha}{\cos\Phi}\right)$ %	$0.05\,\alpha$%	nil	nil
		In Phase Ratio Box Error	$\frac{\Delta R}{R}$	$\left(\frac{\Delta R}{R} \times 100\right)$, % of R_I	$\pm\left(0.0001 + \frac{0.000025}{R_I}\right)$ %			
Phase Angle	α. (meas. as $\tan\alpha$)	Tangent Approximation	α	$-\left(\frac{\tan\alpha - \alpha}{\alpha} \times 100\right)$, % of α	$\alpha = 0.2$ rad (11.46 deg) $\Delta\alpha/\alpha \equiv -1.3\%$			
		In Phase Ratio Box Phase Shift	γ	γ	n.a.	n.a.	Less than 100μ rad	
		Meter Accuracy	m	m% full scale angle	n.a.	n.a.	2%	n.a.
		Quad. Ratio Box Error	$\frac{\Delta R}{R}$	$\left(\frac{\Delta R}{R} \times 100\right)$, % of α	n.a.	n.a.	n.a.	$\pm\left(0.001 + \frac{0.0001}{R_Q}\right)$%
		Quadrature Scale Error	ΔA_Q	$\left(\frac{\Delta A_Q}{A_Q} \times 100\right)$, % of α	n.a.	n.a.	n.a.	0.1%
		Calibration Error	Absolute std. & field calibration	0.1% of α	n.a.	n.a.	n.a.	0.1%
		Null Circuit Error	Z_D, Z_L	$(1 - K)$ 100, % of α	n.a.	n.a.	0.01% For $\lvert Z_L/Z_D \rvert = 10^{-4}$	nil
Quadrature	E_Q (read on meter in Fig. 1A and 1B); R_Q (read on ratio box in Fig. 1C)	In Phase Ratio Box Phase Shift	γ	$(\gamma\, R_I\, E_S/E_Q) \times 100 = (\gamma/\alpha) \times 100$, % of E_Q	$\frac{0.01}{\alpha}$ %			
		Null Circuit Error	Z_D, Z_L	$(1 - K) \times 100$, % of E_Q	n.a.	0.01% For $\lvert Z_L/Z_D \rvert = 10^{-4}$		nil
				$\left(\frac{1}{\cos\Phi} - K\right)$ 100, % of E_Q	$\left(\frac{1}{\cos\Phi} - 1\right)$ 100% + 0.01% For $\lvert Z_L/Z_D \rvert = 10^{-4}$	n.a.	n.a.	n.a.
		Meter Accuracy	m	m% full scale E_Q	2%	2%	2%	n.a.
		Quad. Ratio Box Error	$\frac{\Delta R}{R}$	$\left(\frac{\Delta R}{R} \times 100\right)$, % of E_Q	n.a.	n.a.	n.a.	$\pm\left(0.001 + \frac{0.0001}{R_Q}\right)$%
		Quad. Scale Error	ΔA_Q	$\left(\frac{\Delta A_Q}{A_Q} \times 100\right)$, % of E_Q	n.a.	n.a.	n.a.	0.1%
		Calibration Error	Absolute std. & field calibration	0.1% of E_Q	n.a.	n.a.	n.a.	0.1%

(a) Parameter errors are sum of applicable error factors; (b) Approximations $\alpha = \tan\alpha$ and $\delta = \tan\delta$ are used throughout Table; (c) typical of presently available commercial equipment; typical test frequency of these equipments is 400 cps; (d) not applicable.

the E_I and E_Q components of E_O. One error factor contributing to δ is ϕ. This error is determined by the relative impedances of the null detector and the output impedance of the test item.

Figure 2 indicates the effect of δ. Voltage $\Delta R_I E_S$, expressed as a fractional error of ratio R_I is

$$\Delta R_I/R_I = \tan\delta \times \tan\alpha = \delta \times \alpha$$

for small angles. Table II delineates these errors and others, along with typically realizable error values. Under Fig. 1A, two cases are shown: (1) where Fig. 1A does not have a phase shifter and (2) where the phase shifter is used to eliminate Φ.

Figures 1B and 1C show more elaborate setups. Figure 1B and 1C differ from Fig. 1A in that they inject a precise quadrature signal into the measuring circuit to cancel the quadrature component. Hence, in Fig. 1B and C, no current flows at null, except for noise and harmonics. In Fig. 1B and 1C, δ is caused by the precision passive networks that produce the injected quadrature; on the other hand, in Fig. 1A, δ is caused by the phase angle volt-meter and/or ϕ.

Figures 1B and 1C differ in that Fig. 1C contains a calibrated quadrature-injecting source that provides a direct readout in deg, rad, or tan α.

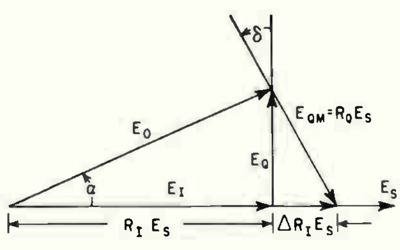


FIG. 2—This vector diagram applies to all circuits shown in Fig. 1

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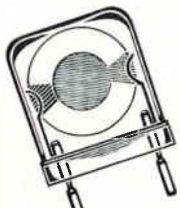

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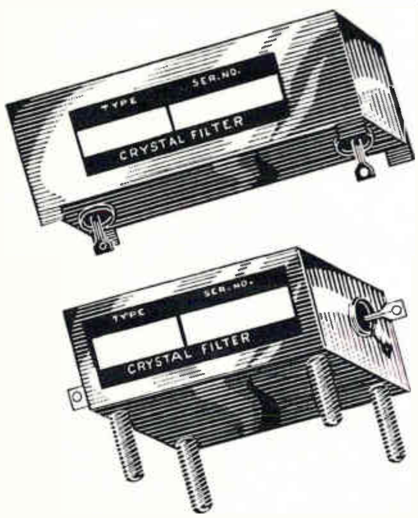

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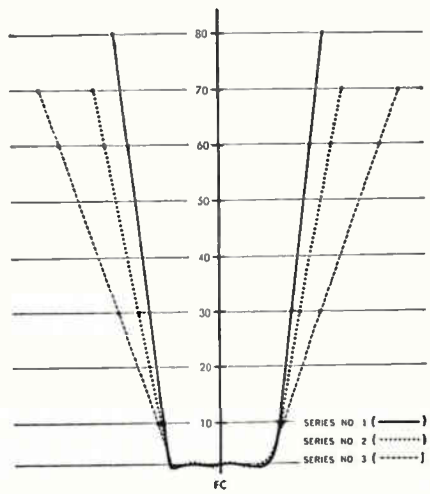

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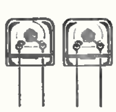

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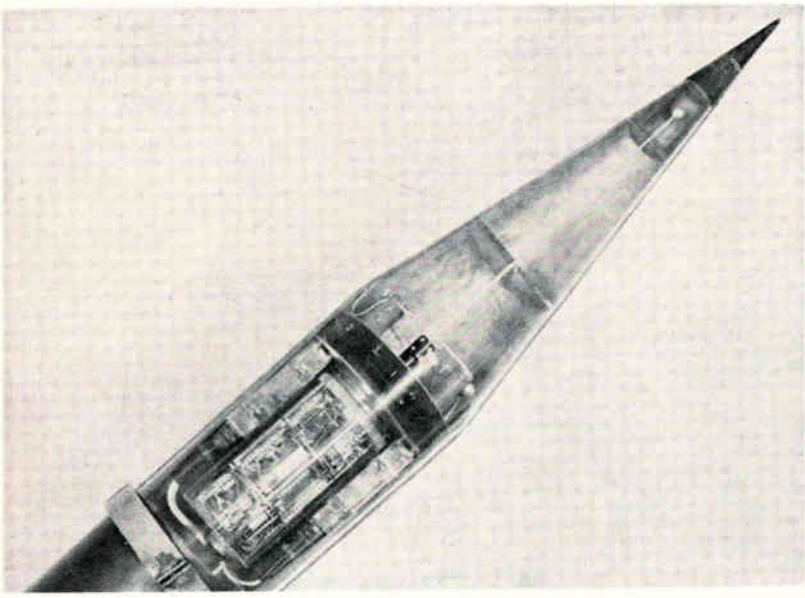

Instrumented rocket has electronics at center and battery on each side. Two smaller probes pop out at right angles to center probe when cover shell breaks off

By KUNIO HIRAO,
Chief. Research Section of Plasma Physics Radio Research Labs. Ministry of Post and Telecommunications, Tokyo, Japan

IONOSPHERIC electron density and temperature measurements can be made more accurately using a sensing device called a resonance probe. The new probe will be launched by a Nike-Cajun rocket from Wallops Island, Virginia, in April. The cooperative effort was planned by the Radio Research Laboratories of Japan and NASA to compare ionospheric data obtained using the resonance probe with that from a NASA probe also included in the instrument package.

During three Kappa rocket flights in Japan, successful measurements were made of ionospheric electron density and temperature using the resonance probe. The first observations were made in March 1961 with the rocket launched from the Japanese Rocket range to an altitude of about 180 Km. Measurements were made throughout the time that the rocket was in the ionosphere using the resonance probe for electron density and temperature and a conventional Langmuir probe for ion density.

Scientists have been making direct soundings of the ionosphere by rocket since 1946. Data about electron density in the ionosphere has been obtained using the Langmuir probe and by continuous-wave propagation. The Langmuir-probe method has also been used to measure electron temperature. However, there is some ambiguity in measurements of both electron density and temperature using the Langmuir probe.

Adding A-C Voltage

To measure electron density and temperature using the Langmuir probe, the direct current and voltage characteristics of the probe are determined while the probe is in the plasma. In some recent experiments, a swept-frequency a-c voltage was superimposed on the d-c voltage, which changes the direct current and voltage characteristics of the probe.

At lower frequencies, the change in probe characteristics is almost constant with plasma frequency. As frequency of the superimposed voltage is increased, the change in characteristics increases, reaching a maximum at the plasma resonant frequency of the environment. As frequency is further increased, the change in direct current and voltage characteristics of the probe decreases, finally becoming zero well above plasma frequency.

Since the change in probe characteristics is similar to the effect of an applied force to a mechanically resonant system, the probe has been called a resonance probe. A theoretical analysis of probe characteristics indicates that this analogy is correct.

In using the resonance probe to measure electron density in a plasma, the frequency that causes the greatest change in probe characteristics is found by measuring the direct current or voltage of the probe. Since this frequency is equal to plasma frequency, electron density of the surrounding plasma can be determined from the relationship between plasma density and plasma frequency.

Measuring Electron Temperature

Electron temperature is also determined from direct current or voltage of the probe, but in this case a low-frequency a-c voltage is superimposed on the d-c voltage. Electron temperature is then determined from the relationship between direct current or voltage in the probe and electron temperature.

Measurements of both electron density and temperature using the resonance probe have been found to be considerably more accurate than those obtained using the conventional Langmuir probe.

The resonance probe was developed at the Ministry of Post and Telecommunications in collaboration with the Japan Telephone Corp. The probe, which was built by the Yokogawa Electric Manufacturing Co., includes a hermetically sealed cylindrical electronics package 14 cm in diameter and 28 cm long. The instrument also has a center probe 55 cm long and two

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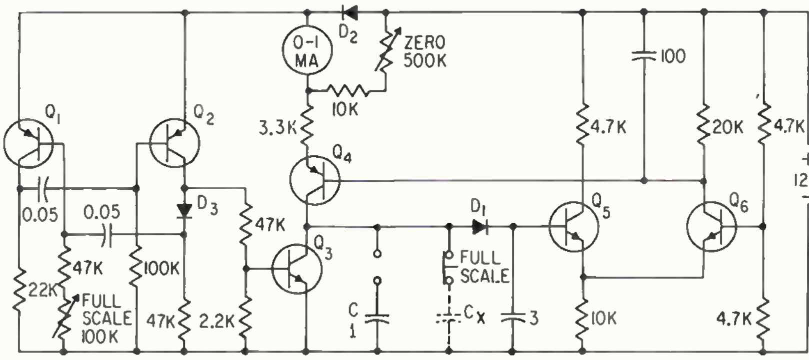
Capacitance Meter Has Linear Scale



Capacitance values from 0 to 1 microfarad are indicated linearly on milliameter, and circuit can be modified for other ranges

By W. MOSINSKI
Flushing, N. Y.

TECHNIQUE for measuring capacitance provides high-accuracy indications directly on a linear scale. The circuit requires no bridge balancing, and measurement ranges can be provided from 0 to 100 pF to ranges that permit testing of large electrolytic capacitors.

The measuring method is based on the relationship between a capacitance C charged at constant current i for time t at voltage V in which

$$C = it/V \qquad (1)$$

If t and V are constant, C is proportional to i. An unknown capacitance is therefore

$$C_x = i_x t/V, \qquad (2)$$

which divided by Eq 1 results in

$$C_x = C(i_x/i) \qquad (3)$$

By making C a known reference ($1\mu f$ in the circuit shown in the figure) and i the full-scale indication of an ammeter (1 ma), i_x indicates C_x directly and independently of t and V if they do not change during the measurement.

The measurement range of the circuit in the figure is 0 to 1 μf. A source of constant frequency is provided by Q_1 and Q_2, which by switching Q_3 on and off establishes charging time. The capacitor charges when Q_3 is off and discharges when it is conducting. Charging current supplied by Q_4 is maintained at a constant value by Q_5 and Q_6.

The only external adjustments are the zero and full-scale settings, which are quite stable. To obtain other measurement ranges, frequency, charging current or voltage must be changed in accordance with Eq 1.

At lower measurement ranges, internal capacitances from wiring or similar sources becomes evident, but it can be compensated by the zero adjustment. Measurement accuracy depends primarily on the reference capacitor, with other factors being less important. Although current indicated on the meter is higher than actual charging current, it is the ratio of currents that indicates the unknown capacitance. Leakage in the capacitor under test, however, does affect accuracy.

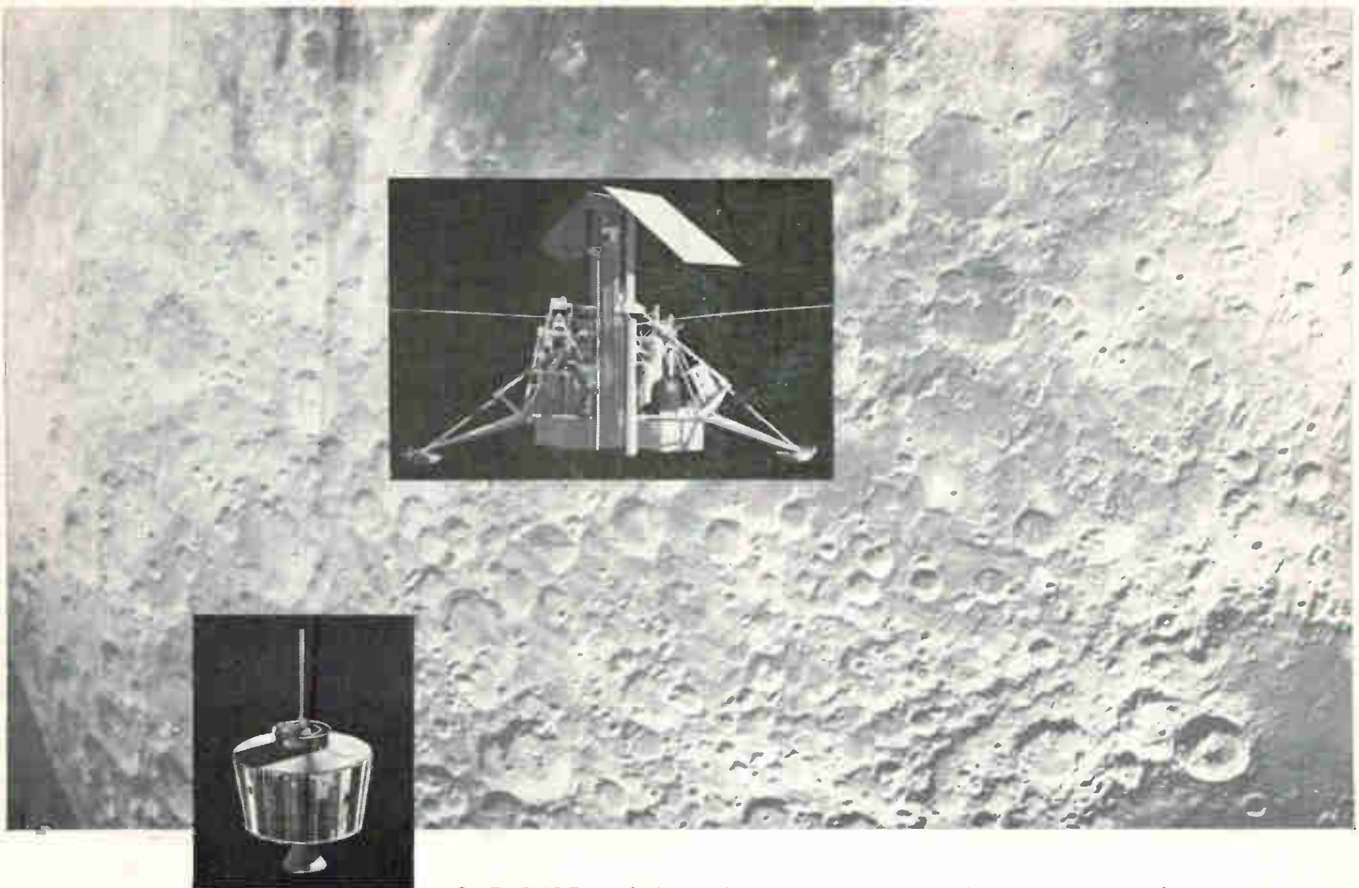
An alternative scale that may be useful in many cases can readily be provided. By putting C_x in series with C, the meter will indicate current i_x so the Eq 3 becomes

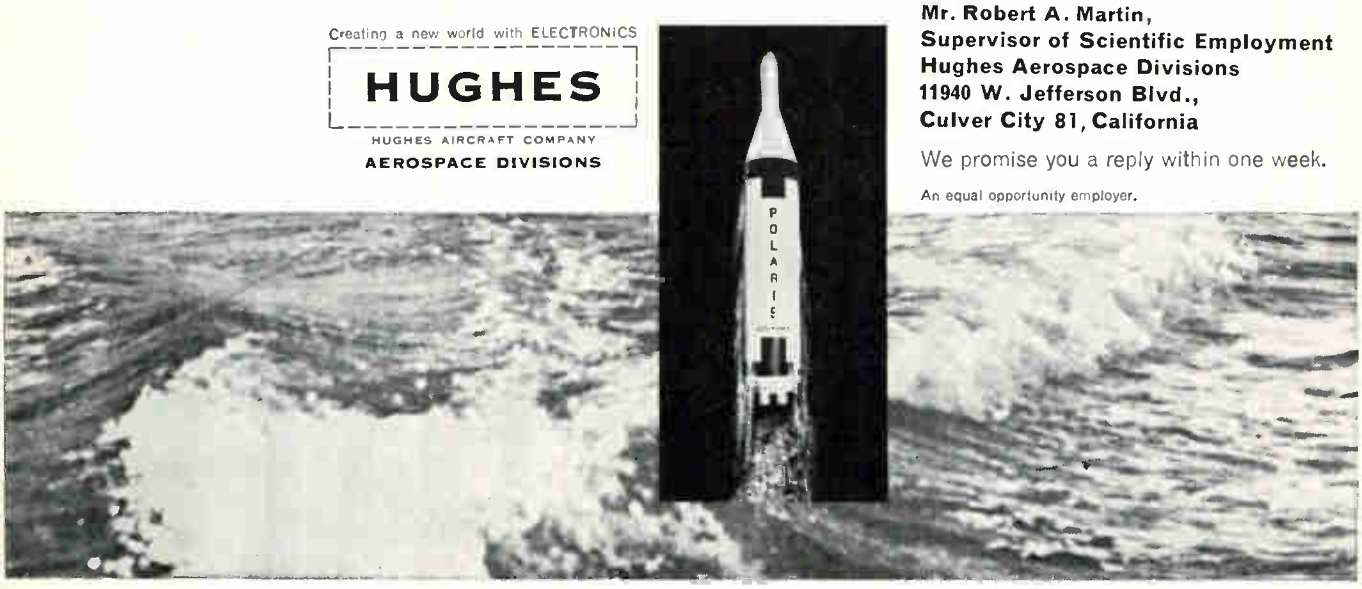
$$CC_x/(C + C_x) = C(i_x/i)$$

from which

$$C_x = C\, i_x/(i - i_x) \qquad (4)$$

Capacitance in this case is indicated on a scale similar to that of a conventional ohmmeter with zero at the bottom and infinite capacitance at the top.





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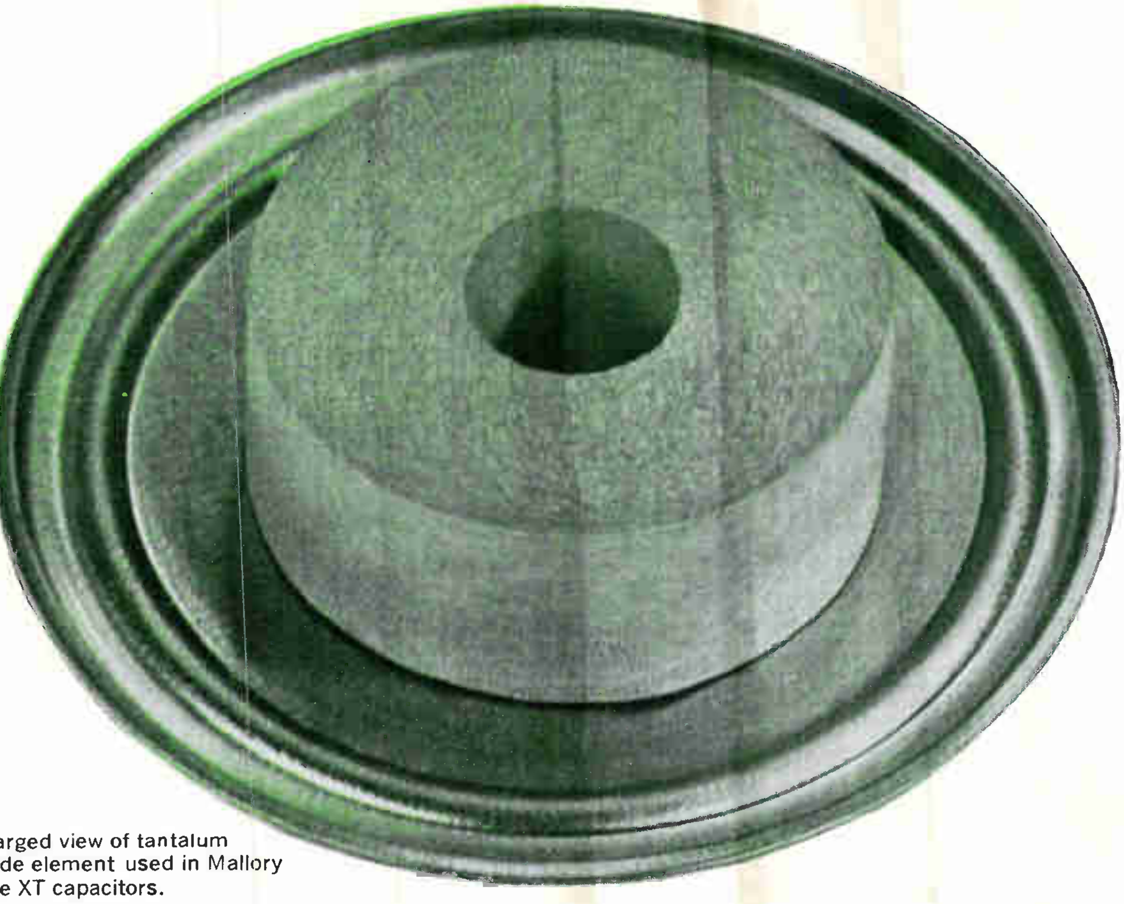

Enlarged view of tantalum anode element used in Mallory Type XT capacitors.

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XTH	200°C	7 mfd, 630 volts to 240 mfd, 18 volts
XTL	200°C	3.5 mfd, 630 volts to 120 mfd, 18 volts
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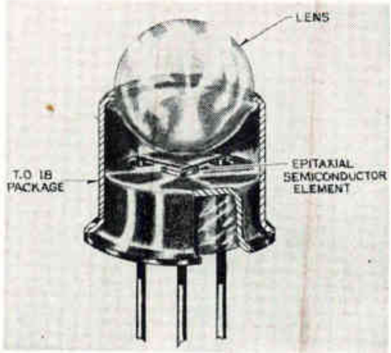
Transistor Uses Electro-Optical Drives

A NEW transistor, developed at Philco's Lansdale Division, Pennsylvania, is an epitaxial planar device designed to respond in nanoseconds to both light and electrical signals. Computer logic operations may be performed in response to both types of signals simultaneously, according to C. G. Thornton, director of semiconductor R & D.

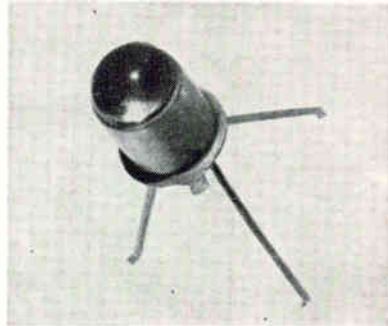
The new device may be particularly significant to future generations of computers wherein light rather than wiring could be used for electrical connections—permitting unprecedented speed in the transfer of intelligence among various elements within the computer.

The device combines the properties of ultra-fast switching transistors with ten times greater light sensitivity than available phototransistors. Use of optical and electrical drives permits an overall propagation time of less than 0.1 microsecond.

In fabricating the electro-optical transistor, a special spherical lens was designed, and the glass was selected on the basis of refractive index and thermal coefficient of expansion. The focal lens is tailored to the TO-18 package. The use of carbon molds in forming the lens was avoided to eliminate the possibility of light diffusion from carbon particles trapped in the glass.



Configuration of electro-optical epitaxial planar transistor in TO 18 package



Transistors with lenses may be building blocks in the substitution of optical and electrical paths in computers

The active region of the device, 0.025 mm², is placed within a few microns of the semiconductor surface, insuring high sensitviity.

Thornton noted the devices unique capacity to read high speed computer tapes and then transfer information with the speed of the fastest switching transistors available.

In combining transistor and light sensor, a flexibility has been achieved that also opens up new possibilities for high frequency communications in conjunction with modulated laser sources having a frequency output within the sensitivity region of the electro-optical transistor. The device operates with greatest sensitivity in the region of 0.4 to 1.1 microns.

Perhaps the most serious problem that limits the speed of modern computers is the problem of communication within the machine. As the frequency increases, the radioactive losses increase, the unwanted cross-couplings increase, and the length of time it takes to transmit signals from point to point become significant. Thus, while it is relatively easy to build a high speed memory, it is extremely difficult to communicate in and out of this memory without serious complexity, loss of speed, or both. Optical communication techniques may solve many of the problems in this area.

The resolving power of a good lens is better than 100 lines per mm, resulting in a total of 10^4 lines per sq mm. Assuming a really poor lens, the resolving power is better than 10 lines per mm, or 100 lines per sq mm.

If a ray of light can be made to carry information, it should be possible to pack anywhere from 10^4 to 10^2 communication channels within a sq mm. There is virtually negligible interaction between these communication channels, even

CHARACTERISTICS OF ELECTRO-OPTICAL TRANSISTOR

	Conditions	Min.	Max.
Collector to Base Breakdown Volt., BVCBO	IC = 10 μa	35 v	
Collector to Emitter Breakdown Volt., BVCEO, pulsed	IC = 10 ma	15 v	
Emitter to Base Breakdown Volt., BVEBO	IE = 10 ma	5 v	
Turn-On Time t_{on}	IC = 10 ma IB_1 = 3 ma IB_2 = 1 ma		25nsec
Turn-Off Time, t_{off}	IC = 10 ma IB_1 = 3 ma IB_2 = 1 ma		75nsec
Light Current Sensitivity, ICE light intens. = 100 ft-C			1 μa/ft-C
t_{on}			25nsec
t_{off}			75nsec

temperature = 25 deg C

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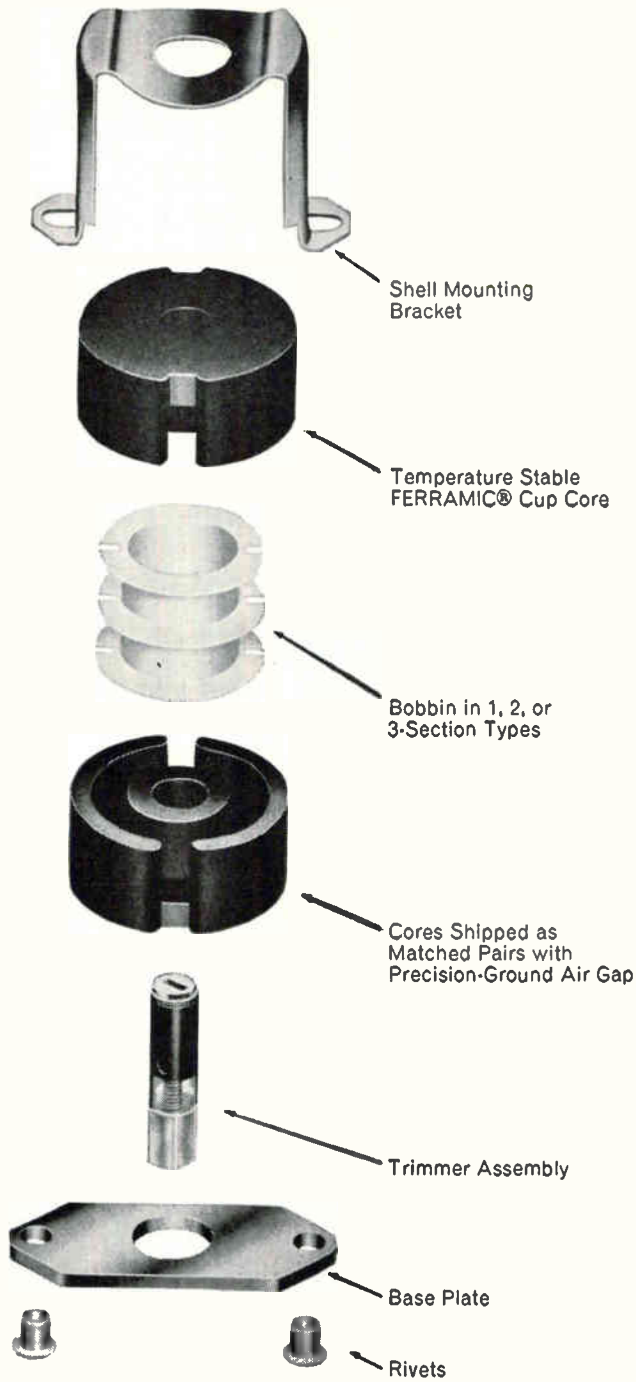

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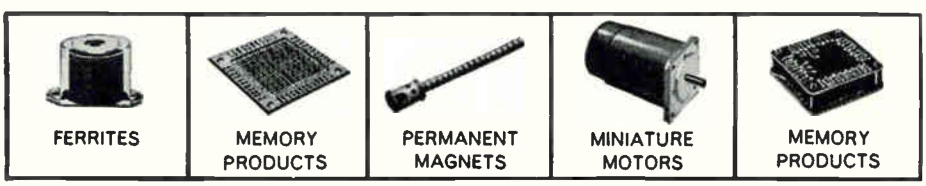
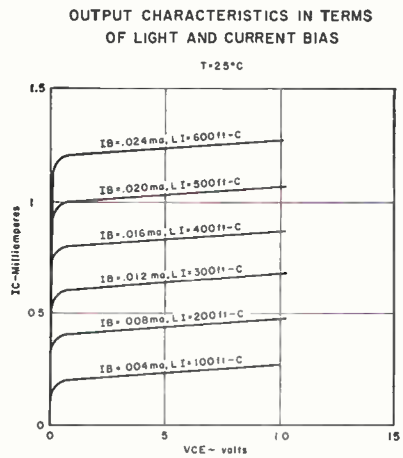




though they are so tightly packed.

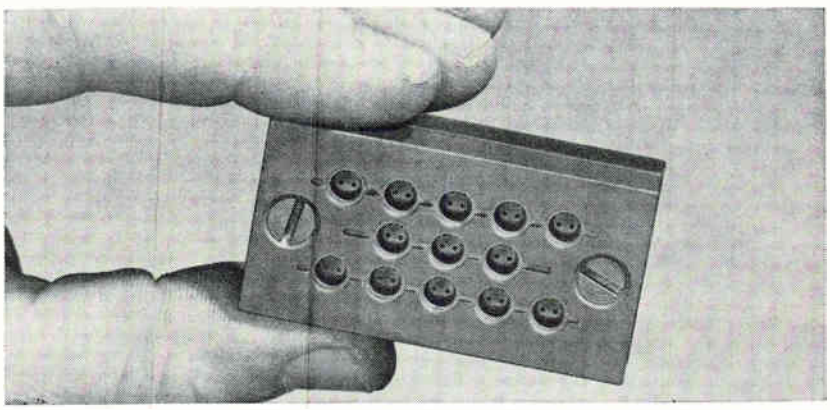
The speed of transmission of these channels is that of the speed of light and transmission loss is extremely small. Also, transmission can be accurately controlled by the use of well developed optical techniques. The use of fiber optics would allow for increased flexibility in the transmission paths. A large number of information paths can be easily interconnected optically by the use of a diffusion element. Optical techniques will only be truly successful with a small, inexpensive, fast, low powered source of light transistor.

Other desirable aspects of optical communications are based on the fact that optical signals are highly directive in nature. Thus signals can be aimed sharply at receivers, resulting in secure communications. In addition, optical antennas are extremely small, high gain devices.

The wave aspects of light may be used to perform some extremely complex electronic functions in the realm of network synthesis.

Prototypes are available at $35 each.

New Ceramic for Molding Wafers



New molding boat solves old problem of alloying indium to germanium or silicon wafer, holds closer tolerance required for semiconductor tooling

A CRITICAL operation in semiconductor manufacturing is the alloying of indium to the germanium or silicon wafer.

This controlled alloying of the semiconductor materials is accomplished at temperatures around 1,600 F, with the parts contained in an alloying jig.

There are severe requirements for the high temperature process. The alloying jig must be of refractory nature, able to resist "wetting" by molten indium. The jig must have a low thermal expansion rate, so that thermal changes will not cause warping or charge in tolerance. Jig material must contain minimal reducible oxides, which can cause contamination of the semiconductor.

The jig must be capable of being produced in extremely small sizes to very close tolerances.

A new ceramic material, called GR-100, developed by Duramic Products Inc., Palisades Park, N. J., is said to meet the requirements. The material is one-third the weight of stainless steel and has lower thermal expansion; it is four times the hardness of graphite and can be produced to a finer surface finish.

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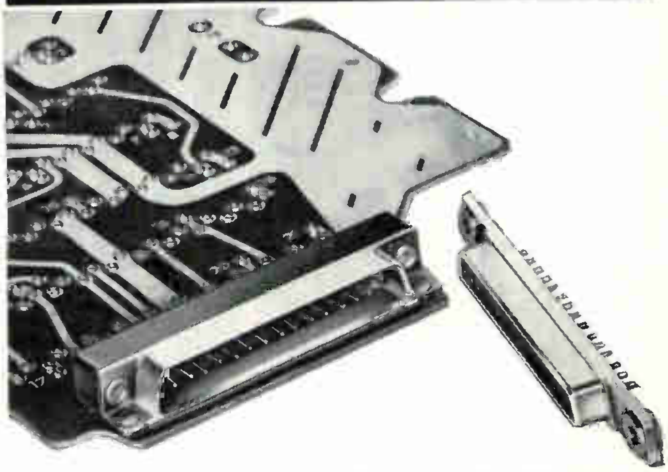

A significant step ahead by Methode — the more efficient, better performing NAS-714 and NAS-715 Series of Plugs and Receptacles with 7, 11, 15, 19 or 23 contacts. Designed to meet all the requirements of the NAS-713 specification.

WITH THESE ADDED FEATURES:

- Closed entry, removable socket contacts for solder crimp termination in NAS-714 type receptacle
- Crimp type sockets meet MIL-C-26636 requirements for termination
- Closed entry sockets use Berylco pressure spring for maximum reliability
- NAS-715 circuit board plugs have removable contacts for maximum economy
- Split type socket contacts optional

Typically Methode, these new, improved printed circuit connectors feature outstanding reliability and uniformity—good reasons way more industry leaders turn to Methode first, for quality that lasts!

SAMPLES and detailed literature are available.

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Chicago 31, Illinois

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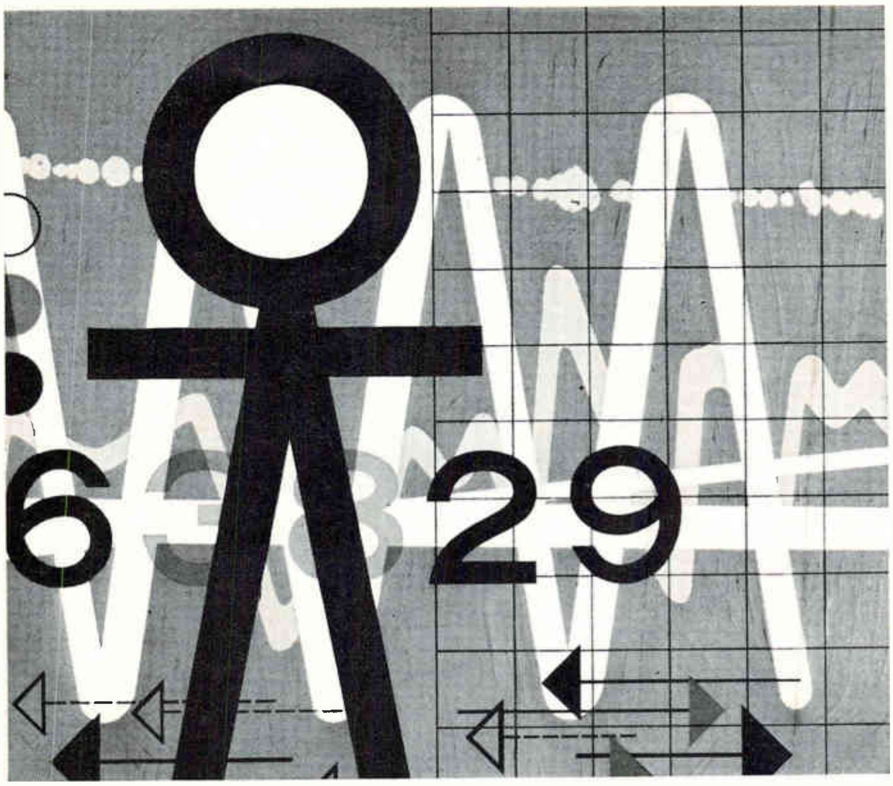

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This is Federal Electric's role. It encompasses engineering for the application, installation, evaluation, maintenance and operation of complex electronic systems. Present projects include troposcatter communications systems, digital data processing systems, early warning systems and missile test range instrumentation systems.

The heart of this engineering activity is our central engineering staff at Paramus. This professional staff plans, engineers and guides the programs and projects of the company and supports the efforts of our field engineering staff throughout the world. Positions now open to qualified engineers include the following:

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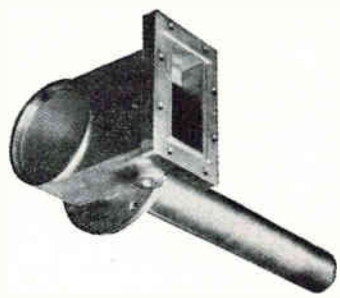

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electronics

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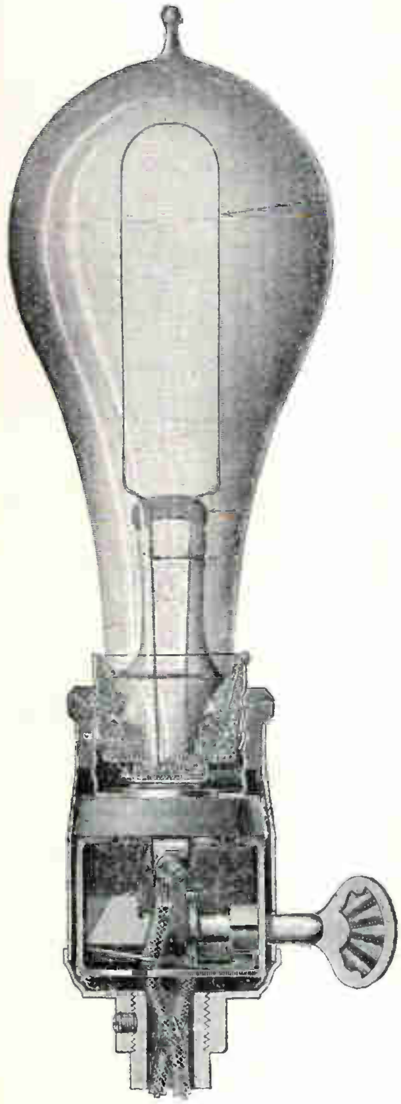
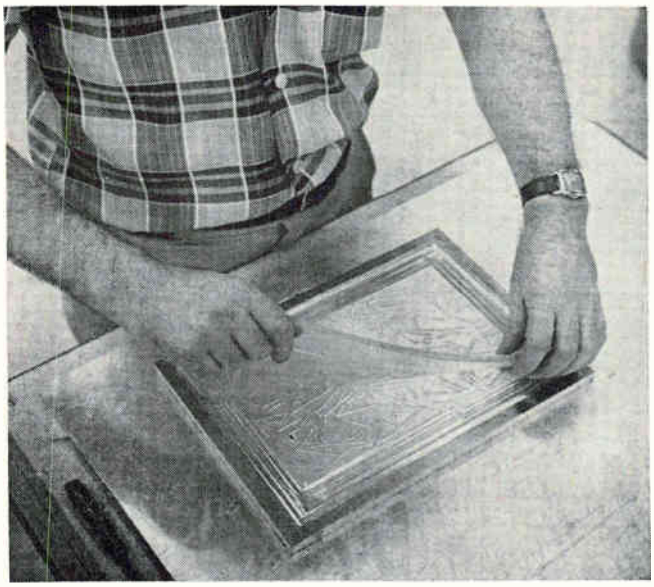
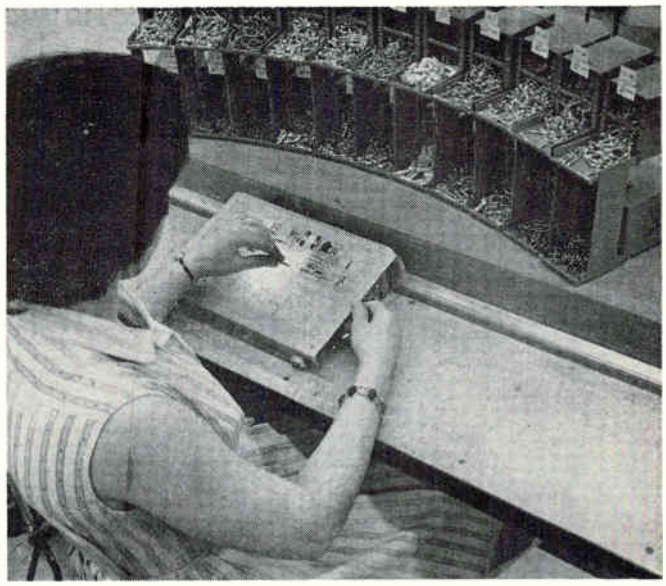
Write **The Editor, electronics, 330 W. 42nd St., New York 36,** stating experience, aspirations and past earnings. Mark the envelope "Confidential" and it will be kept that way.



CIRCLE 73 ON READER SERVICE CARD



Clear plastic mold, with somewhat the same consistency as an art-gum erasure, is peeled from aluminum mold



Circuit diagram under mold guides operator in placing components

Plastic Mold Simplifies Component Boards

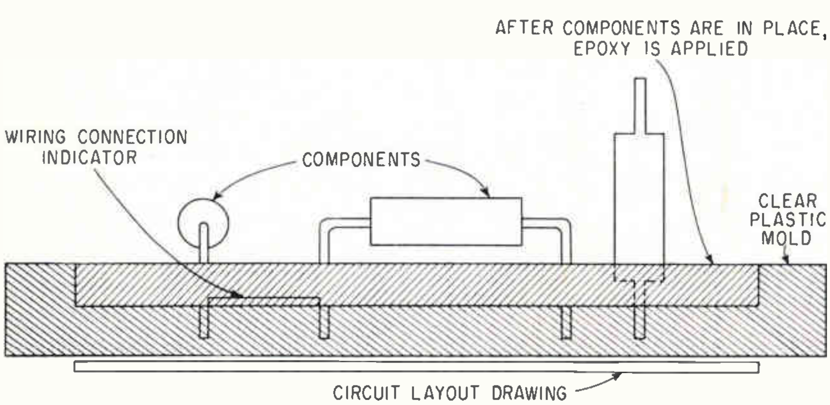
By G. J. MAROTTA
A. J. MURABITO
Western Electric Co.,
Merrimack Valley Work,
North Andover, Mass.

AMPLAS, standing for Apparatus Mounted in Plastic, is a word coined by Western Electric[1] to describe a method of fabricating component boards. The basic idea is shown in the sketch. A clear plastic mold is placed over a scale drawing of the circuit and the components are put in position by hand. Epoxy is then poured into the mold to a depth of about $\frac{1}{8}$ inch. When the epoxy has cured and the plastic mold is peeled off, the components are held rigidly by their leads. Interconnections are then made manually with bare wire, except where crossovers might cause a short, and the boards are then dip-soldered.

The technique has a number of advantages for certain types of production. In particular, component mounting is greatly simplified, since such parts as tube sockets, transistors and connecting plugs can be molded right into the board. All components are held rigidly by the cast epoxy and there is no strain on soldered connections; solder joints are used only for electrical connections and not for support. As the drawing shows, some parts can be mounted vertically, obtaining enough support from the epoxy from only one side of the component. In printed wiring boards, vertical mounting will often require a second board so the component can be supported by both leads.

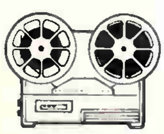
With respect to manufacturing costs, amplas has the advantages of reduced manufacturing lead time, low tooling costs, simplification of design, and ease of manufacture. The only tooling required is the aluminum mold from which the clear plastic molds are made. The aluminum masters cost less than $100 on the average, compared to several thousand dollars for printed circuit tooling. The primary purpose of the aluminum master is to indicate wiring runs and set the size of the final board; since indicated wiring runs can be ignored if desired, changes in circuit design can be accomplished quickly and easily.

After a fairly extensive check of available epoxies that would be suit-



Components are put into place by punching the leads through the clear plastic. After the epoxy sets, the plastic mold is pulled away, and although it can be used again, it is usually melted and recast

Picture of sound being relayed under FREON® solvent



At recent national electronics shows we actually performed the demonstration depicted above. We taped a message, then connected the recorder's playback head to a high-fidelity amplifier. This we immersed in a tank of "Freon" for the entire duration of the show. Wires connected the output stage of the amplifier to a row of headphones. Show visitors listened to the message relayed under "Freon".

This demonstration was possible because "Freon" solvent is a superb dielectric and a selective cleaning agent. It cleans components or complete assemblies effectively without harm to metal parts, finishes, elastomers or plastic insulation.

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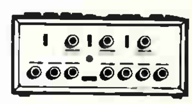

Send for *free* 33⅓ rpm demonstration recording made with the amplifier immersed in "Freon". Write on your company letterhead. If you have a specific cleaning problem, we'll be glad to arrange a visit by our representative. "Freon" Products Division, Room N-2420, E-3, E. I. du Pont de Nemours & Co. (Inc.), Wilmington 98, Delaware.

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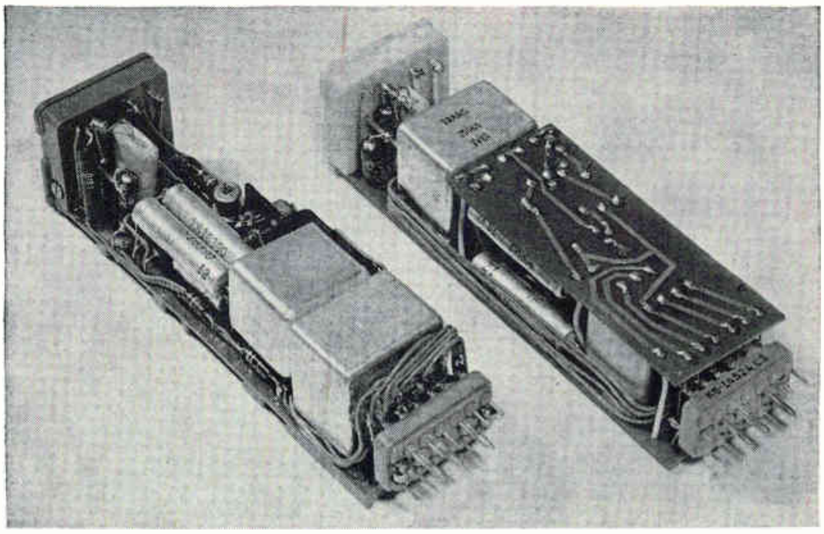
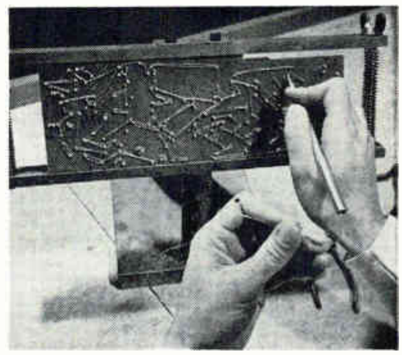


Amplas construction, left, compared with printed circuit board construction

able for the cast board, a relatively new formulation was chosen, primarily because it had high flexural strength and excellent resistance to vibration, being able to withstand 25g when mounted in an aluminum frame. The epoxy is a silica-filled undiluted resin with a new flexibilized hardener of the aliphatic, primary diamine, polyether type. It mixes readily to form a free-flowing system that cures overnight or in 30 minutes at 150 F; water gain for a 2-hour boil is +0.65 percent; dissipation factor and dielectric constant at 10^4 cps are, respectively, 0.021 and 4.5; heat distortion temperature is 148 F. Corrosion tests were passed and resistance to impact at −40 F is superior to XXXP phenolic laminates.

A special plastic was developed for the mold in which the components are held when the epoxy is poured. Developed in association with Western Electric, the material is a plasticized cellulose acetate butyrate compound with a polymeric plasticizer. The material melts at 265 F; its room temperature density allows component wires to be inserted easily yet it is strong enough to accept a relatively large number of close-spaced leads; it seals the leads sufficiently to keep epoxy from leaking through to form insulation; it is not affected by the epoxy and releases the cured epoxy adequately.

After the epoxy has cured (normally 30 minutes at 150 F) the plastic mold is peeled off and point-to-point pencil wiring is completed for



Bare wire, fed through a pencil tube, is looped around circuit leads in accordance with molded-in connection guides

interconnections, with the wirer following the raised guide lines in the epoxy. Soldering is then accomplished on an automatic dip soldering machine. Because the connections being soldered are raised above the board, and because of the epoxy's heat tolerance, soldering temperature is not limited but can be reasonably as high as needed for good connections.

If a component fails on an amplas board, it is not necessary to throw the circuit away, since sufficient heat applied to a lead will soften the board enough to allow removal of the defective component and insertion of a new one. Also, single board construction, instead of the two-board sandwiches often needed with printed circuits, gives easy access to components.

REFERENCES

(1) G. J. Marotta and A. J. Murabito, A new Concept in Electronic Component Packaging, *Western Electric Engineer*, p 10, July, 1961.

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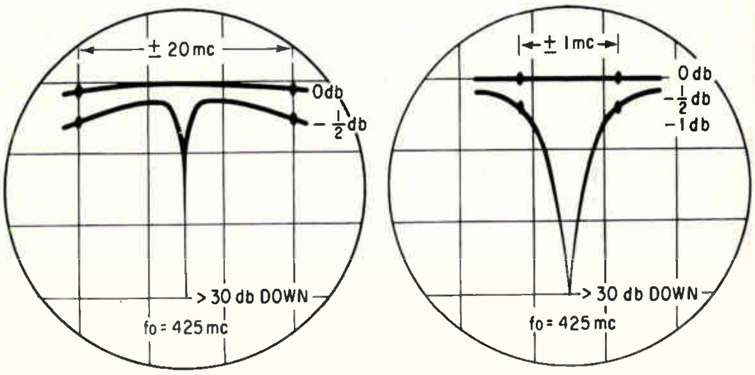
DESIGN AND APPLICATION

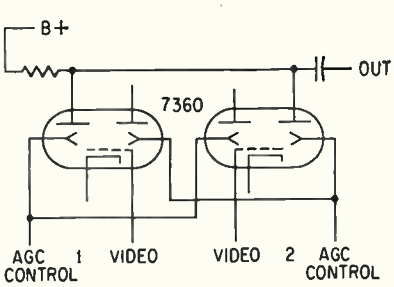


Rejection Filter

30 DB REJECTION AT ¼-PERCENT SEPARATION

RECENTLY announced by Applied Research Inc., 76 South Bales Ave., Port Washington, N. Y., is the MICRO-NOTCH rejection filter whose curve is shown in the accompanying sketch. At a center frequency of 425 Mc (±10 percent), a better than 30 db rejection is shown. The notch bandwidth at 1 db insertion loss is 2 Mc, or less than ½ percent. Insertion loss outside of the notch is approximately 0.5 percent. One photo shows a wide sweep where approximately 10-percent bandwidth is shown. The other photo shows the same filter adjustment with only the sweep width changed. The 1 Mc markers can be seen at the 1 db points. This shows the very narrow steep skirted frequency adjustable rejection filter that provides a better than 30 db difference in loss to two frequencies separated by ¼-percent or more while presenting an essentially resistive impedance at the input. Insertion loss in the passband is extremely low.

CIRCLE 301 ON READER SERVICE CARD



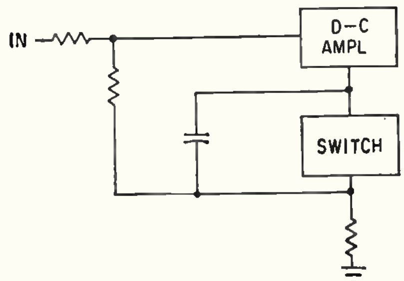
Diversity Combiner

WIDE DYNAMIC RANGE

PRESENTLY available from Defense Electronics, Inc., 5455 Randolph Rd., Rockville, Md., is the TDC-1 Diversity Combiner which uses a pair of beam deflection tubes in a post detection diversity combiner that automatically results in ratio-squared combining with a linear control function. The basic combiner circuit shown in the sketch has corresponding deflection electrodes tied together and opposite plates connected together and sharing a common load resistor. Video signals are fed directly to the grid of each tube while control voltages are applied to the respective deflection electrodes. As control voltages vary, total current in plate load remains the same while relative proportion contributed by each video signal changes. Combined output does not vary in amplitude as long as the two video inputs are of equal amplitude and in phase. Linear control signals are derived from receiver agc circuits.

Conventional telemetry receivers have nearly logarithmic representations of r-f input signals. A direct coupled differential amplifier is incorporated within the combiner so that it establishes an approximately linear relationship between control signals and maintains a constant mean potential between the deflection electrodes and cathode of the beam tubes.

CIRCLE 302 ON READER SERVICE CARD



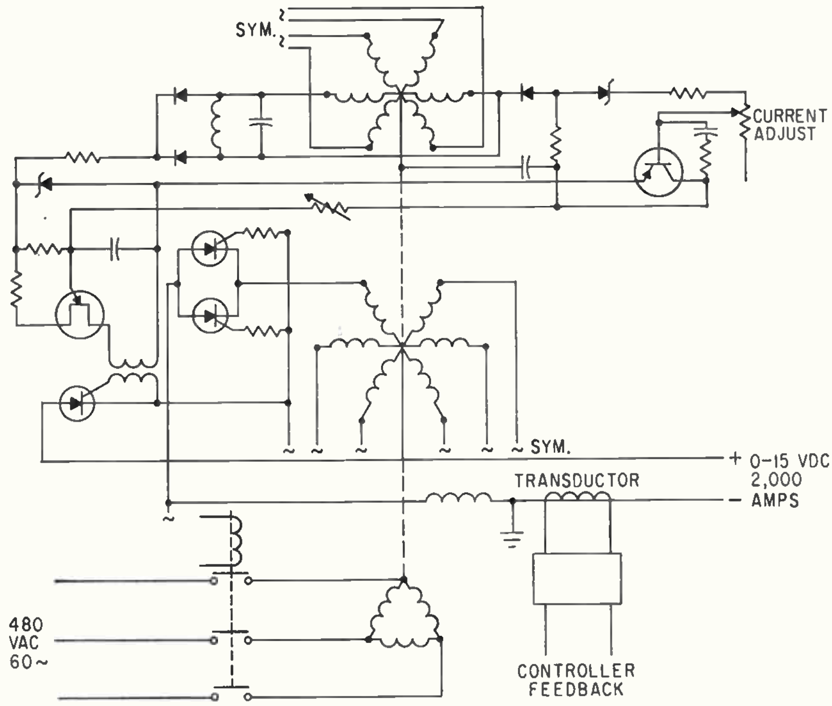
Volts To Freq Converter

MEASURES UP TO 1 KV

ANNOUNCED by Avtron Manufacturing, Inc., 10409 Meech Avenue, Cleveland 5, Ohio, are the T299, T301 and T303 voltage to frequency converters that accept either a-c or d-c voltage signals and deliver a proportional output frequency. Any conventional electronic frequency counter can then be used as an accurate voltmeter. Basic circuit is shown in the sketch. The d-c amplifier and capacitor are connected so that current flowing through the capacitor is directly proportional to d-c input voltage signal. When the capacitor voltage reaches a particular stabilized reference level, the electronic switch closes momentarily to discharge the capacitor. Frequency at which the switch operates is therefore proportional to d-c input level. Capacitor and switch are arranged so that both positive and negative input signals can be measured. With external electronic frequency counter, full scale readings of 0.1,

1, 10 and 1,000 v, d-c or a-c, can be measured thereby supplanting the need for a large number of voltmeters to accomplish measurements over the same ranges.

CIRCLE 303 ON READER SERVICE CARD



Research Furnace

15 V AT 2,000 AMPERES

INTRODUCED by Tylan Corporation, 4203 Spencer Street, Terrance, Calif., is the power supply 153-001 capable of delivering 2,000 amperes at up to 15 volts. Originally designed and built for black body radiation studies at temperatures over 5,000 F, it has been applied to ablation studies, operating large magnets and calorimeter calibration. The regulation is ±1 percent for 100 to 2,000 ampere loads and the water flow is 2 gpm, 10 −50 psig between 32 and 100 F. The power supply is either current or voltage regulated and may be operated from a pyrometer to accurately control furnace temperature. The basic elements are a transformer, silicon-controlled rectifiers and an inductor. Conduction angle of the rectifiers is selected by the current control, and is held constant ±1 percent for load and line changes by a feedback loop which senses current through a transductor. Overall dimensions are 22 × 22 × 36 and it weighs 600 lbs and does not require a soundproof air conditioned room.

CIRCLE 304 ON READER SERVICE CARD

Frequency Multiplier

SOLID STATE

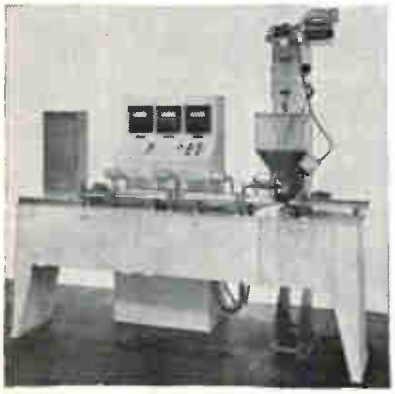
MICROWAVE ASSOCIATES, INC., Burlington, Mass. The MA-8028 can be driven with 3 w c-w power at about 36-40 Mc and will deliver 200 mw at the 32nd harmonic in the L-band range. The bandwidth is 1.25 percent. Body is 5⅜ in. long, 2¾ in. wide and 2 in. deep, excluding mounting pads and connectors. Total weight is less than 2 lb. Nominal input impedance is 50 ohms with type N input and output connectors.

CIRCLE 305 ON READER SERVICE CARD

Subminiature Pot

WATERS MFG., INC., Wayland, Mass. The VL/3 p-c pot has numbered positions on the case to allow fast and accurate reading of the wiper position over a rotational span of 320 deg controlled by mechanical stop. Available in a resistance range from 10 ohms to 15,000 ohms, it will operate over a temperature range from −55 C to +150 C.

CIRCLE 306 ON READER SERVICE CARD



Coating Machine

FOR COMPONENTS

CONFORMING MATRIX CORP., 830 New York Ave., Toledo 11, O. Model PR-1 is a high production machine for the application of 10 to 15 mils thick coatings of epoxy materials to axial lead components. The automatic feed unit accepts either adjustable or portable magazines according to the required handling rate of the components.

CIRCLE 307 ON READER SERVICE CARD

Sealed Cell

SONOTONE CORP., Elmsford, N. Y. The S-113 sintered-plate, nickel-cadmium, rechargeable sealed cell is $\frac{7}{8}$ in. by $1\frac{5}{8}$ in. in size and weighs only 1. 8 oz.

CIRCLE 308 ON READER SERVICE CARD

Wide Range Test Set

FOR TRANSISTORS

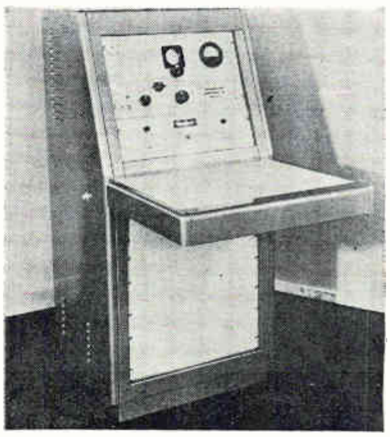
SYRACUSE ELECTRONICS CORP., P. O. Box 566, Syracuse 1, N. Y. Test set measures all the important parameters on the standard commercial types of unijunction transistors. Suitable for lab use or limited production testing, the instrument measures stand-off ratio, interbase resistance, emitter saturation voltage, base-two modulated current, emitter leakage current, peak point current, and base one peak pulse voltage.

CIRCLE 309 ON READER SERVICE CARD

Digital Voltmeter

HEWLETT-PACKARD CO., 1091 Page Mill Road, Palo Alto, Calif. The 405BR/CR digital voltmeter features automatic ranging, simple touch-and-read measurement and bright, clear readout.

CIRCLE 310 ON READER SERVICE CARD



Ultrasonic Generator
BROADBAND

INTERNATIONAL ULTRASONICS, INC., 331 Centennial Ave., Cranford, N. J. Broadband ultrasonic generator provides output for research and development in chemical, medical, metallurgical, plastics, flaw detection, and a wide range of other applications. Using a special output transformer developed by the company, model IU-250-BB generator has continuously-variable output from zero to 250 w at 10 Kc to 2 Mc and can be built for down to 1 Kc on special order.

CIRCLE 311 ON READER SERVICE CARD

Electrometer Head
VIBRATING VANE

WAYNE KERR CORP., 1633 Race St., Philadelphia, Pa., offers a vibrating vane electrometer head that has a high effective mechanical Q, operates at a resonant frequency of 1 Kc, has an input impedance of 1,000 trillion ohms, and can be energized from tube or transistor circuits.

CIRCLE 312 ON READER SERVICE CARD

Delay Line
MAGNETOSTRICTIVE

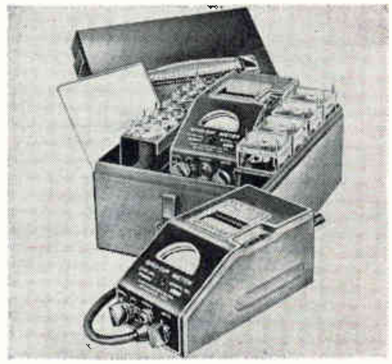
TEMPO INSTRUMENTS, INC., Technical Industrial Park, Plainview, N. Y., announces a series of magnetrostrictive delay lines designed for use as memory units in smaller digital computers and sophisticated business and accounting machines. These sonic delay lines are available in unsealed and in hermetically sealed cases. Delay length is 3,500 μsec; repetition rate 2 Mc—NRZ; temperature stability ± 0.08 μsec. 10 to 50 C; size, $11\frac{1}{2}$ by $12\frac{1}{2}$ by $\frac{7}{8}$ in.

CIRCLE 313 ON READER SERVICE CARD

Magnetic Shields
FOR DEWAR FLASKS

MAGNETIC SHIELD DIVISION PERFECTION MICA CO., 1322 No. Elston Ave., Chicago 22, Ill., offers a line of diversionary Netic and Co-Netic magnetic shields which minimize effects of the earth's magnetic field as well as all other low level fields on samples being tested under cryogenic conditions in any size dewar flask. Two, three or four concentric cylindrical shields can be used, one inside the other. For viewing the sample under cryogenic test conditions, a multi-section viewing port is provided.

CIRCLE 314 ON READER SERVICE CARD



Grid-Dip Meter

FOR LAB & INDUSTRY

JAMES MILLEN MFG. CO., INC., 150 Exchange St., Malden 48, Mass. Model 90662-A laboratory and industrial grid-dip meter contains a transistor d-c amplifier to permit full scale meter deflection throughout the entire tuning range of 225 Kc to 300 Mc. A self-contained 800 cycle tone modulator is included.

CIRCLE 315 ON READER SERVICE CARD

S-W Amplifier

TRANSISTORIZED

FXR, division of Amphenol-Borg Electronics Corp., Danbury, Conn., offers model B813T transistorized standing wave amplifier. Full scale maximum error is only ±0.05 db at 5 db. Calibrated range is 75 db. Price is $285 with rechargeable battery.

CIRCLE 316 ON READER SERVICE CARD

PRODUCT BRIEFS

MINIATURE MICA CAPACITORS radial-lead. Cornell-Dubilier Electronics, 50 Paris St., Newark, N. J. (317)

X-BAND MICROWAVE DELAY LINES multiple output. Franklin Technical Corp., Kulpsville, Pa. (318)

P-C DRILL PRESS high speed. Digital Systems, Inc., 1042 E. Edna Place, Covina, Calif. (319)

OPTICAL MASER high stability. Minneapolis-Honeywell, 2600 Ridgway Rd., Minneapolis, Minn. (320)

METAL FILM RESISTANCE CARD for microwave attenuation. Filmohm Corp., 48 W. 25th St., New York 10, N. Y. (321)

BRUSHLESS MOTOR/FAN high speed. Astro Dynamics, Inc., Second Ave., Northwest Industrial Park, Burlington, Mass. (322)

SONIC DEVICE detects missing parts. Wintriss Controls, Div. of Industrionics, Inc., 20-24 Vandam St., New York 13, N. Y. (323)

HIGH TEMPERATURE JIGS from new ceramic material. CFI Corp., Ceramics for Industry, Cottage Place, Mineola, N. Y. (324)

ROTARY JOINTS single and dual channel. Electronic Specialty Co., Kennedy Antenna Div., 155 King St., Cohasset, Mass. (325)

SPIN-OVER JACK for printed circuits. Sealectro Corp., 139 Hoyt St., Mamaroneck, N. Y. (326)

BROADBAND MOUNTS for square law detection. MSI Electronics Inc., 116-06 Myrtle Ave., Richmond Hill 18, N. Y. (327)

PRECISION RESOLVERS minimum size Solvere, Inc., 1902 W. Chestnut St., Santa Ana, Calif. (328)

HALL GENERATOR thin-film. Helipot Division, Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif. (329)

DATA ACQUISITION SYSTEM analog to pulse duration. Genisco, Inc., 2233 Federal Ave., Los Angeles 64, Calif. (330)

T-W TUBES for space applications. Hughes Aircraft Co., Microwave Tube Div., 11105 S. LaCienega Blvd., Los Angeles, Calif. (331)

Literature of

POWER SUPPLY Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. Two-page bulletin describes the capabilities of the type 3-131 power supply unit. (332)

GLASS INDUCTORS Corning Electronic Components, Bradford, Pa. Reference File CE-5.02 describes metallized glass inductors in panel mount and p-c styles. (333)

DIGITAL LOGIC ELEMENTS Tech Serv Inc., 4911 College Ave., College Park, Md., has prepared a catalog on transistorized digital logic packages. (334)

TUBE REFERENCE HANDBOOK Calvert Electronics, Inc., 220 E. 23rd St., New York 10, N. Y., offers a reference handbook on the English Electric Valve line of communication and microwave tubes. To obtain a copy write on company letterhead.

INSTRUMENTATION Baldwin-Lima-Hamilton Corp., 42 Fourth Ave., Waltham 54, Mass. Catalog 4400-A shows instruments for readout on strain gages, transducers. (335)

PEAK DETECTOR SYSTEMS Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif. Bulletin 131 describes peak detection with analog-to-digital conversion. (336)

TEFLON TERMINALS Alisco Co., 809 Stewart Ave., Garden City, N. Y. offers a reference manual on Teflon terminals. (337)

SCR TESTER Power/Radiation, Inc., Box 616, Suffern, N. Y. Technical data bulletin describes model R-102 portable silicon controlled rectifier tester (338)

DIRECT WRITING RECORDER Brush Instruments Division of Clevite Corp., 37th and Perkins, Cleveland 14, O. Bulletin illustrates the crisp tracings made by the Mark 200 recorder. (339)

ELECTROSTATIC CHARGE AMPLIFIER Kistler Instrument Corp., 15 Webster St., North Tonawanda, N. Y. Bulletin describes model 568 electrostatic charge amplifier with universal range. (340)

POWER SUPPLY Microdot Inc., 220 Pasadena Ave., South Pasadena,

the Week

Calif. Bulletin ACPS-1 deals with a transistor regulated a-c/d-c power supply. (341)

BWO Watkins Johnson Co., 3333 Hillview Ave., Palo Alto, Calif. Bulletin describes a 100-w c-w O-type bwo for Ku-band. (342)

PLASTICS Chemical Development Corp., Danvers, Mass., has prepared a catalog "Products For the Plastics and Allied Industries." (343)

ELECTRONIC WARFARE SPECTRUM The Hallicrafters Co., 5th and Kostner Ave., Chicago 24, Ill. New military and civilian regulations on active airborne ECM in the U. S. and Canada are summarized in a color-coded wall chart. (344)

VACUUM FURNACE Lindberg Engineering Co., 2450 W. Hubbard St., Chicago 12, Ill. Bulletin 113 describes and illustrates a vertical cold wall vacuum furnace. (345)

POWER SUPPLIES Anders Electronics, Inc., 640 Memorial Drive, Cambridge, Mass. Technical data sheet TS105 deals with a line of high amperage power supplies for computer applications. (346)

MAGNETIC TAPE ADAPTER Electronic Engineering Co. of California, Box 58, Santa Ana, Calif. Two-page data sheet describes the EECO 754 magnetic tape adapter for ERMA/IBM. (347)

ROTARY COMMUTATING SWITCH Precision Specialties, Inc., P. O. Box 118, Pitman, N. J., has available data sheet A-4 on the rotary commutating switch. (348)

DATA TRANSMISSION SYSTEM Lynch Communication Systems, Inc., 695 Bryant St., San Francisco, Calif., has available literature on the type B109 data transmission system. (349)

SOLENOIDS Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif. Catalogs are available for both the SE and SG series of solenoids. (350)

INCANDESCENT INDICATOR Transistor Electronics Corp., 3357 Republic Ave., Minneapolis 26, Minn. Data sheet 193 covers a transistor controlled incandescent indicator with replaceable lamp. (351)

George J. Pandapas

Arthur Asch

W. P. Maginnis

Electro-Tec Realigns Top Management

ELECTRO-TEC CORP., West Caldwell, N. J., manufacturer of precision slip ring assemblies, relays and switches, has announced three changes in top management.

George J. Pandapas was elected chairman of the board of directors, relinquishing his duties as president. Pandapas founded Electro-Tec in 1945.

Arthur Asch succeeds him as president and was appointed treasurer. Asch has been with Electro-Tec since 1950 and has served in the capacity of executive vice president since 1956.

W. P. Maginnis joins the firm as executive vice president. Prior to assuming his new post, Maginnis was vice president of Maxson Electronics Corp., NYC; vice president of ITT's Components Division, Clifton, N. J., and also chief engineer of the Components Division of RCA, Camden, N. J.

In November 1961, Electro-Tec opened its new 30,000-square-foot headquarters plant at West Caldwell, N. J. The company also operates manufacturing plants at Blacksburg, Va., and Ormond Beach, Fla.

Otarion Electronics Elects Kranz

OTARION ELECTRONICS, INC., Ossining, N. Y., has expanded its research activities with the formation of a separate research division. Fred W. Kranz has been named a vice president of the company and director of the division.

Kranz, formerly a vice president of the Sonotone Corp., served as a consultant to Otarion before his new appointment.

Zenith Radio Plans $7 Million Expansion

DIRECTORS of Zenith Radio Corp., Chicago, Ill., have authorized contracts for construction of a new $7 million dollar building on its 28 acre plot of land located immediately south of the company's main plant.

The new building with total floor area of 672,000 sq ft will be devoted to manufacturing and warehousing, and general administrative offices. The additional space will permit rearrangement of facilities to provide for further expansion of research and development and manufacturing operations.

Construction is scheduled to begin in late spring as soon as final architectural plans are approved. It is anticipated that the manufacturing area will be in operation late this year, and that the entire project will be completed by the summer of 1963.

Grow Corporation Names Greenbaum

THE GROW CORP., Plainview, N. Y., recently appointed William H. Greenbaum as engineering manager.

Greenbaum is a former vice president and director of engineering of Otarion Electronics, Inc., and senior supervising engineer of the Sonotone Corp.

Republic Electronics Hires Two Engineers

REPUBLIC ELECTRONICS, Huntington, L. I., N. Y., has appointed Milton S. Goldstein senior mechanical engineer, and Richard G. Gundlach project engineer. Both will be associated with the company's recently acquired $215,700 Coast Guard contract for development and production of 200 portable transmitter-receiver systems.

Before joining Republic Electronics, Goldstein was with Com-

RELIANCE DEVELOPS ADVANCED COMMERCIAL FREQUENCY-CONVERTED D-C POWER SUPPLY

Facts book now ready covering data processing and communications equipment

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2. Low cost, compact, high frequency components.
3. Maximum protection against line voltage and frequency disturbance.
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Talk to our people about this new Reliance development . . . and be sure to get the booklet with all technical facts. Write today. Reliance Electric and Engineering Co., Dept. 83-3, Cleveland 17, Ohio. Canadian Division: Toronto, Ontario.

RELIANCE ELECTRIC AND ENGINEERING CO.

CIRCLE 210 ON READER SERVICE CARD

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electronics

A McGraw-Hill Publication, 330 West 42nd St., N. Y. 36

Flame-Retardant laminated plastics for electrical and electronic applications

There are now 4 flame-retardant Synthane laminates to help the designers of computers, missile control equipment, transformers, circuit breakers or any other components subject to flame or heat.

These four grades FR-1, FR-2, FR-3 and FR-4 not only have excellent flame retardance but they combine many more properties desirable in an electrical insulation, such as low moisture absorption, low dielectric losses, mechanical strength and machinability. Supplied plain or copper clad. It will pay you to send for samples for your own evaluation and test . . . or write for information.

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CIRCLE 89 ON READER SERVICE CARD

puter Sciences, Inc. Gundlach was formerly with Loral Electronics Corp.

Litton Industries To Build in Atlanta

LITTON INDUSTRIES, INC., Beverly Hills, Calif., will build a $16-million electronics plant in Atlanta, Ga.

Plans call for completion of an initial $4-million facility, providing 500 jobs, by the end of 1962, to be followed within six months to a year by a $12-million expansion, which would bring employment up to 2,000.

According to Litton vice president Crosby M. Kelly, the Atlanta plant will probably produce data processing systems of the type used in the country's missile defense warning system, unless the company should find in the next few months that there is a more urgent need for the new operation to make some other precision product.

Tempo Instrument Occupies New Plant

TEMPO INSTRUMENT INC. has occupied its newly-completed plant in Plainview, L. I., N. Y. Designed to company specifications, the building contains over 25,000 sq ft of office, engineering, and manufacturing space, has facilities for about 250 employees per shift.

Tempo manufactures electronic components and equipment for such applications as business or military computers, missile, space vehicle, and aircraft guidance systems, ground-based radar installations, and similar systems.

RCA Space Center Adds Two Buildings

RADIO CORP. OF AMERICA has announced that more than 100,000 sq ft of engineering and administrative space will be added to its Space Center near Princeton, N. J., through the leasing of two new buildings.

When the Space Center first opened in 1958 only 40,000 sq ft of floor space was utilized. Since then, new additions have brought the total available engineering space to more than 200,000 sq ft. The new buildings, scheduled for completion in the Fall of this year, will bring total area to more than 300,000 sq ft.

Number of employees at the Princeton facility is now approaching the 1,500 mark. This, plus the additional space, gives the RCA Space Center the capability of handling additional projects, according to Barton Kreuzer, vice president and general manager of the Astro-Electronics Division.

PEOPLE IN BRIEF

Lt. Gen. William E. Hall, USAF (Ret.), has been elected chairman of the board of Madigan Electronic Corp. **D. W. Spence**, ex-Texas Instruments, named manager, recorder products at Houston Instrument Corp. **Carr Wilson**, from Datex Corp. to the parent company, Giannini Controls Corp., as senior staff engineer. **Daniel M. Ekstein**, former president of Matthew Instruments, Inc., appointed director of R&D of Medical Developments, Inc. **Augustine R. Stratoti**, previously with Sylvania, now chief electrical engineer for Gabriel Electronics. **Donald G. O'Brien** leaves American Measurement and Control, Inc., to form D. G. O'Brien, Inc., in Waltham, Mass. Loral Electronics Corp. promotes **Ralph Rosenfeld** and **Luther Nashman** to div. mgr. and engineering mgr., respectively, of the Defense ECM Div. **Richard Reigel** moves up to director of manufacturing at Babcock Relays. Three new members have been added to the technical staff of the R&D Laboratory of Fairchild Semiconductor: Edward **Duffek**, formerly with Stanford Research Institute; **Arthur E. Lewis**, ex-Hoffman Electronics; and **Everett Guthrie**, most recently with Melabs.

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electronics

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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.*
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FEDERAL ELECTRIC CORP. A Div. of I T & T Corp. Paramus, New Jersey	72	4
GENERAL ELECTRIC CO. Communication Products Dept. Lynchburg, Virginia	128*	5
GENERAL ELECTRIC CO. Defense Systems Dept. Syracuse, New York	127*	6
GENERAL ELECTRIC CO. Light Military Electronics Dept. Utica, New York	130*	7
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* These advertisements appeared in the 3/16/62 issue.

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HOME ADDRESS ....

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

HOME TELEPHONE ....

Education

PROFESSIONAL DEGREE(S) ....

MAJOR(S) ....

UNIVERSITY ....

DATE(S) ....

FIELDS OF EXPERIENCE (Please Check)

3-23-62

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☐ Antennas	☐ Human Factors	☐ Radio—TV
☐ ASW	☐ Infrared	☐ Simulators
☐ Circuits	☐ Instrumentation	☐ Solid State
☐ Communications	☐ Medicine	☐ Telemetry
☐ Components	☐ Microwave	☐ Transformers
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Please indicate number of months experience on proper lines.

	Technical Experience (Months)	Supervisory Experience (Months)
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RESEARCH (Applied)	......	......
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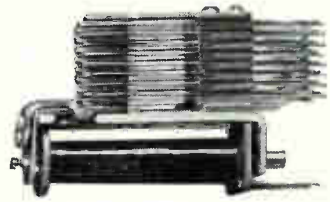

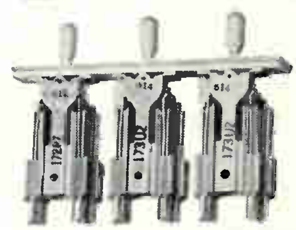

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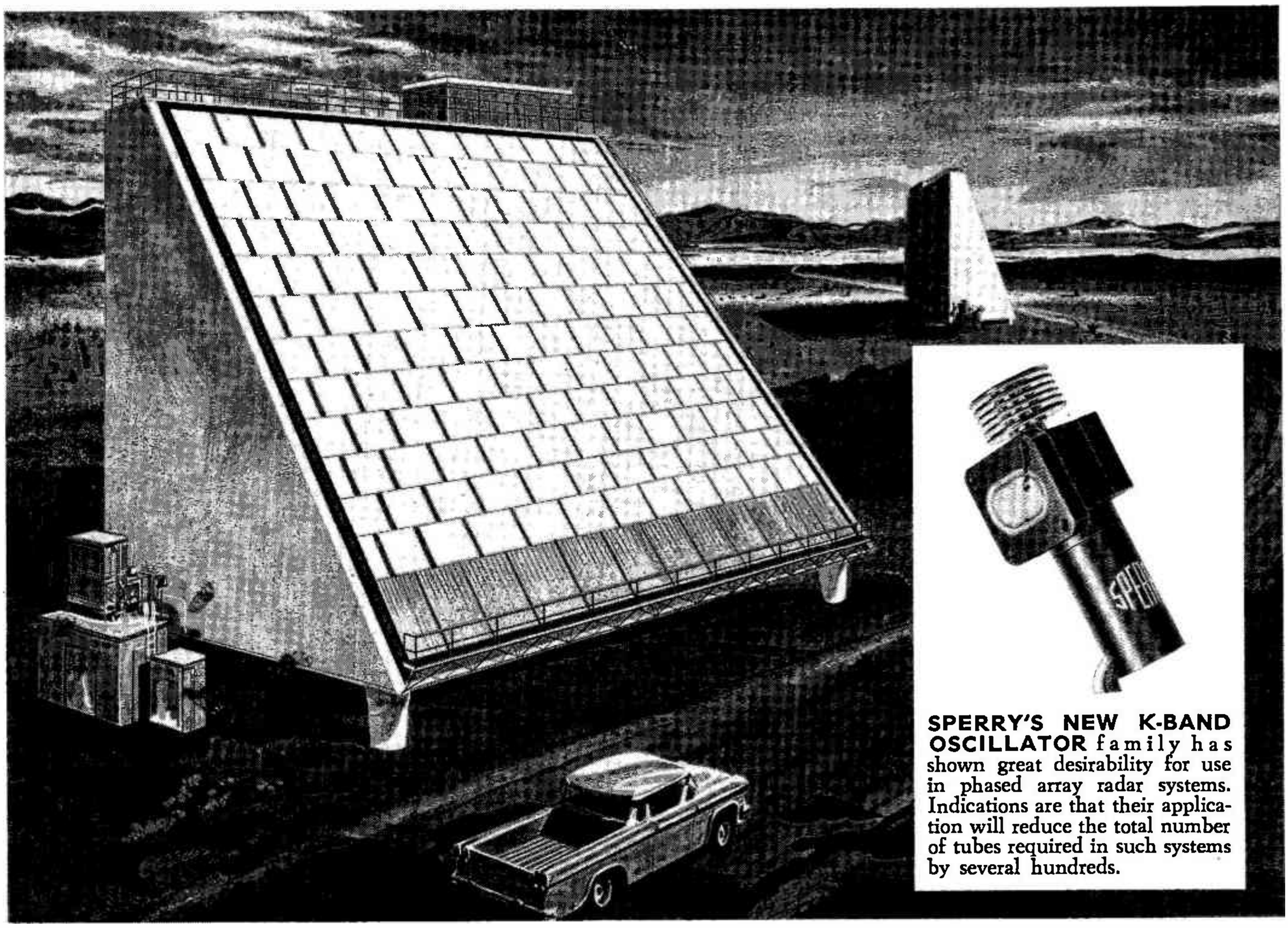
SPERRY microwave memo



SPERRY'S NEW K-BAND OSCILLATOR family has shown great desirability for use in phased array radar systems. Indications are that their application will reduce the total number of tubes required in such systems by several hundreds.

Production-ready K-band oscillators deliver 600 mW over a 20 Mc bandwidth

A new family of K-band two-cavity oscillators is now production-ready at Sperry Electronic Tube Division, Sperry Rand Corporation, Gainesville, Florida.

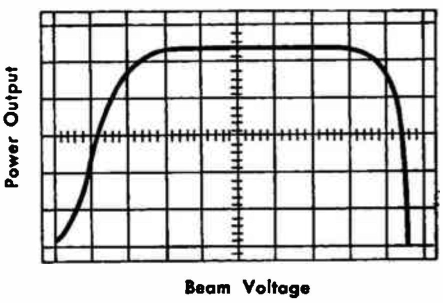
The new tubes show particular promise for parametric amplifier pumping applications because of their inherent amplitude stability and high power output levels at K-band frequencies (18-26.5 Gc). Depending on voltage mode of operation, power levels from 200 to 600 mW are available. While the lower level is highly promising for single amplifier pumping, the higher outputs offer tremendous possibilities in applications where several amplifiers must be pumped simultaneously. In fact, one tube—operating on the mode which delivers 600 mW minimum power output—will pump 10 or more parametric amplifiers.

COMPONENT SAVINGS POSSIBLE

The capability of these new tubes to pump several parametric amplifiers will greatly reduce the number of tubes required in many systems. In phased array radars, for example, a net saving of several hundred tubes may result when a switching network is coupled with multiply pumped parametrics.

DESIGN ECONOMIES REALIZED

Dramatic reductions in system design costs are indicated when the new Sperry Tubes are used in doppler radars, FM communications systems, and other K-band applications. Operating in a flat-top mode these tubes have an amazing 20 Mc bandwidth. This characteristic permits tremendously increased latitude in the specification of other parts. The system designer, freed from the tedious necessity of closely matching components, works more quickly, more efficiently, and more economically.



A typical main mode, adjusted for optimum flat-top operation

FREE K-BAND BROCHURE

A NEW, FREE BROCHURE DESCRIBES THE CAPABILITIES OF THE NEW SPERRY K-BAND OSCILLATOR FAMILY IN GREATER DETAIL. FOR YOUR COPY, WRITE TO SPERRY ELECTRONIC TUBE DIVISION, SEC. 118, GAINESVILLE, FLORIDA.

Since the new Sperry family is ready for volume production, you can start specifying them *now*. Unit price is $2,995. Cain & Co., which represents Sperry Electronic Tube Division nationally, has a salesman near you. He'll be happy to help you work out the details. Call him today!

SPERRY ELECTRONIC TUBE DIVISION

GAINESVILLE, FLA. / GREAT NECK, N. Y.
SPERRY RAND CORPORATION

NEW RCA-4037 PENCIL TUBE

A modern approach to your 2C40 Applications

The RCA-4037 is a low-power transmitting tube designed for plug-in use with almost any 2C40 cavity.

Gold plated for maximum electrical efficiency, the RCA-4037 is manufactured to the same high standards set by the RCA Pencil Tubes used in space exploration. Benefits of this design include increased operating efficiency, higher degree of reliability, small size, and long life—and at low cost!

The RCA-4037 features a low heater power of 0.85 watt—about one-fifth that of comparable types. Overall performance of the 4037 is enhanced by high plate efficiency—it is capable of delivering 0.075 watt output at 3370 Mc.

Next time you need a power-tube replacement for a 2C40 cavity, consider RCA's 4037 Pencil Tube.

RCA-4037 OCTAL BASED PENCIL TUBE

- About three times the cathode area per watt of heater power as compared to planar types
- One-third the warm-up time of comparable planar types—12 seconds to reach 90% of operating dc plate current
- Output power and frequency remain essentially constant over 10% heater-voltage fluctuations
- Cantilever arrangements of coaxial electrodes provides low interelectrode leakage, adds to efficiency, insures reliability

For a technical bulletin, write: Section C-19-Q-4, Commercial Engineering, RCA Electron Tube Division, Harrison, N. J.

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