April 21, 1961

electronics

Optical radar system (below) uses coherent light beam from ruby maser, can differentiate between small objects three miles away, p 51

Predicting spurious outputs in radio transmitter design, p 68

A McGraw-Hill Publication 75 Cents

Type 1570-AL Automatic Line Voltage Regulator
for 115v, 60-cycle lines . . . **$530.**

Hold 10% line-voltage variations to 0.25%

Output voltage adjustable over a ±10% range from a base value of 115 volts.

Correction range in percent of output voltage	±10%	±20%
Output current in amperes	50	25
KVA	5.75	2.9
Correction accuracy as percent of nominal output voltage	±0.25%	±0.5%
Correction speed in volts per second	10	20

. . . Without introducing waveform distortion...

. . . At continuous loads up to 50 amperes and short-time surges up to 500 amperes...

. . . No power factor restrictions or dead zones...

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April 21, 1961

electronics

A McGraw-Hill Publication *75 Cents*

W. W. MacDONALD, Editor

BUSINESS

ENGINEERING

DEPARTMENTS

another Sarkes Tarzian production breakthrough!

Specifications at 25° C			
Tarzian Type	Zener Voltage (V)	Test Current (MA)	Dyn. Imp.(MAX) (Ohms)
VR6	6	25	4.0
VR7	7	25	5.0
VR8.5	8.5	25	6.0
VR10	10	12	8.0
VR12	12	12	10
VR14	14	12	11
VR18	18	12	17
VR20	20	4	20
VR24	24	4	28
VR28	28	4	42
VR33	33	4	50
VR39	39	4	70
VR47	47	4	98
VR56	56	4	140
VR67	67	2	200
VR80	80	2	280
VR90	90	1	340
VR105	105	1	400

Tarzian Silicon Voltage Regulators now at workday prices

- 1-watt
- Epoxy enclosed
- 6 to 105 volts, in 20% increments
- Standard tolerance is 20% (all common tolerances available on request)
- Immediate availability

Sarkes Tarzian did it in 1957 for silicon rectifiers and has done it again in 1961 for silicon voltage regulators...devised production methods that make it possible to offer quality silicon semiconductor devices at a price level that permits their use not only in Sunday circuits but also in workday circuits.

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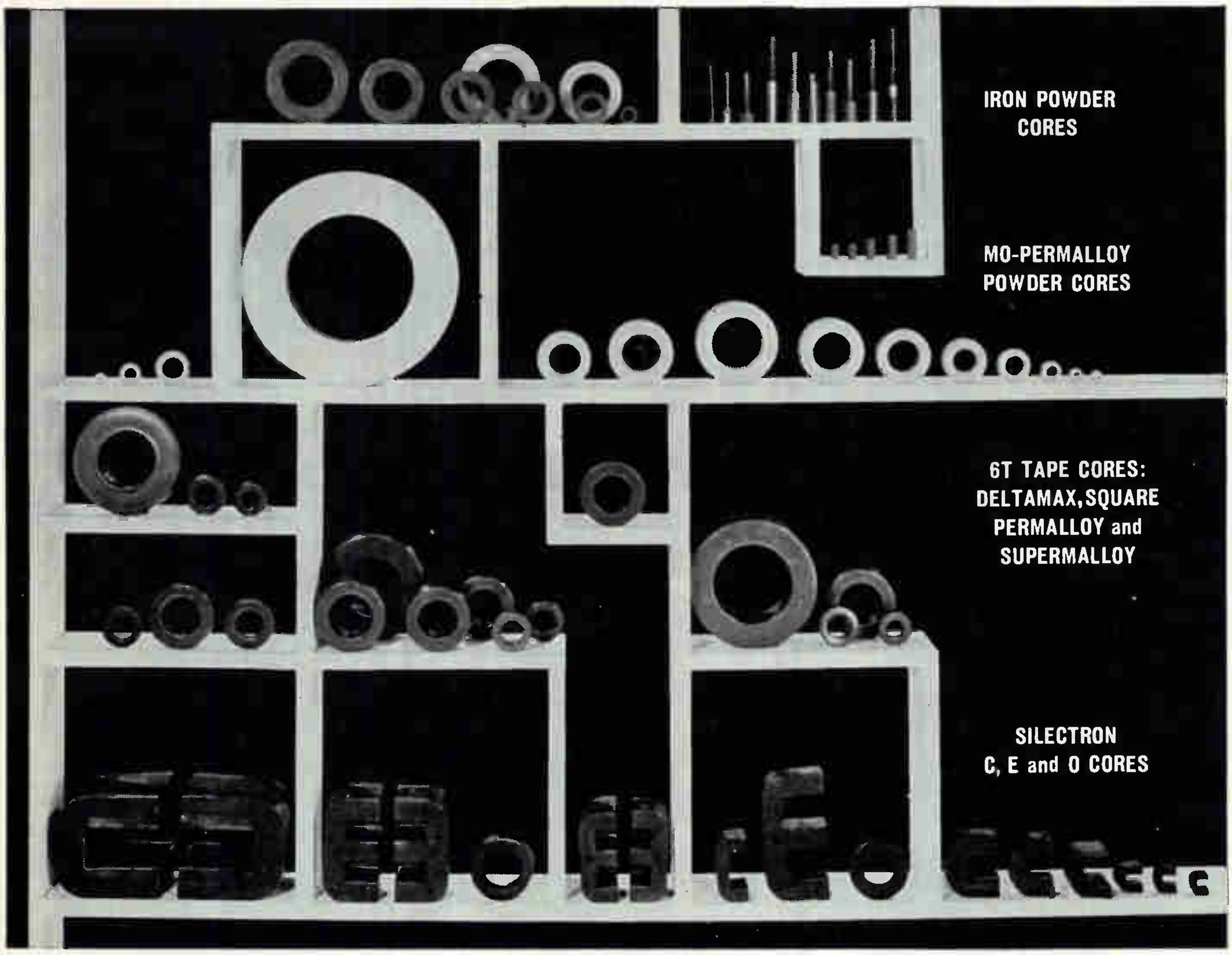

CIRCLE 3 ON READER SERVICE CARD

electronics
Apr. 21, 1961 Volume 34 Number 16

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CROSSTALK

ORGANIC SEMICONDUCTORS. In Chicago this week, over four hundred representatives of the electronics and chemical industries gathered to hear the latest reports on progress in the new technology arising from research in organic semiconductors. The occasion was the Inter-Industry Conference on Organic Semiconductors, co-sponsored by ELECTRONICS and the Armour Research Foundation. The turnout was gratifyingly enthusiastic, and confirmed our belief that organics are slated for a significant role in the future of electronic devices. We're happy to have played a part in these early stages. For facts on how some chemical companies hope to use organic research as a ticket to the semiconductor market, see p 22.

OUR MAN ON KWAJALEIN. He is, as you probably guessed, Pacific Coast Editor Hood. He isn't stationed there permanently even though, we suspect, the beautiful waters have a strong appeal for such a sailing enthusiast. Also appealing, as you can see on p 20, is the exciting electronics story developing on Kwajalein. The island is busily preparing for Nike Zeus tests. Hood went to Kwajalein to find out what is going on—and then filed his exclusive article. His swing around the Pacific also has taken him to Kokee Park, Hawaii (see ELECTRONICS, p 28, April 14).

Coming In Our April 28 Issue

COMPUTERS TODAY. The past 15 years has seen a few experimental developments grow into the impressive industrial technology that represents today's computer industry. Since 1956 alone the number of computer manufacturers has doubled and in 1960 the industry as a whole grossed over $1 billion.

To bring you up to date on where the computer industry stands as well as where it is headed, Associate Editor Leary has spent the past two months visiting computer laboratories and installations across the country. Results of this tour, which covered countless miles, will show up next week in a 32-page special report.

The report surveys the technology as it exists now, covering developments in circuits, systems, logic, input—output devices, memories, information retrieval and industrial controls. Trends anticipated for magnetics, tunnel diodes, cryogenics and thin-films are then examined. You won't want to miss this useful and informative special report.

IN ADDITION. A variety of interesting feature material to appear next week includes: designing printed-circuit spiral antennas by J. J. Wolfe and R. Bawer of Aero Geo Astro Corp.; simulating war games with analog computers by V. J. Caggiano of Johns Hopkins University; improving gain control of transistor amplifiers by J. S. Brown of General Electric; and a transistor circuit that regulates a fluorescent lamp by L. L. Blackmer and A. T. Wright of Eastman Kodak.

CIRCLE 5 ON READER SERVICE CARD→

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Raytheon Rayspan Spectrum Analyzers provide several important benefits not available with sweeping gate single filter type analyzers. Through a unique application of multiple filters, it is capable of analyzing entire spectrums as wide as 33 kc at scanning rates as high as 200 times per second with excellent resolution and sensitivity. Frequencies as low as 20 cps can be identified. Resolution for two equal-amplitude signals is approximately 0.7% or 3% of the analysis band depending on the Rayspan model employed. Dynamic range of 40 db.

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The ability to analyze a wide frequency range rapidly and continuously, makes it the most versatile analyzer available for such application as Telemetered Data Analysis, Industrial Noise Reduction, Shock and Vibration Studies, Complex Waveform Analysis, Transmission Surveillance, Speech Analysis, Acoustic Studies, Equipment Inspection. For complete technical data please write to: Raytheon, Industrial Components Division, 55 Chapel Street, Newton 58, Massachusetts.

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COMMENT

Medical Electronics

. . . I have been following your articles on medical electronics (p 49, Jan. 20; p 46, Feb. 3; p 54, Feb. 24) with great interest and I feel that they are very well done indeed. They constitute an excellent survey of the present status of medical electronics and the very fine bibliography enables one to go further in any one phase.

Our interest here at the University of Arizona is to promote an interdisciplinary teaching and research program between our life-science departments and the electrical engineering department. In the Fall we are introducing the first course in this program. It is entitled Electronic Instrumentation and will be open only to life-science graduate students and selected senior premedical students who are life-science majors.

Electronic instrumentation will be taught in its broadest sense in the hope that the students will be able to understand more fully the limitations and possibilities of the electronic equipment which they are working with. Also this course should enable them to set up with considerable confidence an instrumentation system to gain the information desired in their research. The aim of our program is to stimulate an interest in electronic instrumentation *per se* at the graduate-student level as well as to foster interdisciplinary cooperation in research across the campus.

STEWART BECKER
UNIVERSITY OF ARIZONA
TUCSON, ARIZ.

. . . Your articles on medical electronics have caused quite a stir here in Milwaukee. Everyone thinks them to be a most comprehensive and authoritative series. I would appreciate your sending me the full series in reprint form; I fear that by the time I receive the magazine, the articles will be stolen . . .

R. D. NEWELL
GENERAL ELECTRIC
MILWAUKEE

Meteorological Equipment

On p 12 of your March 10 issue, under "Air Force Accelerates Weather System Test" (Newsletter), the AN/FMQ-5 is referred to as Rawin gear. The AN/FMQ-5, developed and manufactured by Olympic, is known as an automatic meteorological station. The AN/TPQ-11 radar cloud-height detector, was also developed and is manufactured by Olympic; this item was referred to but not fully identified in the last paragraph of the item you published.

DAVE GERSTEIN
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LONG ISLAND CITY, N. Y.

X-Band Oscillator

I was interested to see our swept-frequency X-band oscillator mentioned in your description of the Exhibition of the Institute of Physics and the Physical Society ("Solid State Is Theme of British Physics Show," p 25, Feb. 10). However, the tube is swept several *hundred* megacycles in frequency, not several megacycles. Although there was a shortage of creature comforts at the show, there was no shortage of bandwidth.

S. J. LAREDO
DECCA RADAR LTD.
WALTON-ON-THAMES, ENGLAND

Chief Editor MacDonald says he put the right number in the cable but that it got garbled in the transmission.

Universal Counter

Your team of editors . . . must have been so excited about Computer Measurement's 100-Mc universal counter timer that they forgot to include it in their report ("Scanning Last Week's IRE Show," p 18, Mar. 31).

This solid-state instrument not only makes 10-nsec accuracy time-interval measurements, but performs period, frequency and frequency-ratio measurements as well . . .

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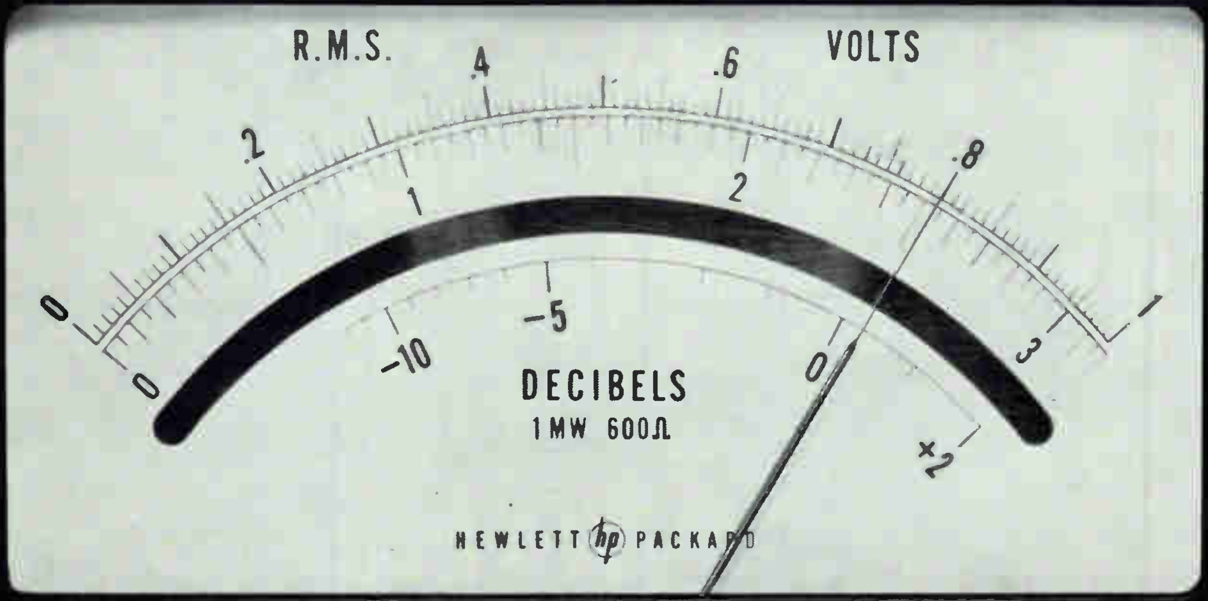
TOWSON, MD.

WHAT IT SAYS... ...*IS!*



Now! Individually calibrated meter scales give you highest accuracy–at no increase in cost!

New individual calibration of meter scales used in standard hp instruments gives you commercial instrument accuracy approaching that of lab standards! Through a servo system, *each* calibration line on *each* instrument's meter face is located precisely and *then* printed. *What the voltage actually is—you read!* No preprinted *approximate* scales are used.

This new standard of hp accuracy assures you that *each* voltmeter scale is calibrated to the exact characteristics of its *individual* meter movement. Scale tracking error is eliminated, and you get improved performance at the same moderate price.

Further, this calibration and inspection procedure at hp automatically rejects faulty meter movements. Tracking characteristics of each meter movement are determined over its entire range, and rigid tolerance control assures optimum performance.

These are the first commercial voltmeters wherein the meter tracking error is eliminated. Check the specifications below for the meter which meets your requirement. You are assured of improved performance, with this source of error eliminated—*plus* all the other advantages you expect in hp instruments: dependability, ruggedness, convenience. They're yours at no increase in cost.

This new standard of calibration is another part of hp's continuing effort to produce more accurate, more dependable, more useful instruments for measurement . . . and to produce them at moderate cost for highest value to the user.

Brief Specifications of the hp individually calibrated voltmeters

hp 400H Vacuum Tube Voltmeter

Voltage Range: 0.1 mv to 300 v, 12 ranges

Frequency Range: 10 cps to 4 MC

Accuracy: With nominal line voltages from 103 to 127 v, overall accuracy is within
±1% of full scale, 50 cps to 500 KC
±2%, 20 cps to 1 MC
±3%, 20 cps to 2 MC
±5%, 10 cps to 4 MC

Price: Cabinet, $325.00; rack mount, $330.00

hp 400L Logarithmic Voltmeter

Voltage Range: 0.3 mv to 300 v, 12 ranges

Decibel Range: –70 to +52 db, 12 ranges

Frequency Range: 10 cps to 4 MC

Accuracy: At nominal line voltage ±10%, overall accuracy is within
±2% of reading or ±1% of full scale, whichever is more accurate, 50 cps to 500 KC
±3% of reading or ±2% of full scale, 20 cps to 1 MC
±4% of reading or ±3% of full scale, 20 cps to 2 MC
±5% of reading 10 cps to 4 MC

Price: Cabinet, $325.00; rack mount, $330.00.

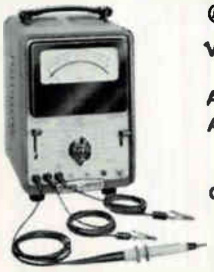
hp 425A DC Microvolt-Ammeter

Voltage Range: Pos. and neg. voltages 10 µv to 1 v full scale, 11 ranges

Accuracy: ±3% of full scale.

Ammeter: Current range, pos. and neg., 10 µµa to 3 ma, full scale, 18 ranges; accuracy ±3% of full scale.

Price: Cabinet, $500.00; rack mount, $505.00.



hp 412A DC Voltmeter-Ohmmeter-Ammeter

Voltage Range: Pos. and neg. voltages 1 mv to 1,000 v full scale, 13 ranges

Accuracy: ±1% full scale on any range

Ammeter: Current range, pos. and neg. currents from 1 µa to 1 a full scale, 13 ranges; Accuracy ±2% of full scale on any range.

Ohmmeter: Resistance range, 1 ohm to 100 megohms center-scale, 9 ranges; accuracy ±5% of reading, 0.2 ohm to 500 megohms ±10% of reading, 0.1 to 0.2 ohm and 500 megohms to 5,000 megohms.

Price: Cabinet, $400.00; rack mount, $405.00.

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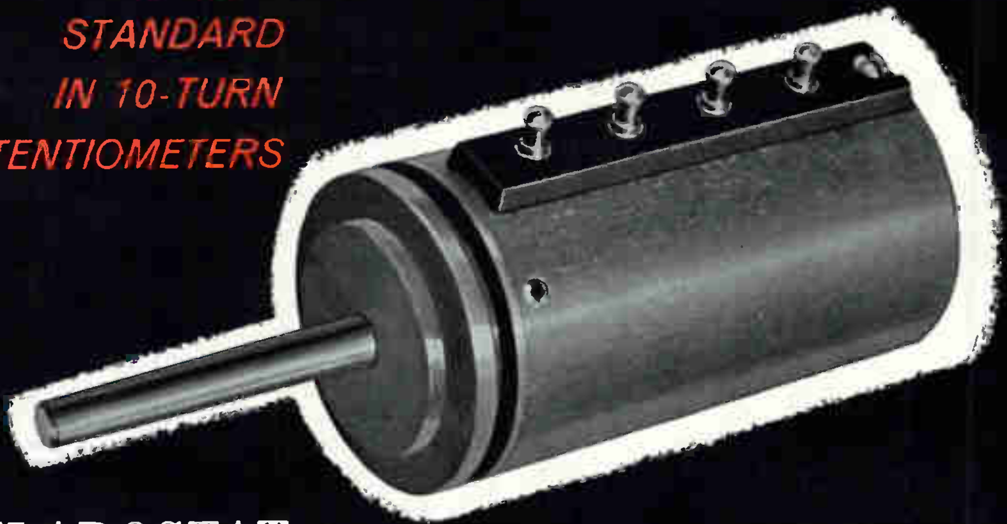

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A new high in potentiometer capabilities . . . the Clarostat Series 59M14, 10-turn, ⅞" potentiometer packs more performance per cubic inch than any other multi-turn pot today. Clarostat's unique design permits more winding length in a given diameter than conventional designs. And, price-wise, the Series 59M14 is competitive across-the-board.

For all your multi-turn potentiometer needs, compare Clarostat for quality, for value . . .

SPECIFICATIONS — SERIES 59M14, 10-TURN POTENTIOMETERS

- Diameter . . . . ⅞"
- Length . . . . 1.55" (Bushing) 1.611 (Servo)
- Maximum Resistance . . . . 100,000 ohms
- Indep. Linearity . . . . ± .25%, To ± .05%
- Wattage . . . . 4.5 watts @ 40°C.
- Taps . . . . Center tap
- Rotations . . . . $3600^{+10^\circ}_{-0}$
- Maximum Torque . . . . 1.0 oz. in.
- Weight . . . . 1.0 oz.

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DOVER, NEW HAMPSHIRE

ELECTRONICS NEWSLETTER

Details Lacking On *Vostok* Flight

AMONG the flood of publicity that Soviet news agencies turned loose after the spacecraft *Vostok* (East) completed its 89-minute flight around the world, there has been little technical detail. The human interest in the historic flight has been high; the propaganda value has been immense; technical details have naturally played a third fiddle. A few facts can be winnowed out:

Passenger Yuri Gagarin remained in touch with home base by h-f and uhf radio from his 5-ton craft. The *Vostok* was in the air 1 hour and 45 minutes of which 89 minutes was orbital flight. The ship was slowed by reverse blasts and settled to earth by parachute. Airborne medics and observers hovered over the landing area, parachuted down when the landing fix was computed.

Telemetry and tv systems were used to observe Gagarin in flight. The ground control station piped music into the craft's cabin during flight. Soviet academician V. Dobronravov commented that "scientific instrumentation, guidance, and communications systems" have been improved along with development of more powerful rocket engines. Other academicians predicted direct studies of upper atmosphere and space, with emphasis on ionospheric currents and magnetic-field boundaries, important to long-distance communications. Some Soviet commentators noted that instruments and automatic controls continue to be of first importance in running a spacecraft.

Britain's Jodrell Bank telescope did not catch the *Vostok*, apparently because the craft did not rise above Jodrell's horizon. The station also did not report receiving any signals from the satellite.

For details on U. S. tracking station performance, see *Washington Outlook*, p 16.

Air Agency Adopts Sidelobe Suppression

FEDERAL AVIATION AGENCY announced last week the adoption as a national standard of a sidelobe-suppression feature for air-traffic control radar beacons. Announcement came at the opening of the International Aviation R&D Symposium in Atlantic City, N. J.

Present equipment has a rotating beam whose sidelobes evoke too frequent responses from aircraft. Suppression feature transmits a nondirectional pulse positioned between the two interrogating pulses of the beacon; this prevents aircraft other than those in the main beam from replying. Immediate result will be to extend range and increase capacity of the present beacon system.

FAA and Britain's Ministry of Aviation reached agreement on technical details of the suppression system prior to recommending its adoption.

In another development, FAA awarded a $928,227 contract to SoundScriber Corp. for magnetic-tape recording gear which will use one-inch tape to record voice interchanges between aircraft and control centers. The equipment will be able to record 30 voice channels simultaneously and continuously for 17 hours.

Nuclear Blast Detector Uses VLF, Infrared

PROTECTION from nuclear or thermonuclear blast for intercontinental ballistic missiles relies on detection system devised by ITT's space communication labs. ITT's system uses both very-low-frequency and infrared sensors to detect fission or fusion blasts well in advance of the arrival of ballistic or acoustic waves, thermal shocks or neutron radiation, all of which travel substantially slower than light. Advance warning from vlf or ir sensors closes all intake manifolds, blast valves and access doors to Titan and Atlas silos, protecting weapons and operating crews.

Infrared sensors detect light from the blast, and vlf equipment using buried antennas hears r-f output in the 100-400 Kc range. Levels at which the system responds are chosen so that lightning flashes, or other meteorological or telluric phenomena, won't set off the protection system. First installation is already in; about 100 more are being produced for the rest of the Atlas and Titan hard sites.

Self-Organizing System Performs Diagnosis

LEARNING MACHINE being developed by Raytheon uses associative reinforcement to organize input information and determine optimum approaches to problem solution. Device is called Cybertron, has turned out medical diagnoses by running through thousands of feet of electrocardiograph tape records. Cybertron will be used in unspecified military applications, will also be given task of evaluating meteorological data.

Conference Calls for Basic Semiconductor Research

AIR FORCE conference on ultrapurification of semiconductor research held in Boston last week heard reports of work at MIT on thermodynamic properties of II-IV and V-VI semiconductor compounds. A researcher from a major silicon-processing firm declared that new emphasis in materials research will be on kinetics, thermodynamics, other relatively neglected fields. Some 500 engineers and scientists at the conference heard repeated calls for more basic work on semiconductor materials by chemists and physicists to achieve better control of lifetime, Hall coefficient, energy gap, charge-carrier mobility, resistivity.

Space Agency Buys Hybrid Computer

NATIONAL AERONAUTICS & Space Administration is using a hybrid computer developed by Electronic Associates. The system uses both analog and digital techniques, is a complex of some 1,500 high-speed computing circuits of which 800 are specially designed amplifiers. Besides classic analog functions—multiplication, differentiation, integration—the system can add and subtract, has a dynamic memory, uses input from any of three automatic digital input-output devices.

In another development, NASA and the Atomic Energy Commission have received seven proposals from industry for R&D of a nuclear rocket engine. Invitations from NASA and AEC followed successful test of Kiwi-A3 at Los Alamos last October 19. Selected contractor will help AEC develop Kiwi-B, prototype of a space reactor, and the engine to go with it. SNAP-2 has meanwhile gone critical in Canoga Park, Calif.; the SNAP series are lightweight systems meant for generating power in spacecraft. SNAP-2 weighs 200 lb, was designed by North American Aviation, produces 50 Kw of heat, 3 Kw of electricity.

Infrared Radiometer Developed for Nimbus

INFRARED RADIOMETER to be carried aloft in the Nimbus weather satellite and map earth's cloud cover completely every 24 hours has been developed by ITT. The Nimbus is scheduled to be launched on a Thor-Agena within a year.

Radiometer will produce temperature map of a 2,000-mile-wide strip of the earth's surface or cloud cover every 90 minutes. Four-inch optical mirror system will focus chopped radiation onto a lead-selenide detector sensitive to the 3.4-to-4.2-micron spectrum. Observations will be stored on electrostatic tape, transmitted to earth on command. High-latitude site—probably in Alaska—will be primary acquisition station.

Logarithmic circuits will permit the radiometer to take cloud-cover readings on the night side and still function in the higher noise levels of the sunlit side. Back of the detector will be aimed out into space to maintain supercooled state for optimum sensitivity.

Electronic Components Resume Upward Trend

SHIPMENTS of electronic components—including tubes and transistors—increased about 4 percent during the last quarter of 1960, according to the electronics division of Business & Defense Services Administration. The rise, which is reported to be continuing into first-quarter 1961, contrasts with a 5-percent decline recorded in the third quarter of 1960. Increased military and industrial demand sparked the rise; shipments of components for consumer gear declined significantly. Total shipments for 1960 were 10 percent over 1959 levels.

In Great Britain, Radio & Electronic Component Manufacturers Federation also announced last week an increase in 1960 production over 1959 of about 10 percent. Total value of British production of components in 1960 was given as $290 million. (The RECMF figures exclude "electron tubes, transistors and cathode-ray tubes.") Exports were up 36 percent over previous-year figures; the U. S. was the largest customer, having purchased over $13 million worth.

Defense Contracts Stress Space, Missile Defenses

CONTRACT for $17 million to develop communications system for Army's project Advent was awarded last week to Bendix Corp. Advent will test the feasibility of a microwave communications satellite operating in a 24-hour synchronous (apparently stationary) orbit. Development of the communications system is already underway at Bendix's systems division; contract includes responsibility for the satellite repeater, special ground equipment, checkout gear and engineering of the entire system. Bendix radio division is building the ground terminal stations.

Polaris missile submarines continue to receive new Navy money. Interstate Electronics was awarded a $9.5-million contract to design, build and test instrumentation systems for "a new class" of Polaris subs. General Telephone & Electronics got a $5-million contract for Polaris communications, with work to be done by GT&E subsidiary Sylvania.

Bell Aerosystems is building a radar-computer system designed to land aircraft automatically on the nuclear carrier *Enterprise*. The system, which uses an Autonetics Verdan computer, will land the craft without pilot intervention. The *Enterprise* will check out the system, which is planned for installation on nine other carriers.

N. J. Turnpike Expands Microwave Communications

NEW JERSEY Turnpike is expanding and modernizing its microwave communications facilities. RCA has been awarded a contract to finish a program begun in 1956 to replace older gear with a high-capacity microwave system providing up to 120 channels for administrative, maintenance and police communications. New stations will be added at the northern and southern termini of the 131-mile pike and at two major interchanges. Original system served seven stations with 40 channels at 960 Mc; new system operates in the 2-Gc band, will have 13 stations all told.

Announce Development Of Flat-Screen Display

DISCOVERY of what was described as a "new approach" to flat-screen optical displays was announced by Electro-Tec Corp. last week. The announcement, couched in general terms, said the principles of molecular electronics involved were basic, and that the device was "a complex of materials whose electrical, thermal and physical characteristics" were such that "an optical display can be induced across the complex by modulation with a voltage." Discovery is "in development stages."

Chinese Use Tubes In Radio-Tv Receivers

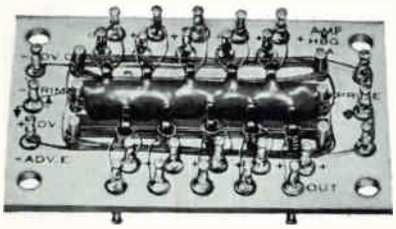
CHINESE PEOPLES REPUBLIC is producing radio and tv receivers in factories in Tientsin, Shanghai, Peking and Nanking. In 1958, the year the current five-year plan began, CPR industry produced 1.1 million radio receivers; no figures have been officially announced since, but reliable sources in the Orient indicate production has passed the 5-million mark. Most sets are 5-tube superhets; the Shanghai plant makes a big combination radio-tv-phonograph-tape recorder.

COUNTS LIKE MAD!

Miniaturization . . . extreme reliability . . . almost negligible power consumption . . . low bit cost—these merely provide the base for a whole stack of advantages when you choose AMP-MAD® Counters over other types.

AMP-MAD Counters are made with special multiaperture magnetic cores and wire **only.** Cores and wiring can be totally encapsulated. AMP-MAD devices provide either static count indication, or, in the case of higher count rates, a dynamic output as the count changes.

Identical counter/driver units are triggered by pulses to be counted. As shown (below), in cascaded decade applications, units and tens "carry" kicks over following decade counter/driver and advances the count . . . with no limit to the number of decades!



(Actual length 1 27/32" max.)

Check these additional AMP-MAD features:

- −55°C to +75°C temperature operating range (standard)
- small size—fits miniaturization requirements
- ultimate in reliability
- requires no sustaining power
- one to zero discrimination of 8 to 1 (20 to 1 on request)
- non-volatile count storage
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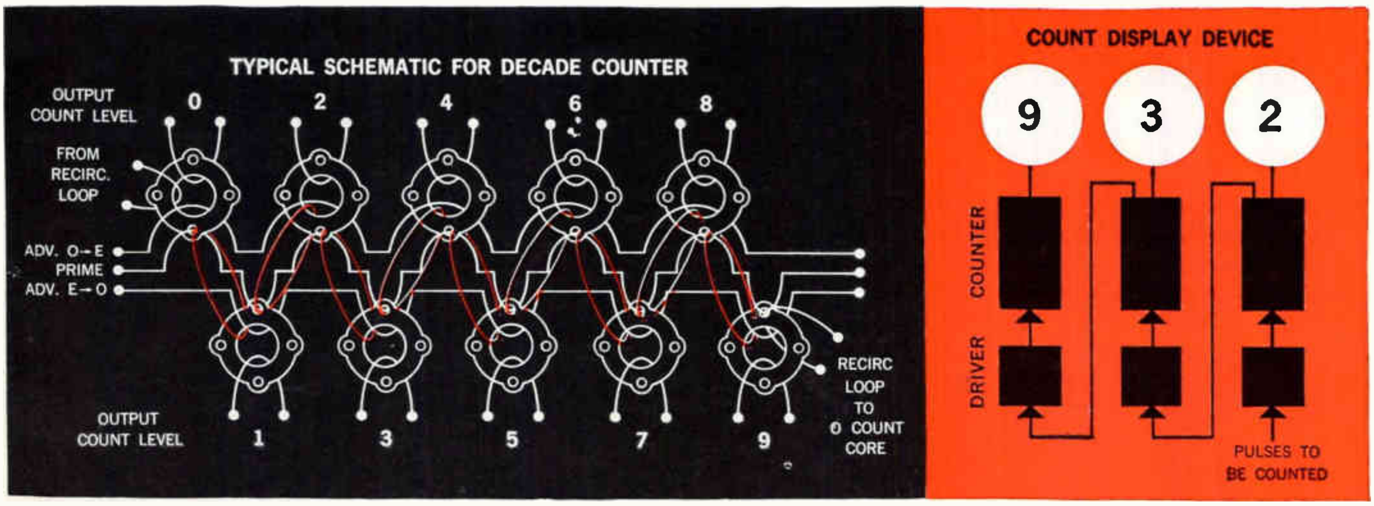

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CIRCLE 13 ON READER SERVICE CARD

ELECTRONICS ABROAD

Burma Importing More, U.S. Third As Supplier

RANGOON—Electronic imports into Burma rose from about $1.7 million in 1958 to $2 million in 1959, according to U. S. Department of Commerce.

The U. S. ranked third as a supplier in 1959, accounting for about $402,000 worth of material. Japan did the highest volume of business, $532,000, followed by United Kingdom volume of $455,000.

Other nations sharing in the Burmese market were West Germany, $132,000, and the Netherlands, $118,000.

At present some business is transacted in assembling consumer radio receivers in Burma from imported components. Items imported for this purpose totaled about $551,000 in 1959.

Most U. S. imports here consist largely of components for commercial rather than consumer electronics. Among these are transmitting and power tubes for broadcasting and radiocommunications use. Most consumer radios are supplied by Japan. Part of these shipments are reparations from WW II days. No television has been established yet.

The government's Electricity Supply Board is the largest importer of electronic items.

Japan Radio Imports Rise in Nicaragua

MANAGUA—Market for popular priced radios here is chiefly Japanese, according to recent observations, and is dominated by multiband receivers. Despite this, price competition continues keen with slightly under ten percent of the consumer radio market going to Federal Republic of Germany.

U. S. position as main supplier of radio receivers has declined although top position in radiophonograph combinations, high fidelity gear and broadcast and communications equipment is still held.

About 75,000 radio receivers and 4,300 television receivers are used in Nicaragua. Most tv sets are from one U. S. company although competition is expected to increase soon.

The nation's imports of radio and tv gear and components have remained relatively steady with U. S. accounting for about 54 percent of the market. Figures: 1959—$566,432, 1958—$552,446, 1957—$562,705.

Dutch Unit Fires Guns, Controls Small Missiles

AMSTERDAM—Security wraps have been partially lifted here from a radar firing control installation called the L4/5, claimed by Dutch spokesmen to outperform any other fire control system.

Main feature of the apparatus is that it can be used for firing guns as well as for controlling small missiles. While following and firing at aircraft targets, the L4/5 antennas are reportedly able to maintain search scanning of air sectors in case of simultaneous attack from more than one source.

The installation's antenna system is able to detect low-flying aircraft and train the guns it controls automatically on target at the push of a button. When targets are within range, another pushbutton provides automatic firing. Several guns can be connected to the system at a time. Dutch military authorities say the equipment is of special value because inexperienced personnel can operate it effectively.

Other than disclosing that the firing controls are transistorized, the manufacturer, Hollandsche Signaal Apparatenfabrieken of Hengelo, a Philips of Eindhoven subsidiary, is keeping most technical details confidential.

British Announce Gas Pump Display

LONDON—Beginning test trials this week in south England is a new gasoline pump display for filling stations which uses pulse trains to show customers price and quantity of gasoline being put in their autos.

Developed by the Wayne Tank & Pump Co., Ltd. in conjunction with Shell International Petroleum Co., Ltd., the system separates pumping functions into three groups: pumping, metering and display. While the first two functions are performed in the normal mechanical way, the display function is remotely initiated at the storage tanks by a d-c energized pulse transmitter which supplies two pulse trains, one for quantity of gasoline, the other for price.

The trains drive stepping motors in a separate display unit mounted ahead of the motorist instead of on the gasoline pump. British developers are planning demonstrations of the new system in the U. S.

Eastern Nations Report Climb in Radio, Tv Sets

VIENNA—Reports reaching here from Warsaw and Budapest sources indicate an upward trend in radio and tv subscribers.

A Polish source, using March 1, 1961 figures, says that nation has 4,047,000 radio set owners and 468,000 tv set owners. Ownership is highest in cities, where 2,768,000 radio sets are registered as against 1,279,000 for rural areas. Polish cities have a total of 404,000 tv receivers while rural areas account for 64,700.

One observer notes that highest set ownership in both radio and tv is reported in cities formerly in German territory: Gdansk (Danzig), Wroklav (Breslau), Cattovice (Kattowitz). Poland's total population is reported at 27 million.

Hungarian Postal Minister, Antal Katona, is quoted from Budapest as saying six tv broadcast stations have been commissioned in Hungary between 1958 and 1960. There are 123,621 tv license holders. Extension of the Hungarian ultra-shortwave network is planned for the 1961-1965 five-year plan, with greatest growth anticipated for the eastern part of the country. Plans will allow the new system to handle up to 60 simultaneous telephone calls between Hungary and the Soviet Union. Hungary's population is reported at 10 million.


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WASHINGTON OUTLOOK

THERE IS growing speculation over just how well the U.S. is able to detect orbiting satellites. The U. S. has an elaborate network of radar stations that are supposed to provide a 24-hour surveillance on unannounced satellite launchings. Its purpose is to guard against having unknown enemy spy satellites orbiting over the U. S.

Reports on U. S. tracking of the first Soviet manned orbital flight on April 12, however, raise some doubt about the effectiveness of the U. S. system. The White House said the U. S. tracked the Russian flight throughout its flight. Other reports are that part of the detection network didn't start tracking until several hours after the astronaut had returned to earth. Then, it was only the empty rocket casing that was being tracked.

The effectiveness of the U. S. satellite detection net is kept under tight security wraps. Information on its operations are released to the public through the National Aeronautics and Space Administration. But, it is the military that decides what, if anything, will be released.

At the earliest, the U. S. will attempt to orbit a man late this year. There are about a half-dozen additional tests that must be conducted before the manned orbital attempt will be made. These include some five more Mermury-Redstone launches and a minimum of three to four Mercury-Atlas shots.

Two of these tests are expected to be made within the next few weeks. One will be the MR-3 shot that is to carry an astronaut in a 115-mile high ride down-range some 290 miles. The other is to shoot an unmanned Mercury capsule into orbit with an Atlas booster, then immediately bring it back to earth.

The possibility of the U. S. shaving months off of its schedule is technically possible if intermediate tests work with 100 percent perfection. But, there is little practical chance of this. Primarily, the reason is that the scientists and engineers want repeated successes before they risk sending a man aloft.

The Soviets monitored their astronaut by television during his flight. The U. S. will not do this. The reason is that the weight of the equipment is greater than the U. S. could accommodate in the Mercury-Atlas vehicle.

We will, however, be in continuous voice communication with our astronaut.

The U. S. was not asked to aid the Soviet Union in tracking its manned capsule. And, some reports say the first time some U. S. stations picked up the empty rocket casing was at 7:13 a.m. EST. Two U. S. tracking stations tracked the empty casing: Air Force's station in Trinidad, and at Moorestown, N. J.

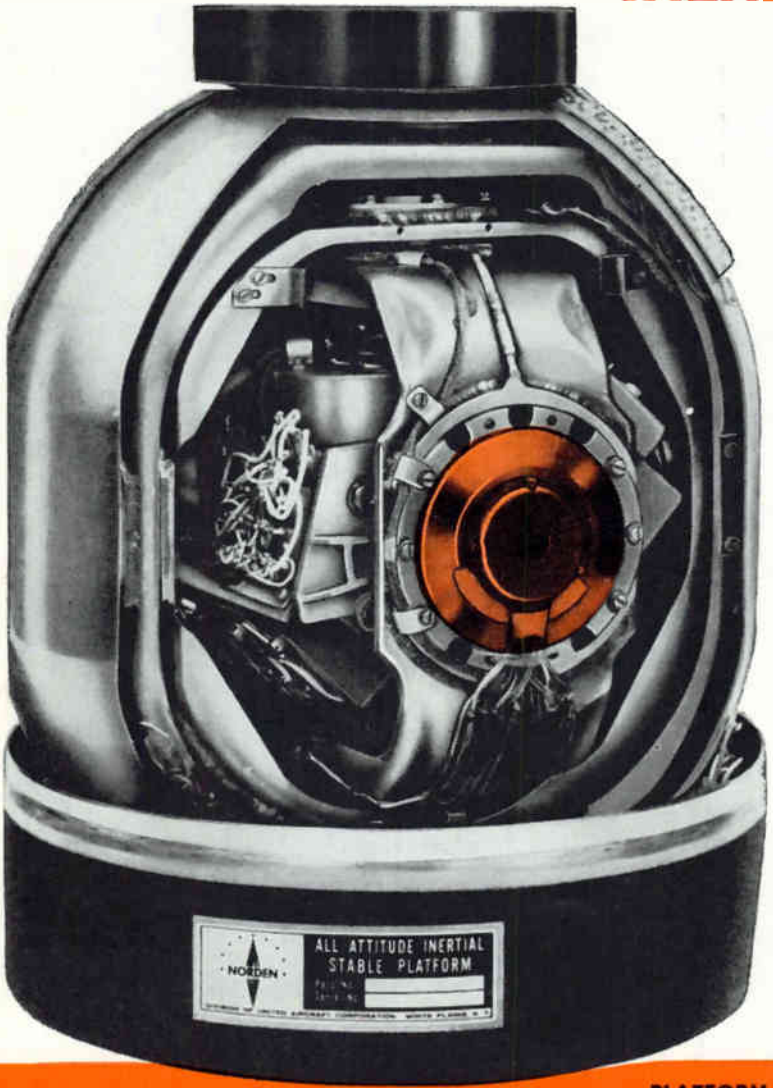
From the information available, one point stands out. The U. S. net to detect satellites apparently is not very good, considering that the Russians say they launched their manned capsule at 1:07 a.m. EST.

A FEDERAL program to electronically survey the world oceans has been started. A Coast and Geodetic Survey vessel has started a five-month test operation on equipment and techniques in the Pacific Ocean.

The ship will traverse a 130-mile wide by 2,000-mile long sector of the Pacific in parallel routes 10 miles apart between Alaska and Hawaii, continuously surveying the area. Once this job is completed, additional data will be collected at specific points.

Following the test operations, an evaluation of the surveying method will be made. Then, a systematic survey of the oceans will be started. Right now, less than 2 percent of the oceans are surveyed, yet they comprise seven-tenths of the world's surface. The total job is expected to take several years.

INLAND d-c torque motors save critical weight in guidance systems



Norden Miniature All-Attitude Inertial Platform uses four Inland torque motors, one for each gimbal axis.

Norden specifies these Inland d-c torque motors because of their compact pancake shape, low-power input and direct torquing. In addition to providing the obvious weight and space reduction, Inland's direct drive positioning eliminates gear train problems such as backlash.

Norden engineers say, "The linearity of the Inland torquers is excellent over a wide range so that precession rates may be accurately established. The torquer fixed field is carefully stabilized so that the torquer gradients will be constant over long periods of time."

Inland d-c pancake torque motors with high torque-to-inertia ratios and linearity of output provide all the advantages of direct gearless servo positioning in a complete line over the full range of 0.1 to 3,000 pound-feet.

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Volts at peak torque, stalled at 250°C	48.0	26.0	25.6
Amps at peak torque	1.21	1.6	1.24
Total friction, oz. in.	0.5	0.8	1.5
Rotor Inertia, oz. in sec²	.001	.007	.011
Weight, oz.	5.0	9.0	14.0
Dimensions (inches):—O.D.	1.937	2.81	2.81
I.D.	.625	1.00	1.00
Thickness	.50	.63	1.00

For complete catalog with engineering data, outline drawings and specifications on these and other Inland d-c pancake torquers, write Inland Motor Corporation of Virginia, Northampton, Massachusetts. Dept. 12-4

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Kwajalein Girds for Early Nike Zeus

KWAJALEIN, M. I.—Brick-and-mortar phase of the Army's Nike Zeus test site here is nearing completion, and installation of electronic gear is being rushed. First attempt by the 47-ft, 11-ton, 3-stage missile to intercept one of 18 Army-purchased Atlases to be fired 4,500 miles from Vandenberg Air Force Base is scheduled for early '62. Sometime earlier Zeus will test itself against 5,400-mph target rockets launched from Roi-Namur Island, 47 miles to the northwest. This latter test program is dubbed Speedball, and will use a two-stage version of Zeus for targets.

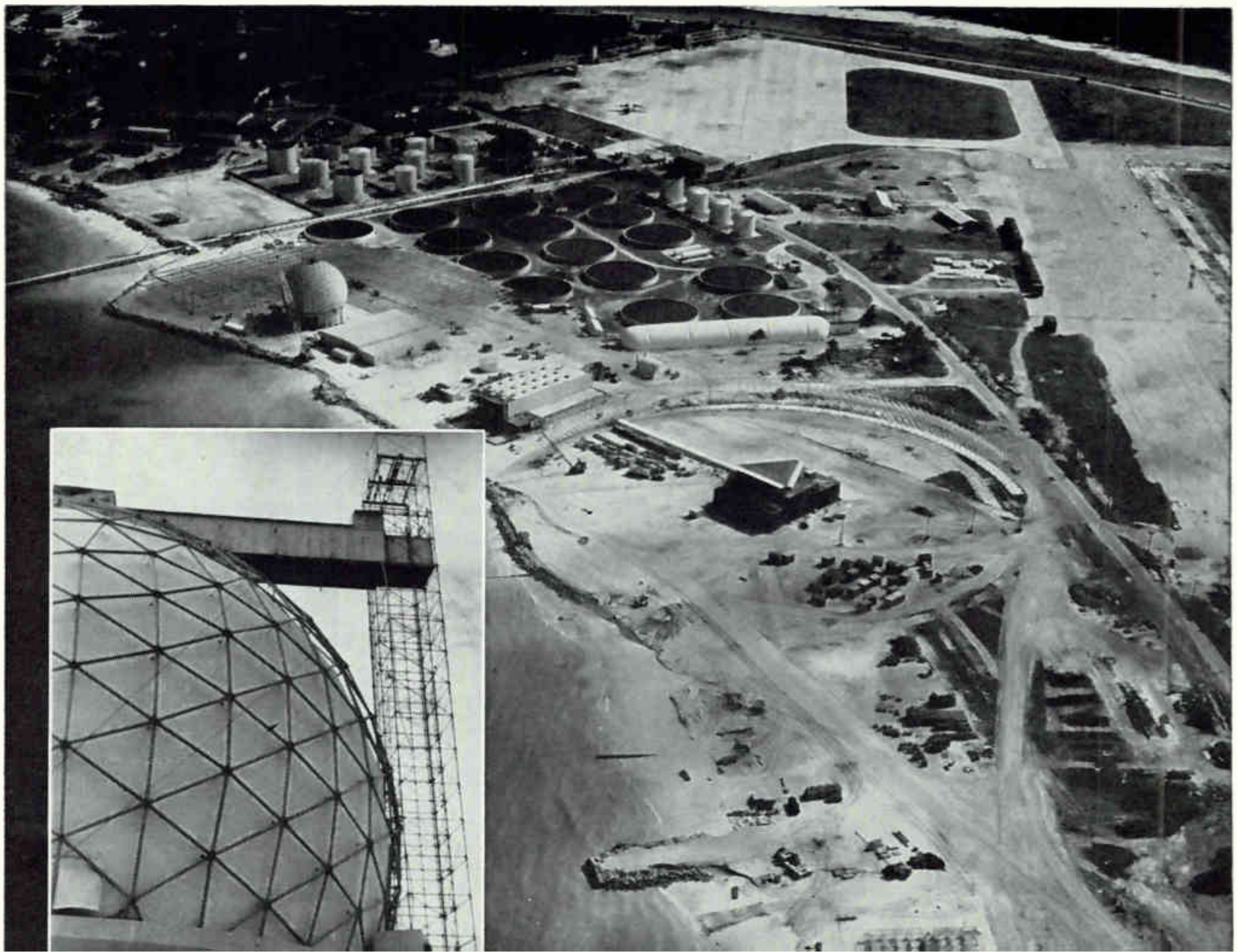
A total of $889 million has been committed to the Zeus program to date, of which $750 million represents R&D, and $90 million has been ear-marked for construction at Kwajalein, White Sands and supporting sites. Work presently under contract is now about three-fourths complete. Preproduction planning funds accounted for $49 million.

Four different types of radar installations are required for Zeus: acquisition, which searches for and acquires incoming objects; discrimination, which informs the system which objects are warheads and which are missile fragments and decoys; target track, which supplies precise data to generate a solution for interception; and missile track, which follows Zeus and supplies information for guidance.

Heart of the Zeus system is the ultrahigh-speed target intercept computer that ties together the radar and missile launching equipment and automatically sequences the operation of each. Thousands of buffer amplifier modules, each using four transistors and several carbon-deposited resistors, comprise the bulk of electronics in the computer. Twistors are used for permanent memory units and make possible extremely fast access and computation times. Automatically wound solder-free connections, many with gold-plated contacts, are used throughout. Data acquisition time is about 2.8 microsec.

Millions of cubic miles of space will be scanned by the powerful Zeus Acquisition Radar (ZAR). Its horizontal triangular antenna, consisting of three arrays each 80 feet in length, is atop the three-story reinforced concrete transmitter building. The antenna rotates at 10 rpm. Ball bearing for the rotating portion are 114 3-inch steel spheres. Outer surfaces of

Overall view shows part of Army's Nike Zeus project on Kwajalein. Inset: Zeus acquisition radar there. Scaffolding is for installing polystyrene cubes within protective Nylon sphere to make up Luneberg lens



Antimissile Tests

By HAROLD C. HOOD, Pacific Coast Editor

the concrete structure are treated with an asphalt derivative and covered with Terne metal, steel coated with tin and lead alloy, as an r-f shield.

An indication of the transmitter's multimegawatt power is seen in the need to erect a $347,000, 62-ft-high steel mesh fence around the area to protect personnel from r-f radiation. This shielding fence, 340 ft in radius, also helps shape the radar beam and prevent ground clutter. Access to the transmitter building from outside the fence is through a corrugated steel arch tunnel—another personnel protection measure.

Six 1,100-lb Varian klystrons power the transmitter, and 50 cabinets of electronic gear in a nearby control room handle r-f switching and tuning; d-c power for the klystrons comes from multiple banks of 52 large capacitors each.

The 102-ft-high hemispherical receiving antenna is 1,100 ft away. It rotates in synchronization with the transmitter antenna. It consists of a large Luneberg lens with many independent monopulse receivers in three horn towers matched to the three parabolic sections of the transmitter.

The lens uses 34,484 two-ft polystyrene expanded foam cubes, and its 2,800,000 pounds rotate on a large thrust bearing. The lens acts much like a huge magnifying glass, focusing the returning radar signal and concentrating it at a detector. Tiny strings of metal impregnated throughout the plastic foam in a precise composition attain the desired dielectric constant for focusing.

Covering two acres of ground adjacent to the receiver antenna is a 32-ft high structural-steel-and-steel-mesh ground plane that reflects and shapes incoming radar signals. Closely regulated power for ZAR is supplied from nine 1,500-Kw diesel engine generators.

Perhaps the most controversial link of the system is the Zeus Discrimination Radar. All military and contractor personnel concerned with this secrecy-shrouded device seem confident that the problem of differentiating between decoys and actual ICBM warheads has been solved, but additional research in identification techniques is being pushed.

After the discrimination radar has sorted out a target, the needle-beamed target-track radar locks on and for the next ten seconds or so establishes the trajectory of the warhead. A 25-ft Cassegranian reflector, surrounded by a 47-ft inflatable radome, is raised and lowered by a 50-ft vertical hydraulic hoist.

Three smaller Missile Track Radars are being installed in a single concrete structure on the 602-acre island. Each will be assigned to a Zeus missile, and will track it from launch to intercept.

Associated closely with the Nike Zeus program and more particularly with its discrimination radar is Project Press (Pacific Range Electromagnetic Signature Studies) on nearby Roi-Namur Island. A part of ARPA's Project Defender established for researching ballistic missile defense, Press will investigate the flight of ballistic missiles from midcourse through reentry. Aim is to determine physical differences between ICBM reentry vehicles and decoys from which identification can be made, and to test methods of discrimination. Press will use target missiles and communications provided by the Zeus program on Kwajalein.

Tradex two-frequency (UHF and L-Band) radar being built by RCA is scheduled for emplacement at the Roi-Namur Press site in late 1961. Optical and infrared measurements will be made by Eniwetok-based planes and instrumentation already operational. Scientific direction of Project Press will be furnished by MIT's Lincoln Lab.

Press' power plant houses seven 1,500-Kw diesel generators, will cost $1,800,000 when completed, and has switching to provide precise or nonprecise power as required.

During initial tests, Kwajalein will be linked to a point-to-point radio-transmitter-receiver site in Honolulu, then by military radio channels and by a leased commercial submarine cable with the mainland. The communications network will be able to carry two voice and 16 teleprinter channels.

Because of the high r-f interference expected on Kwajalein, all long-distance radio communication, both voice and telemetry, is being moved to nearby islands in the atoll. Connection to the main island is by underwater cable. The island of Ennylabegan has been designated as a passive area, and will shortly be the site of all receiving equipment. Work is proceeding on transmission facilities on tiny Gugeegue Island, the active area. Each island has its own diesel power station.

Scheduled tests of Zeus call for no warheads on either the Atlas targets or the intercepting missiles. Success or failure of intercept will be recorded by electronic miss-distance indicators.

Japanese Company Makes Pushbutton Phone Device

TOKYO—Pushbutton device for telephone dialing went on the market here this week. The unit, manufactured by Toshiba, has 29 circuits of 10 digits each. A red light turns on when a call is made. A built-in loudspeaker indicates whether the number being called is busy.

In case of a busy signal, the device can be set to place the call automatically five times, once every 25 seconds. During this period, however, the telephone can receive calls coming in.

If a wrong button is pressed, a special button will cancel the call. Conversations can be broadcast over built-in loudspeaker. The device retails in Tokyo for $161.10.

Chemical Firms Push Organic Research As Ticket to Semiconductor Market

CHICAGO—Several chemical firms are putting money on organic semiconductors as a "long-shot" ticket to a lucrative share of the huge electronic components market. This notice was served by James F. Bourland, General Manager of the Central Research division, American Cyanamid at the Inter-Industry Conference on Organic Semiconductors held here this week. The conference was cosponsored by ELECTRONICS and the Armour Research Foundation.

Dr. Bourland told the conference that chemical company management was interested in organic semiconductors because of the wide-open character of the field and because the chemical industry can apply its own special competence in this area.

"In an area where so little is known," Bourland said, "there frequently lies opportunity for the early explorers. Secondly, for a chemical company heavy in synthesis experience, this route seems to present a more rational approach to the field of molecular electronics, and one which gives it a more even chance of competing against companies already highly sophisticated in electronic theory."

Bourland defined an organic semiconductor as a material containing a significant proportion of carbon-to-carbon linkages, and produced by chemical synthesis rather than metallurgical procedures. In addition, the conductivity must occur by a process involving an electronic rather than ionic mechanism.

Bourland characterized the present state of organic semiconductor science as being comparable to that of inorganic semiconductor materials in the 1930's. He looks for more rapid progress, however, because of the broad base of understanding in the fields of molecular structure and solid-state physics and chemistry that has been achieved in recent years.

Lack of understanding of the conduction mechanism in organic substances is the chief barrier to advancement, he noted. In addition the engineering problems in producing electronic devices may prove formidable. But optimistically, Bourland declared, "Although physical problems of this sort are new to our staff, we find that their competence in this field has increased rapidly. Thus, rather than 'buying new talent' we are developing it within our own organization. When a breakthrough comes, we should be well prepared to capitalize on it."

Bourland went on to list the possible advantages of organic semiconductors:

• Possibilities of synthesizing a large variety of tailor-made devices for which inorganic materials are inherently unsuited.

• Overcoming the inherent inflexibility of raw material supply as one of the major problems in inorganic semiconductors.

• Low thermal conductivity, characteristic of most organics, will overcome an important limitation of conventional semiconductors.

• Simplified fabrication techniques due to plastic properties of organics could result in films, filaments and molded shapes as semiconductor components.

See Television Price War In Japan Receiver Mart

TOKYO—Television receiver price war in Japan is predicted by observers here as mounting inventories of black and white sets begin to drag down prices.

It's expected the domestic market here will be flooded with 40,000-Yen ($111) sets by Summer because the yearly output of sets by then will reach 3,800,000, as compared with a demand of 2,500,000.

Tokyo observers say the majority of Japanese manufacturers are giving serious thought to marketing $100 sets to bring more sales volume within buying range of more Japanese families and thus reduce the margin between production and demand.

Price war on color sets is termed

New Eye for Cathode Ray Display

Miniature crt display device by Westinghouse allows telescope-type viewing of radar and tv data. It uses a 0.60-in tube, costs $150 "inevitable" by some Tokyo sources who predict a landslide of price cutting. Toshiba introduced a low-price color set late last month by dropping consumer cost 10 percent to $1,333 for its 21-in. model, and cutting the 17-in. unit by 40 percent to $950. Other manufacturers such as Hitachi, Sanyo, Hayakawa and Matsushita are expected to follow suit.

In 1960, Japan produced 5,192 color sets—3,221 were 21-in. and the remainder 19-ins.

Swedes, Swiss to Install U.S. Air Doppler Radar

STOCKHOLM — Scandinavian Airlines System here and Swissair headquartered in Zurich, Switzerland, have adopted Bendix doppler radar navigation systems for their Douglas DC-8 and Convair CV-990 jet aircraft. Both airlines plan fleetwide installations and are making provision for dual installation on all aircraft.

The installations will include the radar gear to determine true ground speed and wind drift angle and computer equipment to combine the radar data with heading information to give course and distance information.

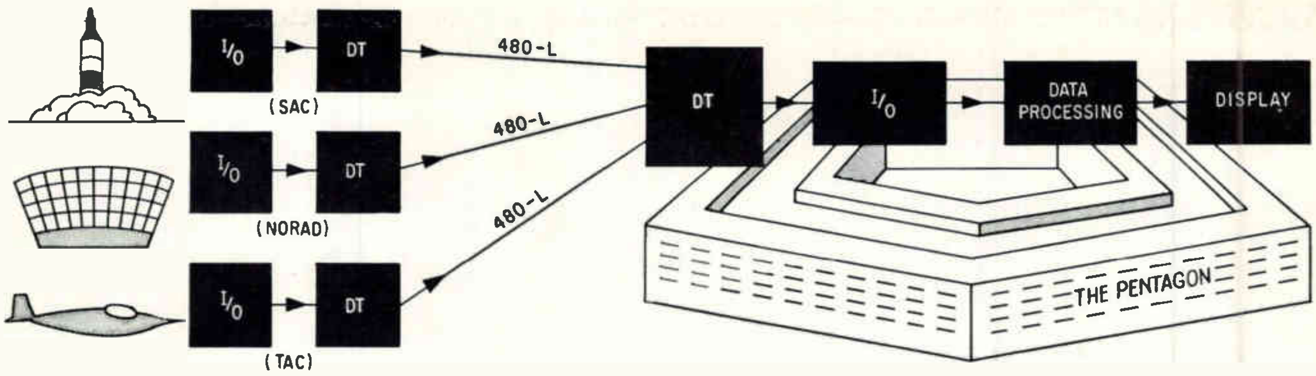
The Bendix equipment, in use by several U. S. airlines, is also aboard NATO's Fiat G.91 Light Strike fighters.

Britain's Air Ministry Orders U.S. Equipment

LONDON—British Ministry of Aviation has received initial deliveries on a $1,008,990 order for airborne high frequency single sideband communications systems from Collins Radio.

The HF-103 systems which include a transceiver, control and shockmount will be used aboard RAF Argosy C.1. turboprop military transport aircraft. The radio gear provides long and short-range communications. The transceiver operates in the 2-30 Mc range on 28,000 directly selectable channels.

The Argosy C.1. is a ramp-loading plane with "beaver tail" rear doors for air dropping freight.



LEGEND: I/O = INPUT / OUTPUT DT = DATA TERMINAL
480-L = USAF'S WORLD-WIDE COMMUNICATIONS NETWORK

USAF to Get Automatic Data Acquisition Net

ROME AIR DEVELOPMENT CENTER, N. Y.—Plans to automate the system that acquires information from USAF's far-flung command headquarters and transmits it to USAF's command post in the Pentagon got the go-ahead last week from the Air Council—a group made up of chiefs of staff from the various Air Force commands.

Next step comes early in May when the Defense Department will be briefed on the system and asked for formal approval to invite industry to bid on procurement contracts.

Designated the 473-L, USAF's Command and Control system will automatically provide the Air Force high command in the Pentagon with immediate information on Air Force resources.

Instant data on personnel, supplies, status of base facilities and other logistical information will facilitate effective management of the Air Force deterrent strength, according to Major Allen A. Masters. He is lead system engineer for the 473-L at this center, where the system concept was developed.

Data sources for the system include 15 command headquarters in the U. S. and overseas (only three are represented in the block diagram above). Input at many of the headquarters will come directly from computers.

From the Strategic Air Command, for example, input to the 473-L system comes from computers in the underground combat control system center (465-L) at Offutt AFB, Neb. (ELECTRONICS, p 36, Mar. 25, 1960).

Data are fed directly from the SAC computer to a 473-L input/output device. Output from the I/O is translated in the data terminal to the word format for transmission over USAF's world-wide communications network (480-L) to the Pentagon.

Received by the Pentagon's data terminal, the input is translated into the format of the receiving station, then passed on to the input/output device, to data processing and on to display (see block diagram above).

Going from one data processing system center to another has required careful interfacing of the two systems, ELECTRONICS learned from Ernest N. Storrs, technical director of operations for RADC.

For data sources without elaborate systems like SAC's 465-L, message composers will convert messages into machine language and transmit it directly to the 473-L computer in the Pentagon.

Industry's participation in the program to date consists of R&D contract work done by IBM for analysis of equipment performance, human engineering, methods and procedures and reliability of the system. A $400,000 continuation contract to IBM was announced last week.

Contracts for procurement of hardware—to be awarded over the next six months—will reach close to $20 million. USAF, which will act as weapon system manager, will buy gear and services associated with the subsystems shown above; input/output devices, data terminals, data processing, display, programming and systems integrator.

Though actual transmission from data source to the Pentagon will utilize the already-existing 480-L communications system, 480-L will probably have to be beefed up to handle the new traffic.

Contracts, to be awarded by the Electronics Systems Division, Hanscom AFB, Mass., will specify off-the-shelf hardware, or at least already-developed gear that has been successfully manufactured.

Argentina Forms New Radio/Tv Agency

BUENOS AIRES—Details on Argentina's recently formed National Radio and Television Commission show promise of more attention to spectrum use in this country.

Among the Commission's prime tasks will be: draw up basic regulations on its own operation for presidential approval; supervise radio and tv channel allocations; formulate supervisory regulations for radio and tv broadcasting.

Chairman of the new Commission will be a representative of the president. Other members will include the Director General of Radio Broadcasting Activities, the Supervisor of Commercial Radio and Tv Broadcasting.

TEAMWORK IN PLANNING: Hallicrafters "BLUE STREAK" Teams support military programming groups for SAC aircraft at OCAMA and other materiel commands.

TEAMWORK IN INSTALLATION: Advanced ECM equipments are installed by "BLUE STREAK"-SAC teams with a minimum of down time. Maintenance and operational training is speeded up, too.

Every breakthrough in military electronic equipment design creates new, complex and urgent problems in installation, modification, testing, maintenance and personnel training. Hallicrafters radical new "Blue Streak" project—utilizing quick-reaction techniques—*offers experienced Hallicrafters support teams to assist key military personnel* . . . pinpoints problems in advance . . . solves them on the spot with new levels of speed and economy.

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TEAMWORK IN MAINTENANCE: Hallicrafters mobile test vans and in-house repair of black boxes sets new standards in speed and reliability.

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CIRCLE 25 ON READER SERVICE CARD

Space Radio Needs Being Probed

SPACE COMMUNICATIONS frequency allocations problems will come in for additional consideration this Spring.

Attempts to decide on frequencies for communication between earth and orbiting satellites are being made against a background of conflicting opinions. Virtually all major nations are interested in seeing satellite communications systems in operation, but a number of areas of disagreement remain to be resolved.

Among these are:

- Lack of international agreement on frequencies
- Lack of internal agreement within nations by present spectrum users
- Differences of technical opinion on most suitable frequencies

Manufacturers are watching the situation to see how the outcome will affect their markets.

At the international level, the subject of frequencies for earth/satellite communications systems was raised in 1959 by the International Telecommunications Union at the Administrative Radio Conference in Geneva. About the only concrete result was allocation of a few research-only slots between 1,000 and 10,000 Mc.

Adding to the Geneva complications was East-West disagreement. Soviet and Czech authorities said there was inadequate technical data to justify any allocations above 200 Mc. French-British-U. S. stand was that a number of allocations should be made throughout the spectrum for earth/satellite use. The one point of agreement was that further consideration of earth/satellite communications should be given when the group meets again in 1963.

In response to inquiries by the Office of Civil and Defense Mobilization over a dozen federal entities have already commented and indicated their estimated frequency requirements. The total indicated need would come to more than twice the amount of spectrum space between 1,000 and 10,000 Mc that is likely to be available to government users.

Among those commenting were Department of Defense, NASA, Atomic Energy Commission, Departments of Labor, Treasury and Post Office, National Academy of Science, U.S. Information Agency.

Nongovernment parties interested in earth/satellite communications have been working primarily through the Federal Communications Commission to make their views known. Comment falls into two categories: views on how best to establish a satellite communications system and views expressing caution against attempts to share frequencies among point-to-point microwave installations and earth/satellite systems. Some commentators feel that the best frequencies for earth/satellite systems include some now being used by common carriers and private link system operators.

Despite conflicting views, the Commission is seeking to gather opinions on the subject. Among its latest action has been a request for comment on the following:

"Under what conditions can frequency bands for space communications be shared with other services, (a) passive relays, (b) active relays, (c) space systems and functions?

Thus far, no comment on the re-

Studies Jet Stream

Air force shares tv tower with stations WFAA and KRLD, Cedar Hill, Tex., calls it tallest weather research structure. It has 12 platforms for instruments plies has been announced by FCC.

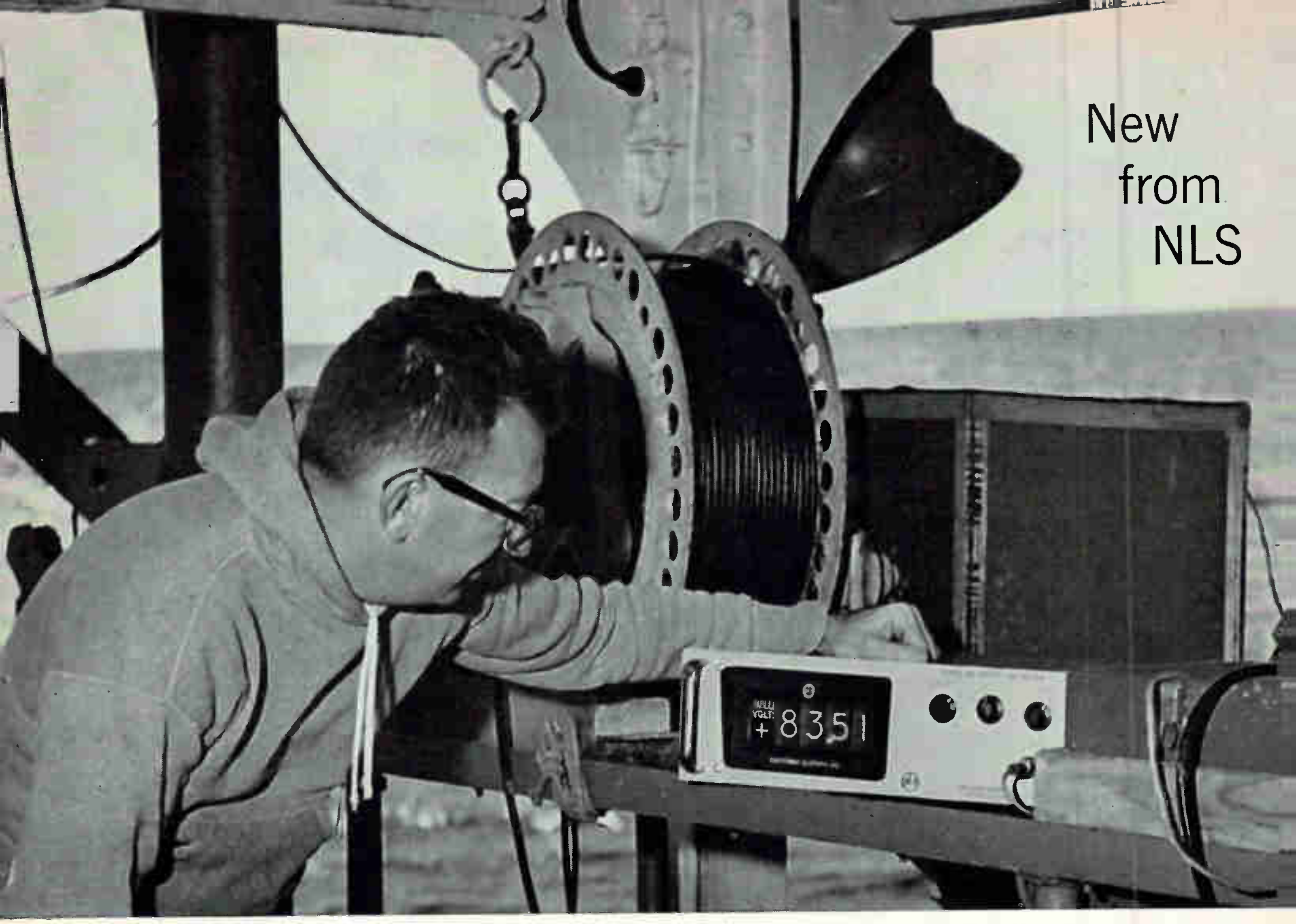
Proposals for satellite communications systems have been made by a number of companies. AT&T plans involve up to 50 satellites at altitudes of 2,000 to 8,000 miles. Frequencies mentioned are in the 6,325 to 6,425-Mc region for satellite-to-ground transmissions and 4,100 to 4,200 Mc for the return trip. Radio Corp. of America has disclosed plans for a three-satellite system using frequencies in the 800-10,000-Mc region at altitudes of 22,000 miles. General Electric spokesmen have mentioned a ten-satellite system at 6,000 miles altitude, but have not specified any frequencies. Hughes Aircraft recommends limited use of frequencies below 500 Mc as well as frequencies in the 2,000-Mc region for satellite to ground, 475 Mc for ground to satellite. Aeronautical Radio, Inc. has mentioned frequencies in the 1,535 to 1,660-Mc region.

National Aeronautics and Space Administration, presently working to orbit its communication satellite, project Relay, plans on 2,200-2,300 Mc and 3,800-4,200 Mc for satellite to ground, and 500 Mc and 5,925-6,425 Mc for ground-to-satellite transmission.

Under discussion is the question of whether the communications system, once established, should be operated by the government or by private interests. AT&T has already made known its willingness to operate the system. Other companies including Radio Corp. of America, Lockheed Aircraft and General Telephone and Electronics, which have teamed together, are on record against one-company operation.

Radioisotope Pills For Family Physicians

RADIOISOTOPES will be used in pill form by the future family physician for routine and scientifically accurate diagnosis, says Willard F. Libbey of UCLA. Atomic power, he says, can supply enough energy to allow the world's population to increase at its present rate for another 500 years. Isotopes will provide more effective fertilizer, new plant strains, and improved pest control for agriculture.



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Here is a new, faster, more precise way to make low-level DC voltage measurements. The NLS V60 full 4-digit millivoltmeter makes 80 measurements per minute, average. It features ±0.01% precision (ability to repeat readings within close limits) — unattainable from pointer meters, strip chart recorders or combination of a digital voltmeter and preamplifier. Accuracy of the V60 is ±0.1% of reading or ±10 microvolts, whichever quantity is greater.

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CIRCLE 28 ON READER SERVICE CARD

Combines Engineering Departments

CREATION of an engineering division to replace all present engineering departments at Case Institute of Technology starting July 1 was recently announced by T. Keith Glennan, president.

Three reasons for the change were cited by Glennan:

First, the recognition that traditional departmental structure is no longer a valid foundation for building an engineering education program that prepares men for responsible positions in industry, government, and education.

Secondly, a flexible organization replaces a rigid one so as to swiftly anticipate engineering educational requirements.

Finally, the student can more easily satisfy varied interests.

GRADUATE students in the department of electrical engineering at the University of California have been doubling in number every four years since 1953. During this time, undergraduates have been doubling every ten years. These conclusions are based on a study by the department on trends in electrical engineering enrollment over the past 15 years.

ELECTRONIC INSTRUMENTATION is the name given an interdisciplinary teaching and research program by the electrical engineering and life science departments at the University of Arizona. Starting this fall and open only to life science grad students and senior premedicos, the program is intended to give a fuller understanding of possibilities and limitations of electronic equipment in medical electronics.

According to Stewart Becker, professor of electrical engineering, students will benefit by gaining confidence in setting up an instrumentation system for obtaining desired information in their research. Interdisciplinary cooperation in research is also a goal.

APPLICATION of digital and analog computers will be the subject of a course to be required of sophomores at the Lawrence Institute of Technology. Work will cover numerical analysis, programming, coding, and computer operation. The basic course will be preparatory to later applications in: differential equations in which course work will require the programming of one problem each in the areas of numerical approximation and series solutions; advanced mathematics for engineers, which now presents solutions by the method of least squares; engineering design; electrical and electronic theory; statistical analysis.

ENGINEERS, scientists, and management personnel, both line and staff, have enrolled in next week's Sixth Institute on Research and Development Administration sponsored by American University (Washington, D.C.).

The five-day program has been arranged especially for those engaged in some phase of supervision or administration of scientific research and development programs. No academic credit is given. Among topics to be discussed: determining budget shares for research and development; evaluation of research.

Weather Computer

Data unit made by Siegler Corp. computes weather information for distribution by phone, radio

MEETINGS AHEAD

Apr. 25-27: Relay Conference, NARM in cooperation with Oklahoma State Univ.; Student Union Bldg., Stillwater, Okla.

Apr. 26-28: Tech. Conf. & Trade Show, 7th Region; Westward Ho Hotel, Phoenix, Ariz.

Apr. 30-May 4: Electrochemical Society; Claypool Hotel, Indianapolis, Ind.

Apr. 30-May 4: Aero-Space Instrumentation Symposium, ISA; Adolphus Hotel, Dallas.

May 1-4: International Scientific Radio Union (URSI), IRE; Georgetown Univ., Wash., D. C.

May 2-4: Electronic Components Conf., PGCP of IRE, AIEE, EIA, WEMA; Jack Tar Hotel, San Francisco.

May 6-9: Symposium on Circuit Theory, 5th Midwest, PGCT of IRE; Univ. of Ill., Urbana, Ill.

May 7-11: Broadcast Engineering Conf., NAB; Washington, D. C.

May 7-12: Society of Motion Picture and Tv Engineers, Semi-annual; King Edward Hotel, Toronto, Ontario.

May 9-11: Western Joint Computer Conf., PGEC of IRE, AIEE, ACM; Ambassador Hotel, Los Angeles.

May 22-25: Electronic Parts Distributors Show, Electronic Industry Show Corp.; Conrad Hilton Hotel, Chicago.

Aug. 22-25: WESCON, L. A. & S. F Sections of IRE, WCEMA; Cow Palace, San Francisco.

Sept. 11-15: Instrument-Automation Conf. and Exhibit, ISA; Sports Arena, Los Angeles.

Oct. 9-11: National Electronics Conf., IRE, AIEE, EIA, SMPTE; Intl. Amphitheatre, Chicago.

Nov. 14-16: Northeast Research and Engineering Meeting, NEREM; Commonwealth Armory and Somerset Hotel, Boston.

Superior performance . . . greater reliability . . . extreme uniformity. . . . mil-quality! These are the dramatic design advantages you gain from Motorola Silicon Epitaxial Mesa transistors. Performance characteristics include: faster switching speeds, higher voltage breakdowns, reduced capacitance, increased power handling capabilities with reduced saturation resistance, and vastly improved VHF power gain performance. The result — outstanding switching and amplifying devices with a wide range of application potential.

For complete technical information on specific Motorola Silicon Epitaxial Mesa transistors, contact your Motorola district office, distributor, or write: Motorola Semiconductor Products Inc., Technical Information Department, 5005 East McDowell Road, Phoenix 10, Arizona.

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TYPE NO.	P_D mW	V_{CB} volts	V_{EB} volts	I_C mA	h_{FE} (typ) @I_C = 10 mA	f_T mc
2N706	300	25	3	200	40	450
2N706A	300	25	5	200	40	450
2N706B	300	25	5	200	40	450
2N707	300	56	4	200	12	450
2N707A	300	70	5	200	30	500
2N753	300	25	5	200	75	450
2N834	300	40	5	200	40	500
2N835	300	25	3	200	40	500

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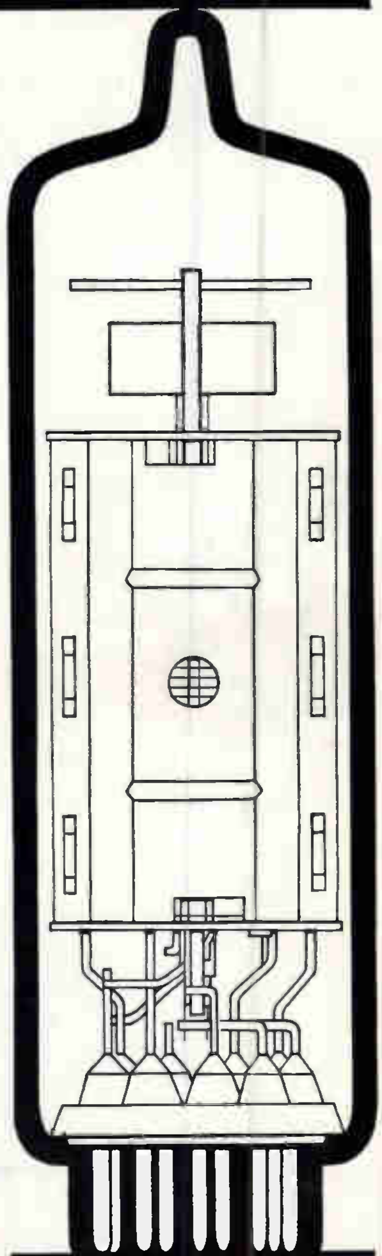
CIRCLE 31 ON READER SERVICE CARD

EL84 6BQ5

high slope output pentode



Output pentode rated for 12W anode dissipation, primarily intended for use in a.c. mains operated equipment.

characteristics

V_a	250	V
V_{g2}	250	V
I_a	48	mA
I_{g2}	5.5	mA
V_{g1}	–7.3	V
g_m	11.3	mA/V
r_a	38	kΩ
μ_{g1-g2}	19	

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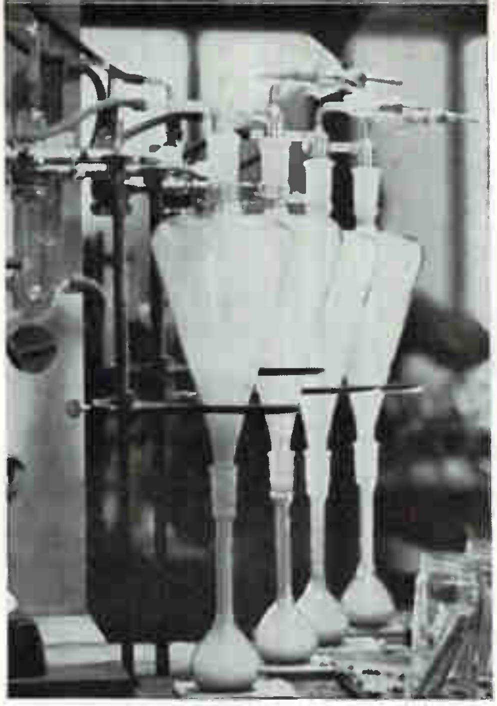


Westinghouse ULTRASONIC CLEANING saves $750 per month at research lab

In Lorillard's new and modern laboratory, quality control and basic research are continuous programs. For both activities, sparkling clean glassware is an obvious necessity.

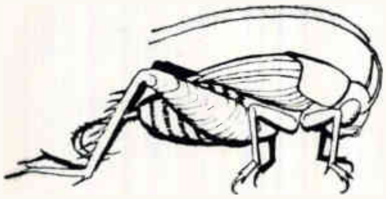
Keeping tar-stained glassware clean once took the full time of five men. Now the job is done by one man . . . operating one Westinghouse Ultrasonic cleaning system.

Benefits: Costs reduced about 80%, thousands of man-hours saved, faster cleaning—about 30 seconds per "load," reduced inventory and breakage, and of course, absolute cleaning.

The new system, installed in February, 1960, paid for itself in savings in the first few months of operation. Capital equipment cost: $2,600.

Ask the Westinghouse Industrial Electronics Department, 2519 Wilkens Ave., Baltimore 3, Maryland, for information on how Ultrasonics can solve your cleaning problem. You can be sure . . . if it's **Westinghouse**

J-35021

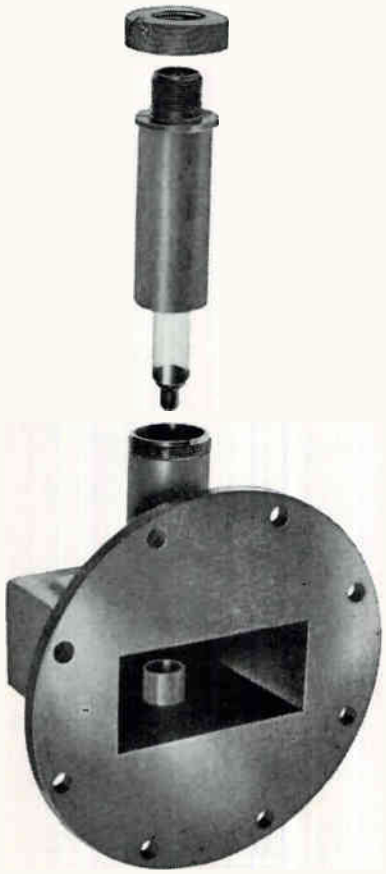


Acoustical noise: 85 db. at 6 inch distance

For noise at microwave frequencies, too, there's an ideal device in a small package. It's the Litton L-2000 series of miniature gas discharge noise sources. Use them for automatic monitoring of the performance and sensitivity of modern radar systems. They're available to cover the most-used frequency bands and come in a variety of mount configurations.

The series features a shielded cathode, low modulator drain, and field-replaceable tube insert. Rugged. Insensitive to a wide range of ambient temperatures. Compactly engineered for demanding air and ground environments. Economical because of replaceability, plus added advantages of logistic simplicity and ease of maintenance.

BIG NOISE FROM A SMALL SOURCE



The tube pictured here is the single-ended L-2000 with the LR-2000 insert, specified for a recent generation of FAA airport surveillance radars and for a variety of well-known "S-band" military systems.

For more data on these or other precision gas tube products, write Litton Industries, Electron Tube Division, 960 Industrial Road, San Carlos, California. Or telephone LYtell 1-8411.

GAS NOISE TUBES

Type Number	Frequency Range (megacycles)	Excess Noise Ratio (db)	Nominal Operating Current (ma)	Nominal Operating Voltage (volts)	RF Coupling
L-2008	200-250	18.5 ± 0.5	25	200	¾" coax*
L-2013	570-630	18.5 ± 0.5	25	200	¾" coax*
L-2006	1200-1400	18.5 ± 0.5	50	175	¾" coax**
L-2000(R)	2700-2900	18.5 ± 0.2	75	30	RG-48/U WG*
L-2018(R)	2700-2900	15.5 ± 0.2	75	35	RG-48/U WG*
L-2011(R)	3300-3700	18.4 ± 0.2	150	30	RG-48/U WG*
L-2009(R)	3400-3700	15.5 ± 0.5	125	20	RG-48/U WG*
L-2007	2000-4000	18.5 ± 0.5	85	135	¾" coax**
L-2010	2000-4000	15.0 ± 0.5	40	60	¾" coax**
L-2001(R)	5400-5900	13.0 ± 0.5	100	55	RG-49/U WG**
L-2002(R)	7500-8600	14.5 ± 0.5	100	40	RG-51/U WG**
L-2003(R)	8500-9600	14.5 ± 0.5	100	45	RG-52/U WG**
L-2004(R)	8500-9600	18.5 ± 0.5	100	45	RG-52/U WG*
L-2017(R)	8970-9190	18.5 ± 0.5	100	45	RG-52/U WG*
L-2005	16000-17000	18.5 ± 0.5	55	55	RG-91/U WG*

(R) denotes replaceable gas tube insert
*single ended mount
**double ended mount

LITTON INDUSTRIES
Electron Tube Division
MICROWAVE TUBES AND DISPLAY DEVICES

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BIG NEWS FOR USERS OF INSTRUMENT LATHES

LEVIN® LATHES

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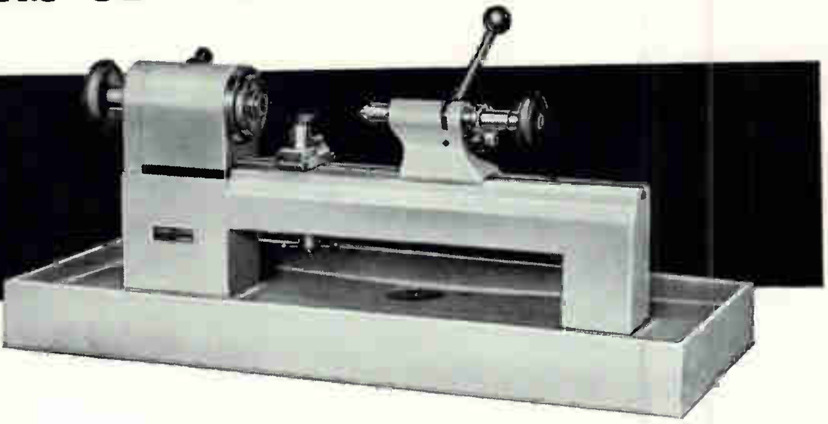
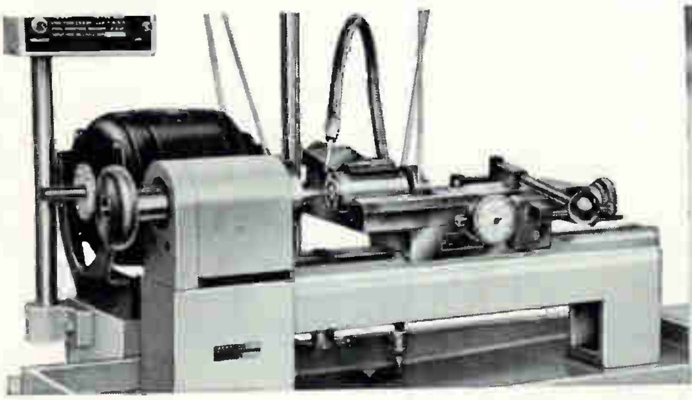


We present the latest in the series of Levin Instrument Lathes, a new model with a half inch collet capacity but with the same sensitivity and precision for which Levin Lathes are so well known.



Here is a typical example of work which can be done in the new Levin ½" capacity lathe. A hole .002" in diameter is being drilled in a nozzle.

Send for literature describing the ½" capacity instrument lathe and accessories.

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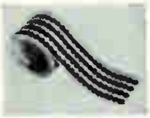

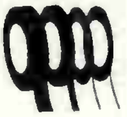

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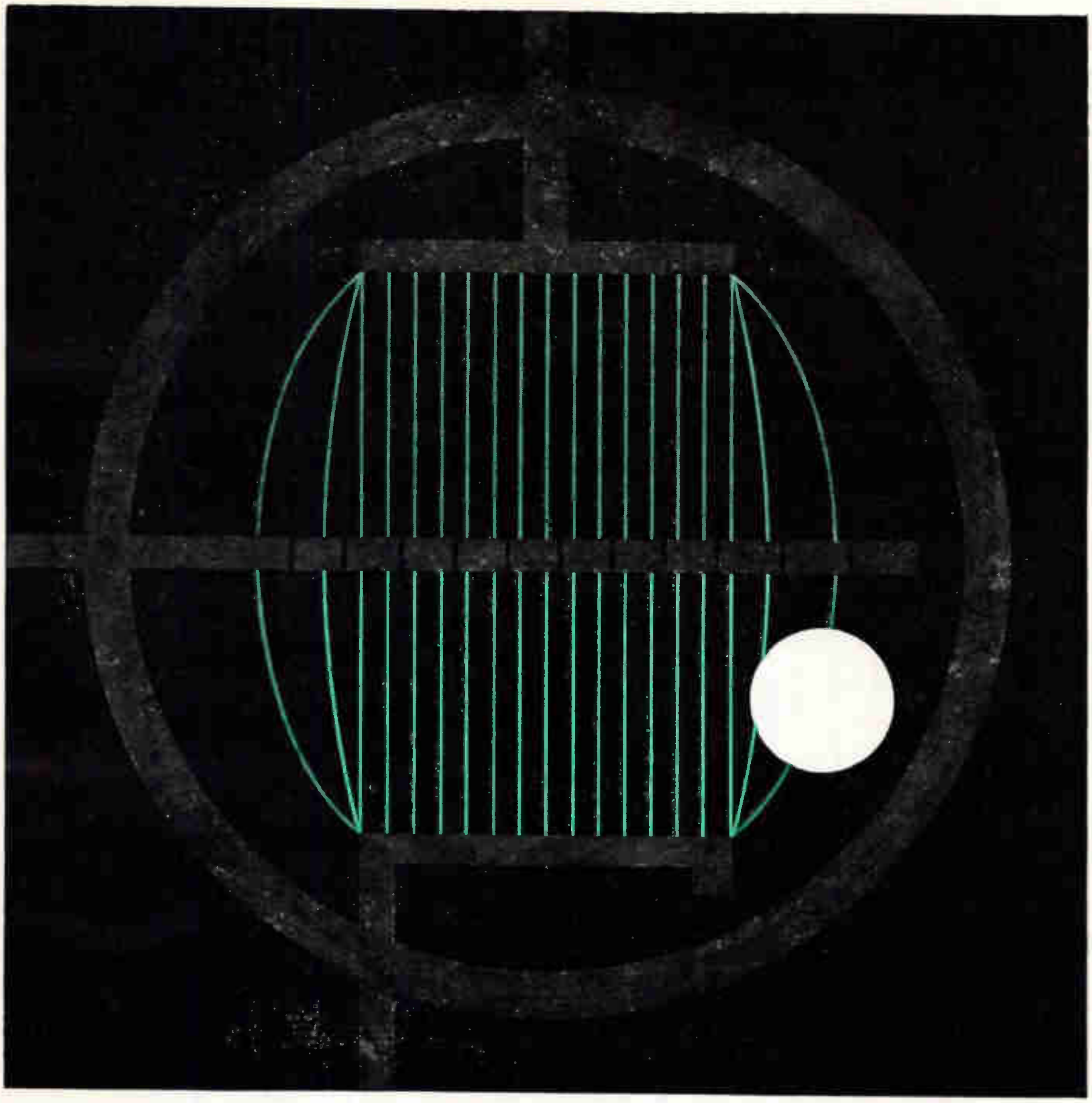
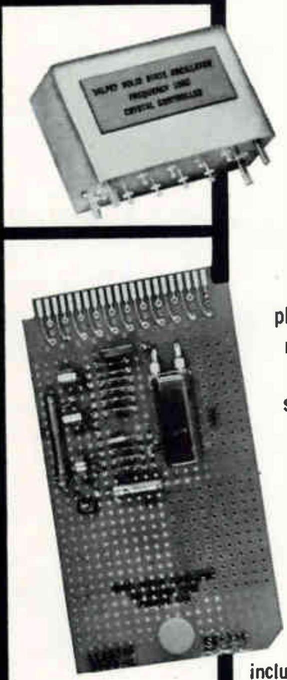


VALPEY *crystal controlled* PACKAGED OSCILLATORS

a stable solid state source for systems



Temperature controlled packaged oscillators, either sealed units or plug-in printed circuit modules, offer the reliability and stability of quartz crystal control over a frequency spectrum of 60 cps to 20 MC. Stabilities from 0.1% to 0.001% are standard, custom designed units stable to 5 parts in 10^8 are available as complete packages. Features include: small size, temperature range from −65°C to 125°C, ruggedized units to meet severe environmental conditions. Outputs available include: standardized pulse, square wave or stable sine-wave — working into load impedances from 50 ohms and up depending on frequency range. The Valpey engineering staff will be pleased to submit quotations according to your specifications for packaged oscillator applications including pulsed or gated circuits, frequency sources and standards, time bases or other advanced circuitry needs. Specification sheets on request.

VALPEY QUARTZ CRYSTALS

Crystals in all frequency ranges can be manufactured or developed to meet long term stability and other special requirements. Miniature and subminiature frequency control crystals for commercial or military applications are available to 125 MC. High frequency crystals for lattice type and single signal filters are available in frequency range from 1500 KC to 23,000 MC.

Ruggedized Low Frequency Oscillator and Filter Crystals compactly designed for applications where space is important and environmental conditions severe. Frequency range 5 KC to 350 KC.

PC-1

For complete information on Valpey Crystals request catalog

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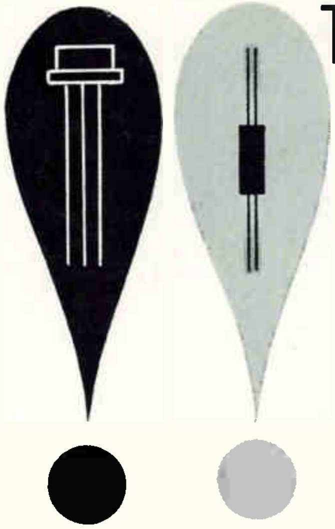

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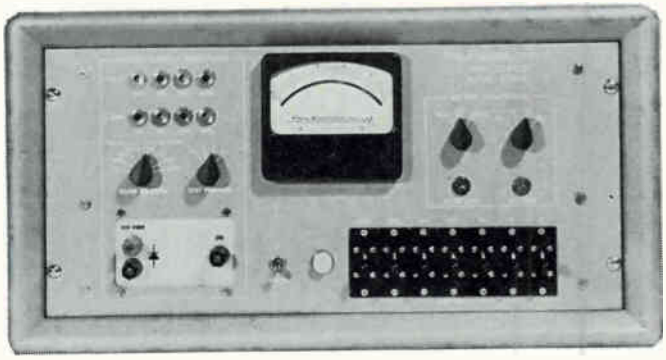

For quantity testing by unskilled operators . . . For precision laboratory use in analyzing Germanium and Silicon semiconductor devices. These Trans Electronics Transistor and Diode Testers provide keyboard metering, with mirror-back (1%) meters. Types available include: Voltage-regulated models providing 6 current ranges between 10 and 3000 milliamps, two voltage ranges of 0-1000 millivolts and 0-3000 millivolts. Remote load sensing is provided with voltage-regulated models. Testers are available in Forward-Current, and Reverse-Current, Saturation-Voltage (E_s-I_b) types. Two classes of Forward Testers provide ranges of 0-3 amps, and 0-3 volts. Other Forward Testers up to 50 amps, custom-built. Two classes of Back Testers provide ranges of 0-1000 volts, and 0-3000 volts, each with 1 milliamp current capability. Meter ranges are 3 milli-microamps to 1 milliamp.

Trans Electronics offers other custom diode and transistor equipment

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NEW BELL LABORATORIES RESEARCH FORESHADOWS COMMUNICATIONS AT OPTICAL FREQUENCIES

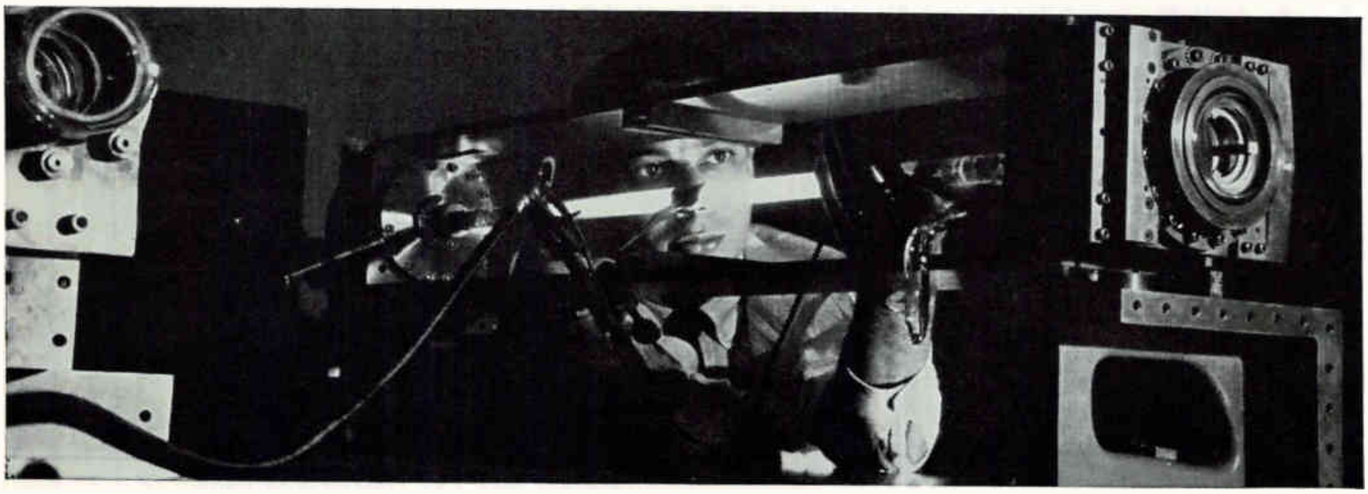
A revolutionary new device, the continuously operating Optical Gas Maser, now under investigation at Bell Telephone Laboratories, foreshadows a whole new medium for communications: light.

Light waves vibrate at frequencies tens of millions of times higher than broadcast radio waves. Because of these high frequencies, a beam of light has exciting potentialities for handling enormous amounts of information.

Now for the first time, Bell Laboratories' new Optical Gas Maser continuously generates light waves that are "coherent." That is, the light waves move in phase as seen looking across the beam.

With further research, it is expected that such beams can be made to carry large amounts of information. The beams can be transmitted through long pipes. They can be projected very precisely through space, and might be used for communications between space vehicles.

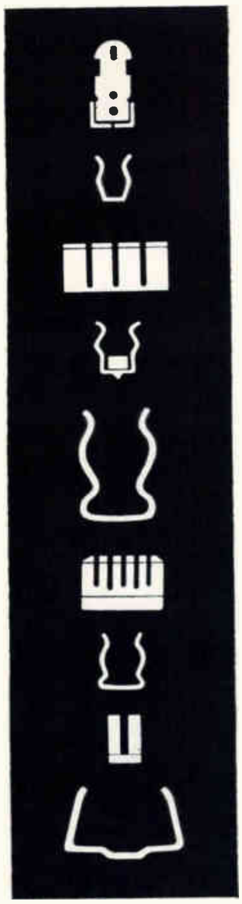
Research with coherent light is another example of how Bell Laboratories prepares ahead for communications needs.



The Optical Gas Maser (above) was first demonstrated at Bell Telephone Laboratories. Heart of unit is a 40-inch tube containing helium and neon. Interaction between gas atoms produces a continuous, coherent beam of infrared light that may one day be used in communications.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT



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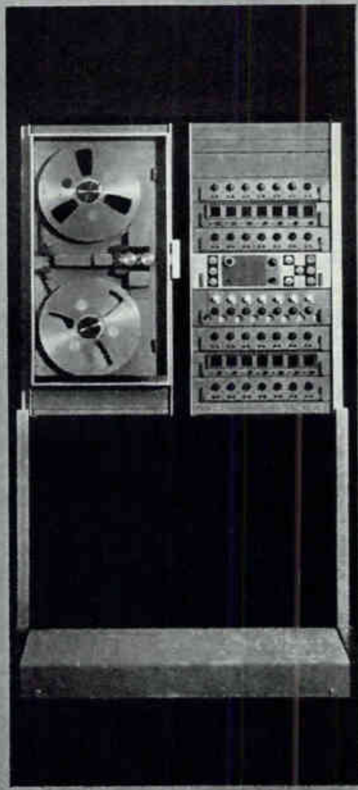

New equipment without capital outlay ...from Ampex

Ampex data recorders on the newly announced lease program can help you in two ways. Leasing lets you pay for the use of your data recorder only as you need it.

Through installment purchases, you are investing in your Ampex data recorder while it works for you.

Either way, pressure on your working capital is reduced to the minimum. Complete program details and equipment specifications from:

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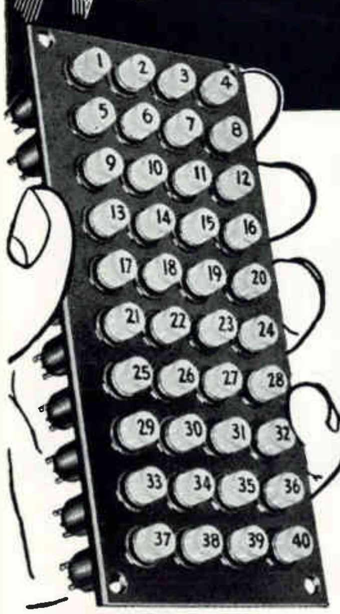
NOW.. MULTIPLE INDICATORS in a compact "package"—



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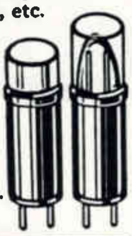

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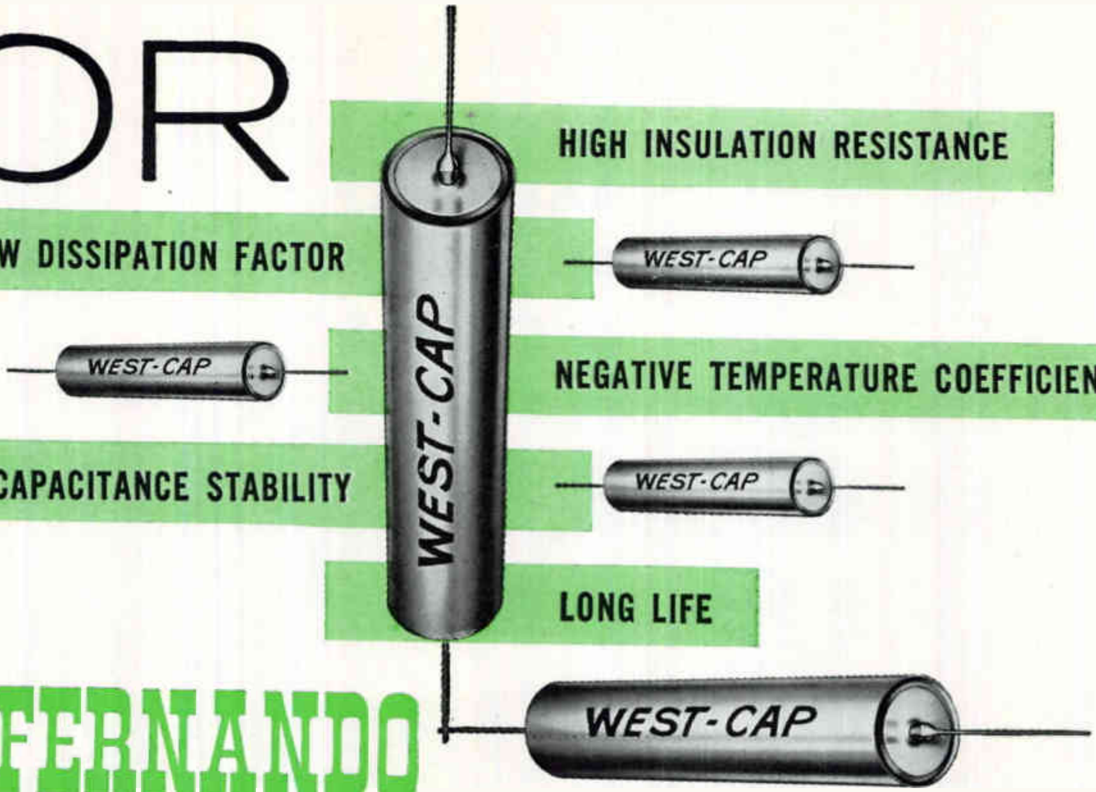

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West-Cap Capacitors are available in a wide range of capacities—in glass-to-metal, hermetically sealed, tubular and bathtub types, made to MIL Specs such as MIL-C-19978 (Ships) and MIL-C-26086/3 (USAF). Natvar Styroflex is used as the dielectric.

Styroflex® Film

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

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Capacitance:	0 to 1200 microfarads in 7 ranges.	SWITCHES:	All switches use silver alloy contacts to insure the highest accuracy.
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Accuracy:	±(0.3% + 1 dial division)		
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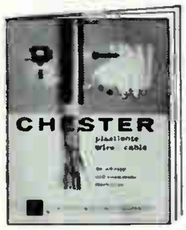

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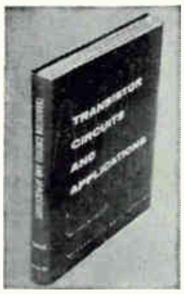

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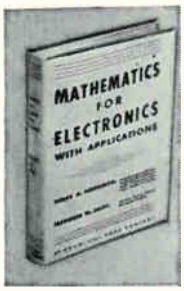

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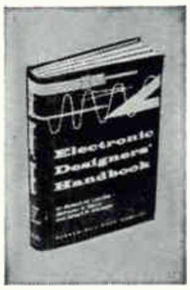

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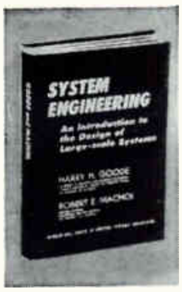

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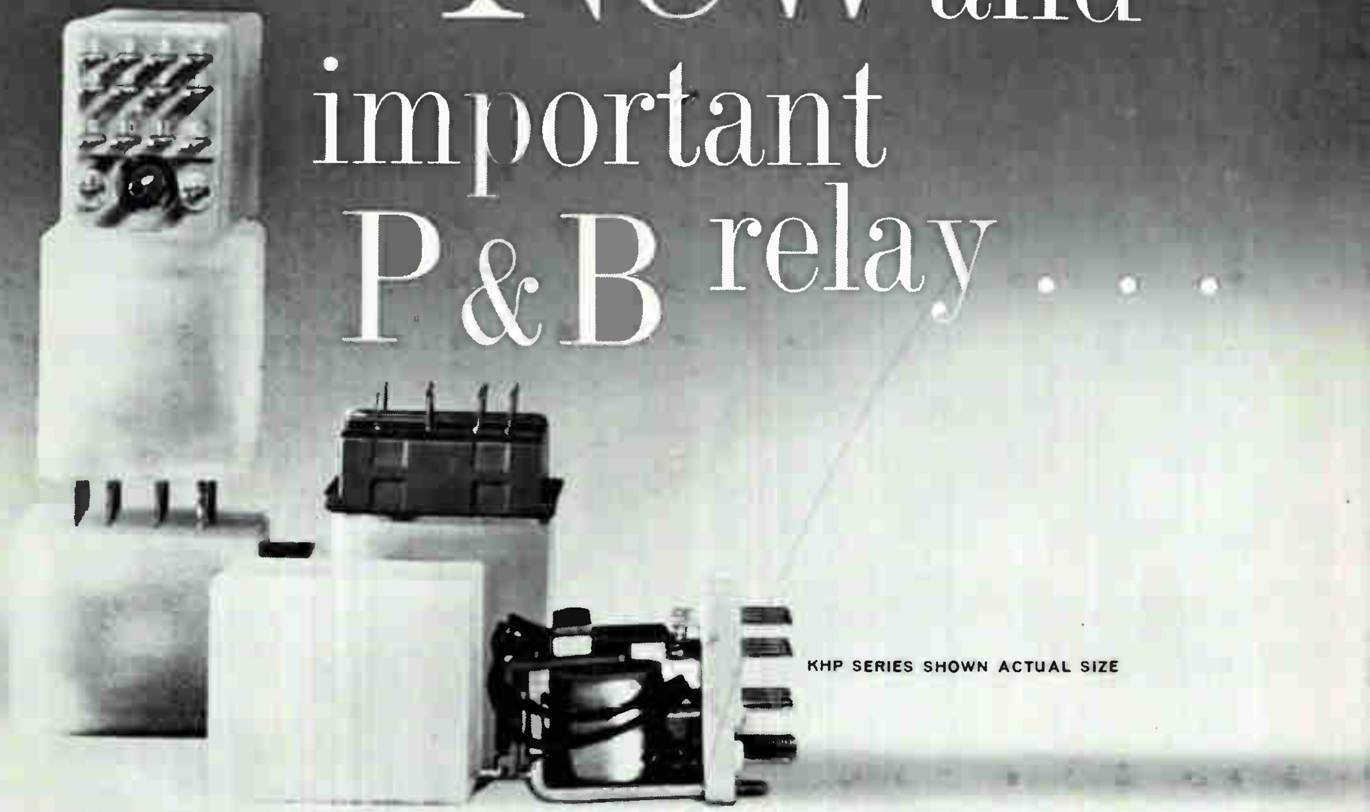

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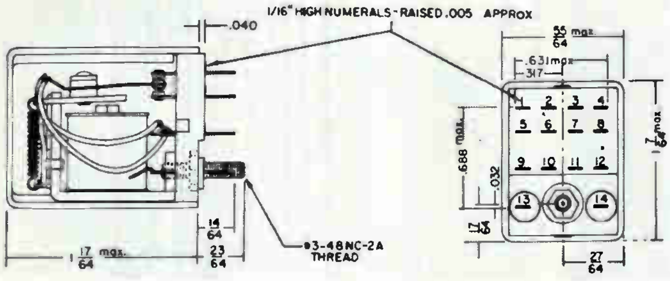

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CONTACTS:
Arrangement: 4 Form C, 2 Form Z.

Material: 3/32" dia. Silver standard. Silver cadmium oxide and gold alloy available.

Rating: 3 amps @ 30 volts DC or 115 volts AC resistive for 100,000 operations.

COILS:
Resistance: 11,000 ohms max.

Temperature: Operating Ambient: —45°C. to +70°C.

Power: 0.5 watts min operate @ 25°C. 0.9 watts nom. @ 25°C. 2.0 watts max. @ 25°C.

TIMING VALUES:

Nominal Voltage @ 25°C.	Max. Values
Pull-in time	15 ms
Drop-out time	5 ms

INSULATION RESISTANCE: 1500 megohms min.

DIELECTRIC STRENGTH:
500 Volts RMS 60 cycles between contacts.
1000 Volts RMS 60 cycles between other elements.

MECH. LIFE: In excess of 100 million cycles.

SOCKET: Solder lug or printed circuit terminals. Available as accessory.

DUST COVER: Standard.

TERMINALS: Solder lug and taper tab.

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of comparable size 8 gearheads

*Will sustain 20 in-oz torque load for 1,000 hours operation and 100 in-oz momentary overload at the maximum ratios.

CPPC one-piece gearhead housing eliminates separate gear plates and fastening posts, improves and maintains accuracy through exact alignment of gear clusters, assures smoother operation and more expedient inspection and servicing.

Gearhead and motor are selectable, individual parts enclosed in the same common motor housing.

Clifton Precision, pioneers in postless gearhead construction, introduces the finest in gearhead design—cage-type, one-piece gearhead housing machined from a single block of metal. In these units, exact duplication of gear centers is accomplished through simultaneous boring of permanently integrated bearing plates (patent pending). Positive and permanent alignment of gear clusters composed of AGMA precision Classes II and III hardened-steel gears integral with shafts journaled at both ends in ABEC class 5 bearings, minimize deflection and backlash, maximize torque load capacity, insure smoother operation and continued reliability of performance beyond normal endurance life requirements. Cage-type construction facilitates inspection and lubrication while gearhead is mounted simply by removing motor.

CPPC motors will stand greater heat than ever before due to the use of new materials. See box at lower right.

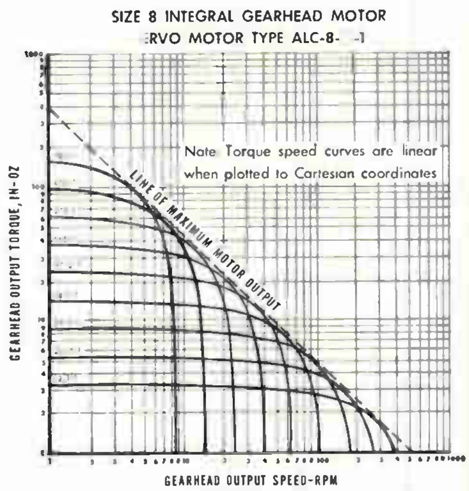
Write for our free pamphlet which gives detailed specifications of our entire gearhead motor and motor-tachometer line, sizes 8, 10 and 11.

STANDARD TYPES

RATIOS Size 8	Size 10	No. of Clusters	Dir. of Rotation
12.09	19.98	2 (3 pass)	reverse
20.63	32.19	3 (4 pass)	direct
34.26	58.28	3 (4 pass)	direct
58.44	93.89	4 (5 pass)	reverse
97.07	169.97	4 (5 pass)	reverse
165.58	273.84	5 (6 pass)	direct
275.02	495.74	5 (6 pass)	direct
469.15	798.70	6 (7 pass)	reverse
779.22	1445.92	6 (7 pass)	reverse

Notes: 1. Any ratio (±3%) is available within the limits of the ratio range at additional cost and may require longer delivery time. 2. Max. backlash = 30 minutes at 2 in-oz reverse gauge load in above units. Inquire if special tolerance is required.

PERFORMANCE CHARACTERISTICS



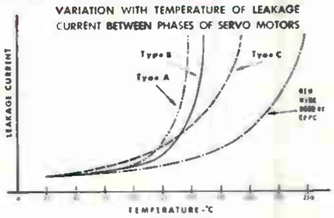
MOTORS

The following CPPC standard motors, electrical characteristics of which can be found in the current CPPC Rotary Components catalog, are offered with our gearheads:

SIZE 8		SIZE 10	
ACH-8-□-1	AMH-8-□-3	ACH-10-□-1	ALH-10-□-1
ACH-8-□-4	ALC-8-□-1	ACH-10-□-4	ALH-10-□-5
AMH-8-□-1	ALC-8-□-4		

CURRENT LEAKAGE

Superiority of insulation in CPPC motors is illustrated by actual comparative curves shown at the right.



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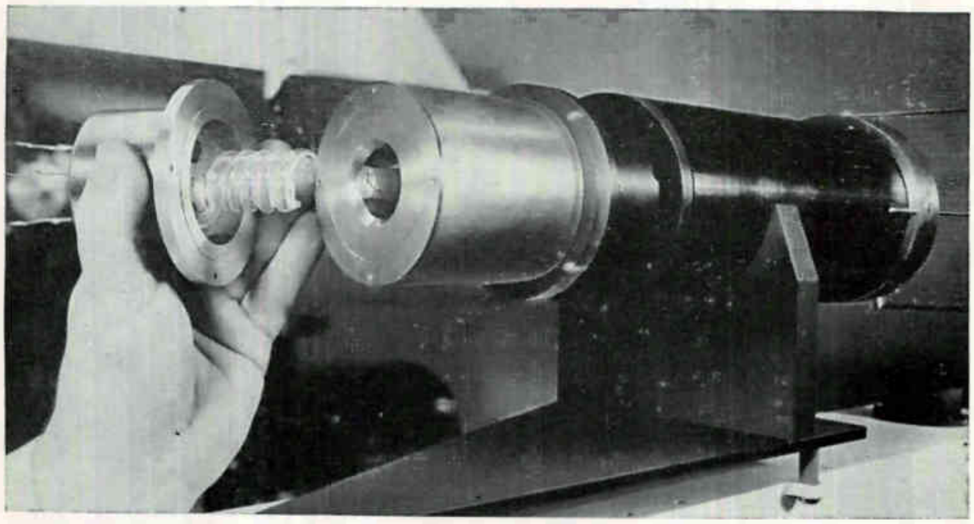
Optical Ranging System Uses Laser Transmitter



View of coherent light transmitter shows flash tube and ruby

Coherent light beam derived from ruby maser provides ranging capability up to 2 or 3 miles. System transmits with an angular beamwidth of 1 minute of arc

By M. L. STITCH, E. J. WOODBURY and J. H. MORSE,
Hughes Aircraft Co., Culver City, Calif.

THE OPTICAL MASER, or laser as it is sometimes called, possesses unique advantages when applied to radar ranging. Compared to microwave radar, it provides higher collimation or directivity, which makes possible high angular resolution. The system transmits with an angular beamwidth of approximately 1 minute of arc. Compared to pulsed-arc light radar, advantages are greater brightness, monochromatic emission that permits the use of optical bandpass filters in the receiver circuit to discriminate between signal and sunlight noise (and thus makes possible long-distance ranging in daylight), and freedom from arc wandering or walking.

Typically the laser source is 10^6 times the integrated brightness of the sun. The degree of monochromaticity of the laser emission is expressed in spectral brightness, which is brightness per unit wavelength. For the laser this is typically 10^{12} times the spectral brightness of the sun.

The system uses these properties of the laser's coherent light transmission and is called Colidar, an acronym from coherent light detecting and ranging. It is analogous to classical pulsed radar ranging; the delay between a signal and its echo is measured to determine range.

There are however, some differences in technology between Colidar and other active ranging schemes. In radar the microwave tube emits power as soon as voltage is applied, so that the envelope of the microwave carrier is determined by and is similar to the pulse shape of the supply voltage modulator. Jitter of the microwave tube is sufficiently low that the modulator pulse is used to trigger the tuning circuits. Pulsed arc radar behaves similarly, although the carrier is not monochromatic as is radar or Colidar, but rather wideband optical noise that must compete against sunlight noise during daylight hours.

The Colidar's laser transmitter is powered by a light source called an exciter or pump, typically a flash tube, instead of a supply-voltage

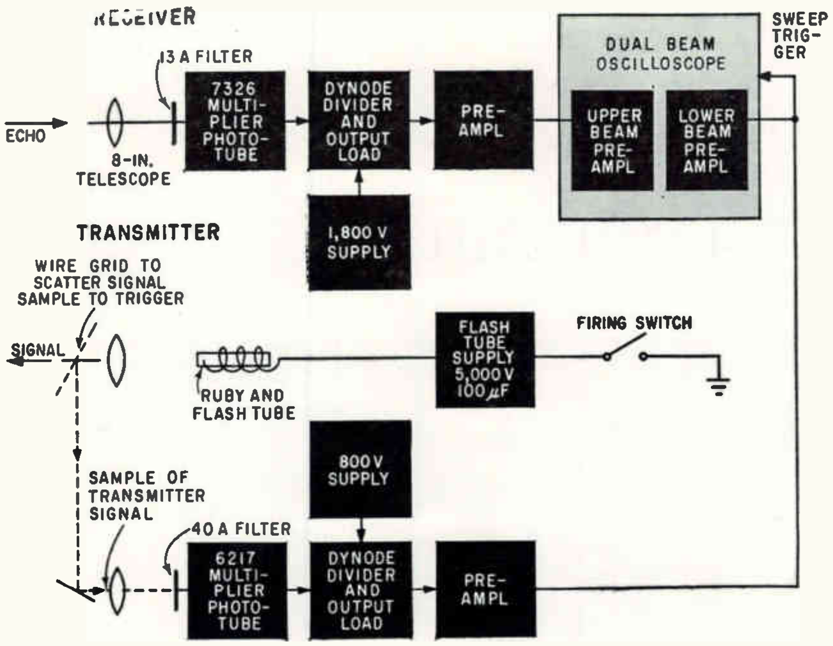


FIG. 1—Block diagram of basic laser ranging system

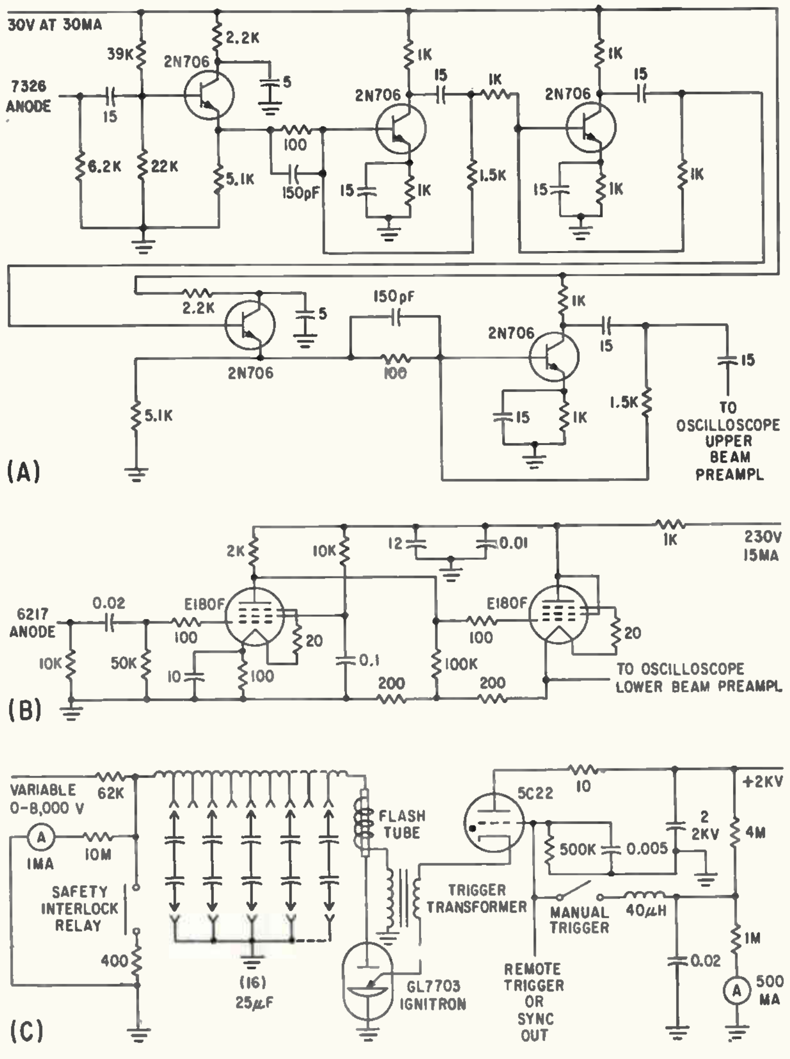


FIG. 2—Receiver preamplifier (A); trigger preamplifier (B); and flash tube power supply (C)

modulator. The relation between the laser emission envelope and the pulse shape of the exciter is complex and dependent on many factors, some of which are difficult to measure. In addition, there is jitter in the starting time from flash to flash. This has necessitated a monitoring circuit to trigger the timing circuit.

The typical output envelope of the laser is a short train of pulses, 10 Kw in power, 1 μsec or less per pulse and of several microseconds interval between pulses. Control of this pulse shape can be accomplished in several ways. One technique provides for reduction of the ruby temperature from room temperature in the present Colidar to sufficiently low temperature. This would result in a long pulse the length of the present pulse train, which could be modulated by a Kerr cell or other fast shutters. The change in pulse structure as a result of cooling was first reported by R. J. Collins of Bell Labs at an AIEE meeting in Los Angeles, 14 February 1961. Recent confirmation comes from D. Buddenhagen of Hughes Research Labs in a private communication.

In the first Hughes model, improvement in the pulse characteristics and lifetime of the flash-tube pump has been achieved by providing the pump output as a short high-energy pulse rather than a longer exponential decay output of much greater energy but lower average power per pulse, which has been in general use.

To understand why there has been improvement calls for a brief review of the principles of laser operation. The ruby absorbs optical radiation in the green region of the spectrum. If a sufficient quantity in watt-seconds of light is absorbed within a period shorter than a characteristic internal relaxation time, the ruby will become sufficiently excited to emit stimulated radiation. This characteristic period is of the order of a millisecond, and the required amount of absorbed light energy is called the threshold energy. If light flux is supplied at a higher rate so that the threshold energy is absorbed in a shorter time, the stimulated radiation begins sooner. This corresponds to higher power operation. Cutting off the light pulse will end the stimulated emission from the ruby.

Since it is desired to have few high-powered pulses, and it is desirable to turn off the pump flash as soon as possible after this has been achieved to conserve tube life, the present mode of driving is an improvement.

The simplest possible system was used for collecting and presenting the returned signals (Fig. 1). The returned signals are collected by an 8-in. telescope and, after being passed through a narrow (13 A) filter, are focused onto the cathode of a type 7326 multiplier phototube. A transistor preamplifier in the multiplier phototube housing amplifies the 7326 output by about 100. The resulting signal is then more than ample for presentation on an oscilloscope using a dual-beam preamplifier.

To start the oscilloscope sweep at the time of the transmitted light pulse, a second multiplier phototube, type 6217, receives a small sample of light from the transmitted light pulse by a wire scattering grid. The anode signal of the 6217 is amplified, inverted and used to trigger the oscilloscope sweep. The same signal is presented on the lower beam of the oscilloscope so that the pulse train can be compared directly with the received pulse to measure the time delay between transmission and reception.

The RCA type 7326 multiplier phototube was used in the receiver after a comparison of the characteristics of many types of phototubes showed it to have the greatest absolute sensitivity at the wavelength, 6943 A, of the laser output. Since the system uses a narrow interference filter in the optical system to exclude light at other than 6943 A, this choice was definitely indicated.

The 7326 has the best ratio of gain to dark current when it is operated at a total supply voltage of about 1,800 v, and although this system is not dark current limited when used in the daytime, a source of 1,800 volts was easily obtained and was used. Nighttime operation is spectacular but of less interest. The apparatus was constructed in such a way that the 7326 could be cooled to reduce the dark current. This would only be done if long nighttime ranges were desired or if such narrow optical filters could be obtained that sunlight noise would no longer be important in the daytime.

Use of a dual-beam preamplifier with an oscilloscope allows the output of the 7326 to be presented directly without further amplification. However, such operation is marginal and for best performance the use of a preamplifier at the phototube is desirable. This is particularly true if maximum range accuracy is desired. The rise time of the output pulse from the laser can be of the order of a few nanoseconds. Thus best use of the equipment requires elimination of long leads of high capacitance between the phototube and the oscilloscope.

To overcome this difficulty and to achieve an overall system rise time comparable to that of the oscilloscope, a transistorized preamplifier was built (Fig. 2A). Voltage gain is about 100, output impedance is about 200 ohms, and output dynamic range is about 1.5 volts for negative input signals when the cable that connects the unit to the oscilloscope is terminated with 220 ohms. This termination is desirable if the effect of reflections in the connecting line is to be eliminated. Rise time of amplifier ranges from 20 to 30 nanoseconds. Noise figure of the unit is not exceptional, the estimated value is about 14 db. However, this is much smaller than the size of the typical dark-current pulses and therefore is of no concern.

A preamplifier has also been included in the trigger multiplier output. This unit is a conventional vacuum-tube amplifier and cathode follower (Fig. 2B). Its purpose is somewhat different than that of the preamplifier used with the receiver, since the signal seen by the trigger phototube circuit is strong and there is no need for additional gain. However, there is need for a reasonably large signal, 10 to 20 v, to get trouble-free operation of the oscilloscope sweep trigger circuits. In addition, a sharp leading edge on the reference signal pulses is desirable for range measurements. The preamplifier allows both these objectives to be reached in a simple way.

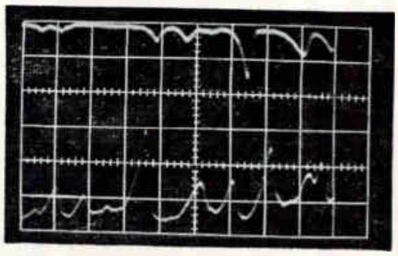


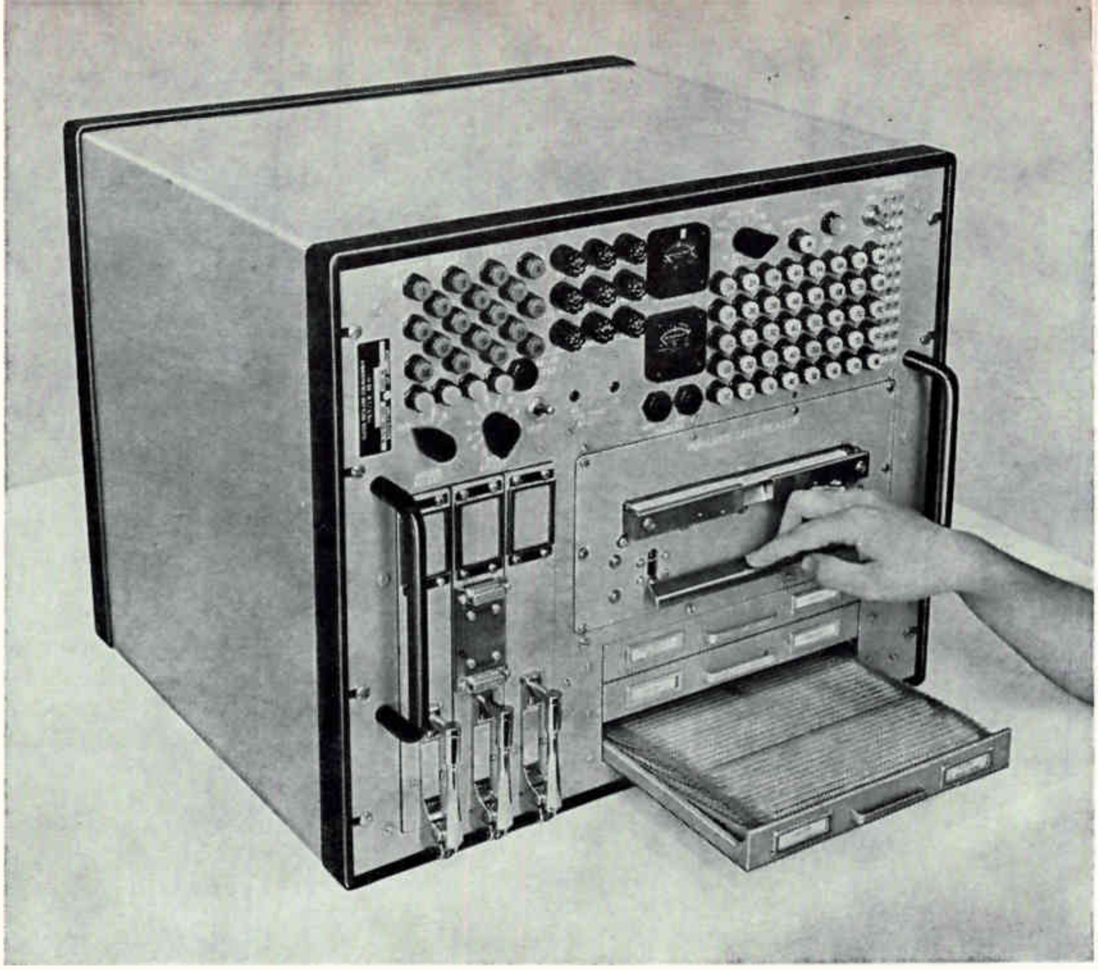
FIG. 3—Waveforms show transmitted pulse train at bottom and echo at top, with a scale of 2 μsec per cm

A variable pulse-forming network produces rectangular pulses of current through the flash tube (Fig. 2C). The coil is 160 turns of ⅛-in. square wire on a fiber glass form 36 in. long by 3 in. in diameter. Total inductance is 200 mh. There are sixteen 25-μf 400-volt capacitors connected to form eight sections of 12.5 μf at 8,000 volts. This gives a maximum energy storage of 3,200 watt-seconds. The coil is tapped at equal intervals to form eight sections of 25 μh each. The characteristic impedance of each section of the network and of the line is 1.4 ohms.

If the line is discharged through a load of this impedance, the voltage across the load will be rectangular pulse of one-half the charged voltage with a duration of 35 μsec per section. Thus the discharge through the flash tube will be rectangular pulses adjustable in eight 35-μsec steps up to 280 μsec in length and with an amplitude up to 4,000 volts. When the full length of the coil is not used, intermediate taps permit adding half-sections by connecting two capacitor sections in series (6.25 μf).

The line must be charged to twice the discharge voltage. As a result, the stand-off voltage of the flash tube is exceeded and normally it would self-flash before the line could be charged. To prevent this, an ignitron is used as a switch to discharge the network. A transformer in the ignitron ignitor lead provides an ionizing trigger for the flash tube.

Typical performance with the present crude breadboard is 2 or 3 miles for daylight operation against diffuse targets such as stucco walls or painted wood surfaces. Figure 3 shows a trace that brings out the relation between transmitted and reflected signal. A scale of 2 μsec per grid indicates a range of about half a mile.



Prepunched cards are kept in drawers at bottom of tester. Indicator lamp patterns and meter readings printed at bottom of cards are exposed during tests

PREPUNCHED CARDS TEST

Multipurpose testing unit can be used by relatively unskilled personnel, is

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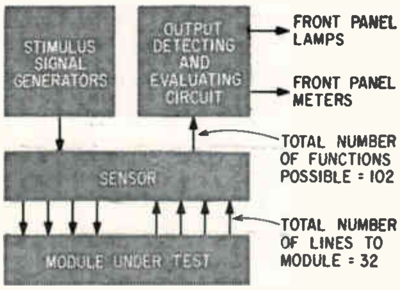


FIG. 1—Test signals are passed through sensor (prepunched card) to module under test. Module output signals are indicated by front panel lamps and meters

RETENTION of experienced electronic maintenance personnel is a serious problem facing the military services. Since the drain of such trained manpower into industry cannot be stopped in the foreseeable future, it is necessary to attack the problem from the test equipment end by using test systems which can perform tasks usually performed by highly-skilled technicians. Such equipments can automatically isolate faults and indicate the defective unit to a relatively low-skilled operator.

Present electronic weapons systems are so complex that they demand advanced test equipments which can quickly isolate faults without the intervention of an operator. The module analyzer covered in this article, performs dynamic go, no-go tests on all removable modules in Air Force data link systems, both airborne and ground. It is completely self-contained, and is programmed by punched cards.

The tester is similar in operation to a tube tester. After an suspected module is removed from the data link equipment, the technician connects it to the module analyzer, selects the program card and places the card in the switching device of the test set. The switching device senses the punched holes in the cards and allows the input signals, voltages, loads and output evaluating and detecting circuits to be

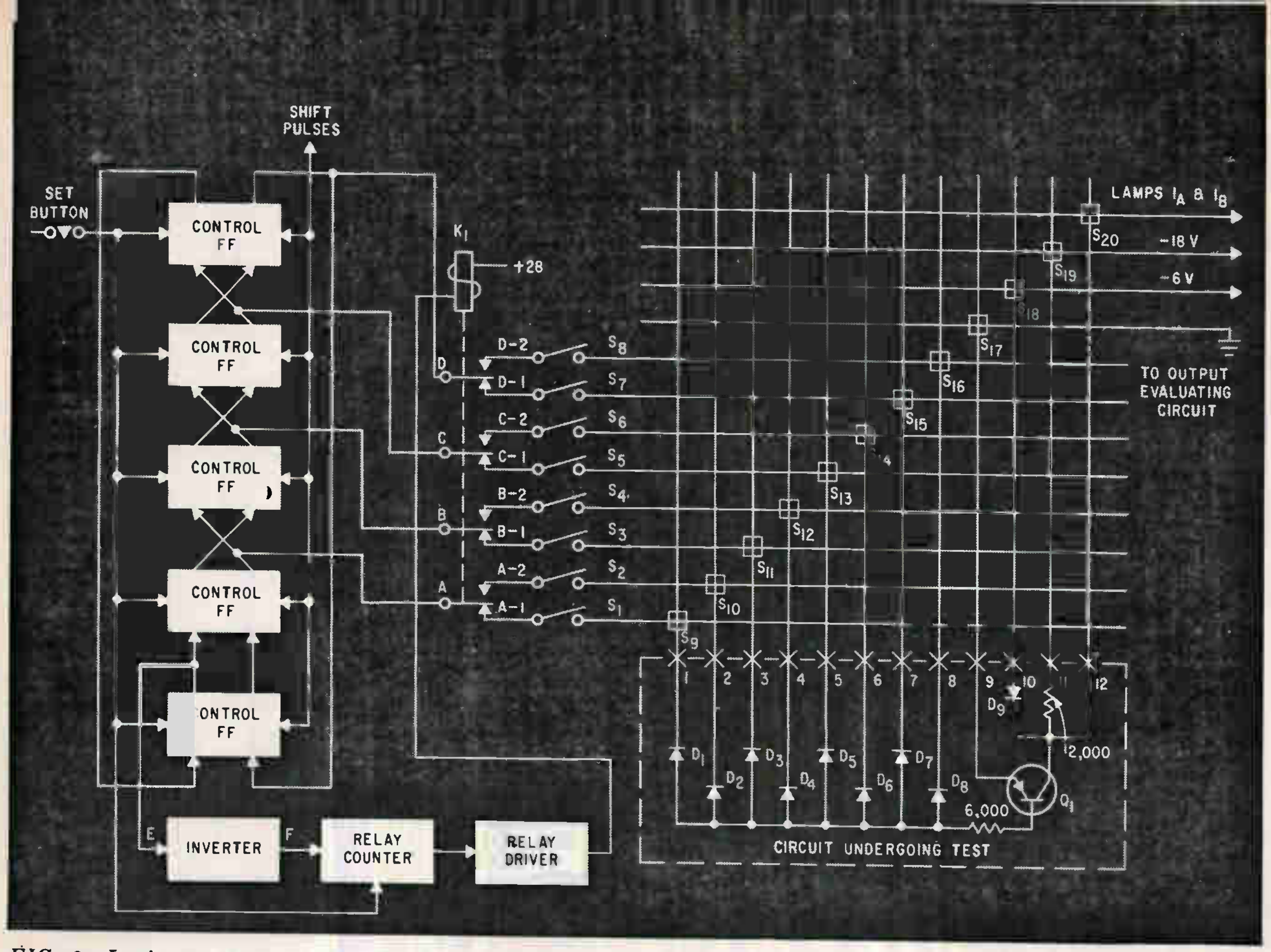


FIG. 2—Logic arrangement showing how test signals are passed to the module undergoing test

DATA-LINK MODULES

programmed by prepunched card. Unit localizes faults to a particular component

routed to the pins of the module as shown in Fig. 1. Printed on the punched program card, together with the part number, are the indicator lamp patterns and meter readings observed by the technician. Fault isolation is accomplished by observing variations in the lamp patterns or the meter readings.

Excitation signals generated within the test set are applied to the input pins of the test modules. When circuits such as binary counters, flip flops or shift registers are tested, excitation signals similar in amplitude and rise time to the signals used in the system are provided. Repetition rates have been reduced as low as one cps to allow indicator lamp readout of the module operation with a minimum of circuits. The readout circuit is designed to load the circuit under test as close as possible to that encountered during operation.

As an example a binary counter stage designed for frequencies ranging from d-c to 150 Kc and with input rise time of approximately 0.4 microsecond can be tested as follows: The punched card sensor switches d-c voltages, input signals and readout devices to the pins. The input signal is a 1-cps square wave of the proper amplitude and rise time. A binary counter will then count and the output pins will have their voltage level changed every second. Two front-panel lamps will alternate with each other, each being on for one second.

The output pins are connected to indicator lamp amplifiers that illuminate a front panel lamp if the clamping diode is open.

A typical binary counter module will contain four bistable stages; therefore a total of eight readout lamps are provided. An operator using the test set to test a four-stage binary counter module will be instructed by the program card to observe the four sets of lamps alternating in a prescribed manner. A faulty stage is discovered by noting the failure of a pair of lamps to alternate. Further fault isolation to the exact component can be accomplished in most cases by noting the exact state of the inoperative lamps and by observing any change in the state of the lamps when a front panel reset button is pushed.

Multi-input gate circuits are quickly and easily tested. Gates with two to eight inputs can be tested and troubles isolated to any of the transistors following the gate, or to any of the input elements (usually diodes), by a ring counter. The ring counter consists of five bistable stages mounted on printed circuit boards, two stages per board. Each stage has its six control elements available at pins on the connector so that the stage can be wired externally as a binary counter, flip-flop or shift register. Each stage has reset diodes that allow for long-term control.

Four stages are used to supply square-wave signals for testing electronic gates as shown in Fig. 2. These signals have an asymmetrical period of five seconds and the period is divided so that the signal will cause conduction in the transistor following the gate for one out of five seconds. Furthermore, the signals are displaced in time so that only one out of the four is at the conduction-causing level at any one time. See Fig. 3.

The fifth stage provides a one second time slot during which none of the four signals are at the conduction-causing level. This is necessary to show that the transistor is not shorted and can be cut off.

To test gates with up to eight input elements, the four-ring counter signals are increased to eight by a relay actuated by the fifth stage of the ring counter through an inverter and a counter.

All or any portion of these eight signals are applied through the punched card sensor to the input pins of the gate being tested. The test is started by pushing a front panel button. Figure 2 shows the arrangement for testing an eight-input positive AND gate followed by an inverter amplifier. When the front panel set button is depressed and held lines A, B, C and D of the ring counter are at the positive level, line E is at the negative level, relay K_1 is deenergized, the shift

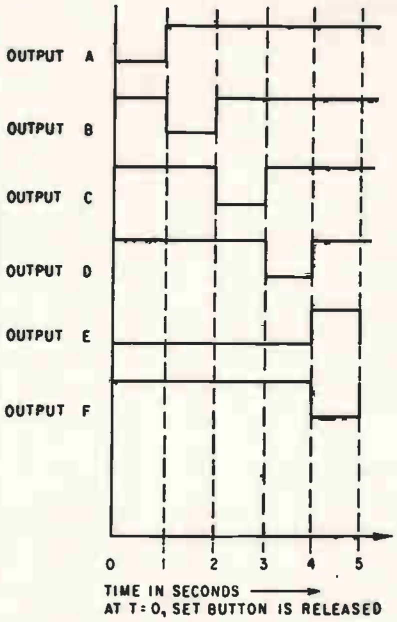


FIG. 3—Time relationship of ring counter waveforms after set button operates

pulses are inhibited, the front panel monitor lamp is on and front panel lamp I_B, driven by an amplifier connected to pin 9 through S_{17}, is on.

When the set button is released, 1-cps shift pulses start feeding into the ring counter. The shift pulses also control the monitor lamp. For the time between shift pulses (one second) the monitor lamp will be off for 0.5 second then on for 0.5 second. This is a blink of the monitor lamp. During the first blink of the monitor lamp after releasing the set button, line A has its level changed from positive to negative and line E changes from negative to positive. The A signal is routed through the A_1 contact of relay K_1 and through switches S_1 and S_9 in the sensor to pin 1 of the gating module being tested. Switches S_1 and S_9, as well as all other sensor switches, are closed by holes in the punched card. If D_1 is good, Q_1 conducts and lamp I_B goes out. If Q_1 is bad, lamp I_B will either not be on when the set button is held in, or will not go out when the set button is released and the input diode levels are subsequently changed from positive to negative. If D_9 is bad, lamp I_A will come on when light I_B is on.

During the second blink of the monitor lamp, line A returns to its positive level and line B has its level changed from positive to negative. This signal is routed to D_3 through the B_1 contact of relay K_1 and through S_3 and S_{11} in the sensor.

During the third blink of the monitor lamp, line B returns to its positive level and line C has its level changed from positive to negative. This signal is routed to D_5.

During the fourth blink of the monitor lamp, line C returns to its positive level and line D has its level changed from positive to negative. This signal is routed to D_7.

If diodes D_1, D_3, D_5 and D_7 are all good, lamp I_B will stay off during the first four blinks of the monitor light after releasing the set button.

During the fifth blink of the monitor lamp after releasing the set button, lines A, B, C and D are all at the positive level causing lamp I_B to come on. At the start of the fifth blink of the monitor lamp, line E returns to its negative level. This signal change is inverted in the inverter amplifier and the relay counter is stepped through line F. This energizes relay K_1 through the relay driver. Relay K_1 stays energized for the next five blinks of the monitor light and makes the ring counter output signals available in four different sensor feeder bars so that D_2, D_4, D_6 and D_8 can be checked. Positive OR gates are tested in a similar manner by applying the complementary ring counter outputs to the posts of another relay.

Digital-to-analog (DACON) circuits can also be checked. Since testing of this type of circuit is not easily done with lamp readouts, a meter has been provided on the front panel to indicate the Dacon output. A typical Dacon module used in data link equipment converts eight digital bits of information into an analog voltage. The tester is capable of testing four Dacon stages per card. The test is started by pressing and holding a front-panel button. With the button held in, all the Dacon switches are open and maximum analog voltage is developed causing the front-panel meter to have a certain upscale reading. When the front panel button is released, the digital information will start to change, causing the bits to be switched in and out starting with the least significant bit. The bit changes are synchronized with the blinking of the front-panel clock light. With each blinking of the light the meter moves down-scale. If any stage is inoperative the meter will cease to move down-scale during that particular time slot and will advance, allowing the operator to quickly recognize the error.

The analyzer is capable of testing approximately 180 different modules and three relay packs. The unit can be rapidly self-checked. The sensor is interlocked to prevent damage in case the switching bars are engaged without a card. The small unit size was made possible by incorporating a switching device in the form of the punched card sensor (Fig. 4.) This device is essentially a static full-card scanner which can direct any of 105 input signals to any of 64 output pins, depending upon the program on the inserted punched card. The relatively small and easy-to-operate sensing device obviates the use of patch boards which are both cumbersome and subject to human error.

The sensor is simple in construction. Its main parts are an upper movable plate with contact pins, lower stationary plate with special board and sliding drawer that positions the punched card properly between the plate and the printed board. A simple spring-lever system lowers and locks the top plate and allows the contact pins to sense the holes in the card. The operator can then read the printed data on the visible portion of the card and compare it to the repetitive light display. The drawer is mechanically interlocked to prevent the top plate from being lowered when the card drawer is not positioned properly. It is electrically interlocked, so that the d-c voltages are present in the sensor only when there is a card in the drawer and the drawer is in the proper position.

The sensor can sense 765 holes in a card, with the 11th and 12th rows used for the printed instruction to the operator. The signals are routed to the connector under test. The input signal enters through a large connector at the rear of the sensor and is then directed through the lower independent contacts, the punched card, and to distribution bars in the top plate. It is then routed to the feeder bar to which the distribution bar is attached. Since all the contacts on the feeder bar are common the same signal can be applied to all or any of the printed strips on the bottom printed circuit board. The signal can then be routed to the required pin on the board under test. This provides 105 input signals broken up into 15 groups of seven each, each group directed to one of 15 feeder bars, each of which in turn covers 32 printed strips. There are five other feeder bars which route the five most commonly used voltages, making a total of 20 bars.

An obstacle commonly encountered in static sensors is the poor reliability of straight-through contact pins. High contact resistance or dust particles can interrupt a signal, particularly when the signal is a low-voltage, low-current waveshape. This obstacle is avoided in the punched card sensor by the use of special chemically milled and plated contacts that impart a positive wiping action by their shape. Another area of difficulty is the extreme tolerance problem presented when attempting to get one pin into each hole. The problem is alleviated by having several common contacts wipe into each hole. It then becomes impossible for the contact to hang up on the edge of the hole in the card. The contacts in the sensor are clipped in place so that they can be easily replaced. The sensing device can be used whenever there exists a need to obtain many pieces of information at one time or when it is desirable to eliminate patch boards and other bulky switching methods.

The design concept used in the present tester permits the testing of different size printed boards. The connectors are mounted in three separate module drawers each of which can be removed from the unit for servicing. When a board becomes obsolete and is no longer used, its connector and plate can easily be replaced by a new type by removing the module drawer. Thus a unit in the field can be kept up to date.

Cards are stored in drawers in such a way that the identifying number on each card can be easily seen. At the same time the cards cannot be bent or torn accidentally.

The circuit is convenient to service since all components, including the power supply, are mounted on a swingout chassis.

The test set can easily be modified to handle the testing of subassemblies from other medium-speed digital systems. Such modifications would be slight for systems using the same logic levels.

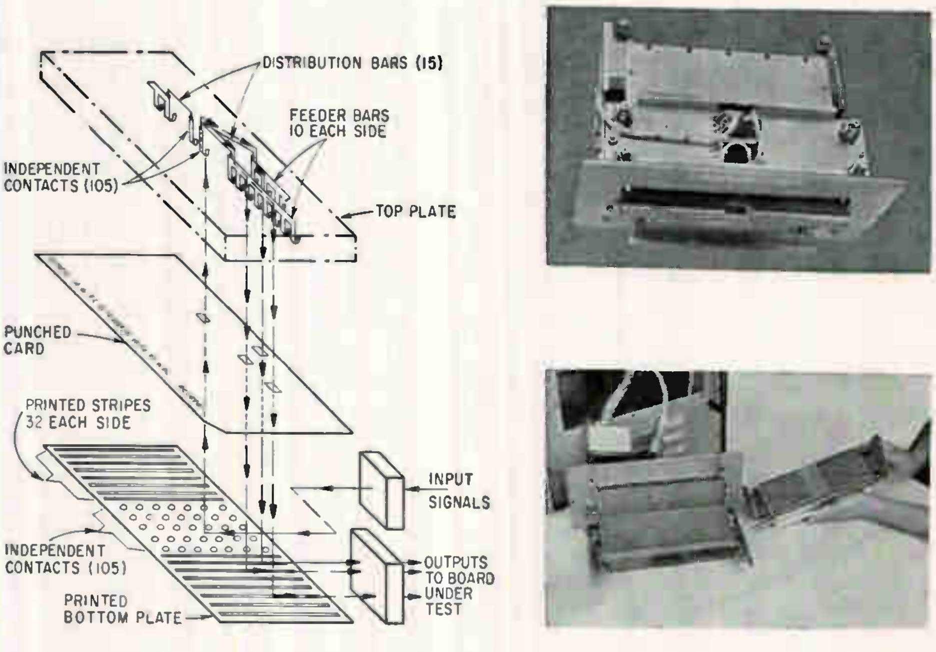


FIG. 4—Punched card sensor (upper right) with interior of sensor (lower right). Mechanical details of signal routing shown at left

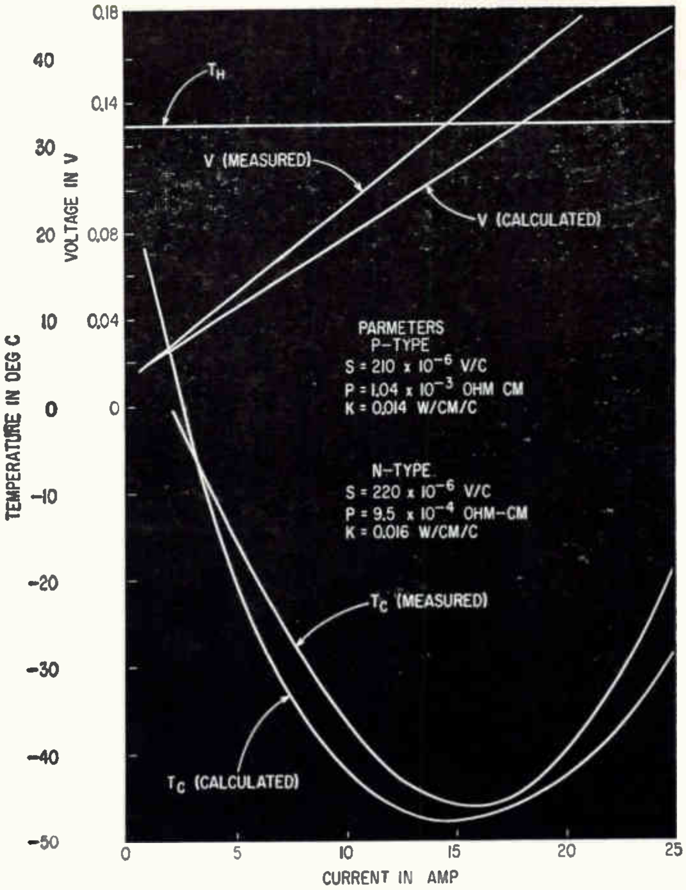
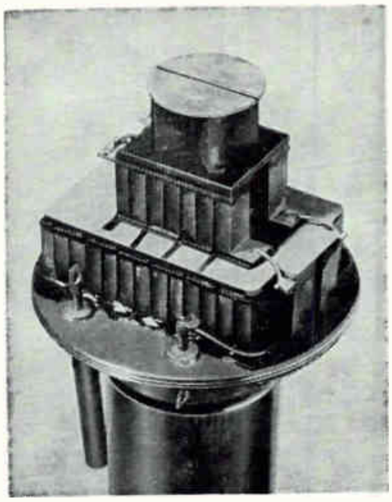


FIG. 1—Calculated and actual performance of thermoelectric couple are compared

Designing



Construction details of three-stage cooler

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RECENT ADVANCES in thermoelectric material technology have made Peltier-effect coolers practical. A disadvantage of most coolers has been the requirement for large currents (15-25 amp) at low voltage (0.1-0.5 v); however by reducing the cross sectional area of the thermoelectric elements and connecting many small elements in series, coolers can be operated at currents of 0.5 to 3 amp at 3 volts or less.

The first step in building a thermoelectric couple is to survey the availability of thermoelectric materials. Semiconductor material can be obtained with a Z value of 0.0025 to 0.003. A simple couple was constructed from a bismuth telluride alloy having the parameters, listed in Fig. 1. Because the cross-sectional areas of the two legs were approximately equal, the couple was optimized (Eq. 5 in box) by varying the lengths of the two legs. Figure 1 shows the theoretical and experimental results.

As seen in Fig. 1, there is a drawback to the use of the couple in an airborne or space vehicle—high current and low voltage requirements. Equation 6 suggests the feasibility of reducing the cross-sectional areas of the legs of the couple and then connecting many small couples in series without a sacrifice in efficiency. For example: Eq. 1 through 6 and the material parameters of Fig. 1 give the results in Table I.

Columns (A) and (C) show results that can be expected from a single couple of 0.25 cu in. of material. Columns (B) and (D) show the results using an equal volume of material (0.25 cu in.), but with 128 series connected couples instead of one couple. Comparison of columns (E) and (C) indicates that a large temperature differential can be achieved with small input power, if the low-current couple is used instead of the high-current couple.

Table II compares the experimental results of four series connected couples, diced from 5 mm dia stock, with a single couple made from the same stock.

Several devices were fabricated using low-current couples. One was a small chamber to control the temperature of a quartz crystal. This prototype chamber was designed to maintain the temperature of a crystal at +20 C while the ambient varied from 0 C to 40 C. It required a current of only 200 ma for cooling and slightly less for heating. Several other chambers have been developed for controlling the temperature of oscillators, discriminators, parametric amplifier diodes and an infrared detector cell.

The Peltier cooler for the infrared cell reduced the temperature to −77 C from an ambient of +25 C by using three stages of cooling. The technique of arranging a number of thermoelectric couples into stages such that the hot junction of the first is cooled by the cold junction of the second, and so on, makes it possible to attain a greater temperature differential than with a single-stage cooler. Stages are thermally in series, and can be connected either electrically in series or electrically in parallel.

After a theoretical study, several three-stage coolers of each type were constructed. With coolers connected electrically in series, there were two major problems. One problem was to find a method of electrically insulating one stage

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** Now with Space Technology Laboratories.

Low-Current Thermoelectric Coolers

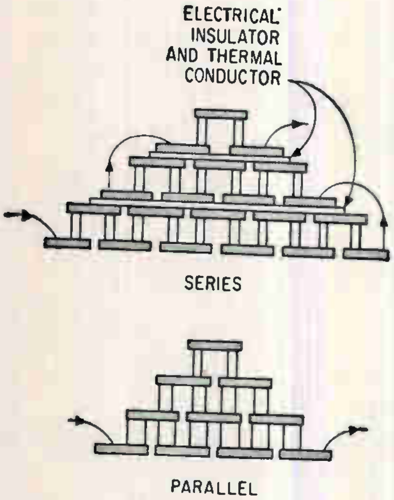

FIG. 2—Common configurations used in three-stage coolers

from another, while maintaining a good thermal path. The second problem was to make the electrical connections from stage to stage, while eliminating the usual leads and their heat load. With coolers connected electrically in parallel, there were also two problems. One consisted of the current unbalance in the outer legs of the two lower stages, and the other was the extremely high current requirement. Figure 2 shows both coolers.

To overcome some of the problems, a hybrid cooler was constructed in which the top two stages were connected electrically in parallel and they, in turn, were connected in series with the bottom stage. The heat load as seen by the top stage was assumed to be 0.125 w. Table III gives the design parameters for the cooler.

As Table III indicates, a temperature gradient of 5 C was expected between the infrared detector cell and the cold junction of the top stage, and a 16 C gradient between the hot junction of the bottom stage and the heat sink. By putting the bottom stage electrically in series, rather than parallel with the top two stages, the current requirement was reduced from over

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THERMOELECTRIC POWER

The thermoelectric power of an p-n semiconductor couple is $S = s_p - s_n$. Electrical resistance of the couple is $R = r_p + r_n$ and the thermal conductance $K = k_p + k_n$. Lengths and cross sectional areas of the legs are L_p, L_n, A_p and A_n.

The useful cooling is

$$Q_{net} = ST_cI - \tfrac{1}{2} I^2 R - K(T_h - T_c) \qquad (1)$$

The required input power is

$$P = I[IR + S(T_h - T_c)] \qquad (2)$$

where IR corresponds to the voltage drop across the cooler when the temperature difference between the hot T_h and the cold T_c junctions is zero, and the second term in the brackets corresponds to the back emf or Seebeck effect induced in the cooler due to the temperature differnce between the hot and the cold junctions.

A measure of the efficiency of the thermoelectric couple is given by the coefficient of performance (COP)

$$COP = \frac{Q_{net}}{P} = \frac{ST_cI - \frac{1}{2} I^2 R - K(T_h - T_c)}{I^2 R + SI(T_h - T_c)} \qquad (3)$$

The COP varies with the current; maximum COP can be determined by differentiating Eq. 3 with respect to I and equating to zero. This yields,

$$COP_{max} = \frac{T_c}{T_h - T_c} \left(\frac{N - \frac{T_h}{T_c}}{N + 1} \right) \qquad (4)$$

where $N = [1 + 1/2\, Z\, (T_h + T_c)]^{\frac{1}{2}}$ and $Z = S^2/KR$. Parameter Z is the figure of merit controlling the value of the COP for a given temperature difference and is maximized when the product KR is a minimum. Because s_p, s_n; ρ_p, ρ_n; k_p, k_n, are not variables for a given material, the ratio of the couple's lengths to cross-sectional areas must be used to minimize KR. Assuming that $A_p = A_n$, the product KR may be written $KR = k_p/L_p + k_n(\rho_pL_p + \rho_nL_n)/L_n$

When this is differentiated with respect to L_p/L_n and equated to zero, the ratio of lengths which will make KR a minimum is

$$L_p/L_n = \sqrt{k_p \rho_n / k_n \rho_p} \qquad (5)$$

Under these conditions

$$KR = [(k_p \rho_p)^{1/2} + (k_n \rho_n)^{1/2}]^2$$

And

$$Z_{max} = S^2/[(k_p \rho_p)^{1/2} + (k_n \rho_n)^{1/2}]^2 \qquad (6)$$

From Eq. 6 it is evident that COP_{max} is independent of the geometry and the volume of material.

One of the prime considerations in using Peltier cooling devices in airborne or space applications is the current required to produce a given cooling effect. If Eq. 1 is rearranged such that,

$$T_h - T_c = \frac{1}{K}(ST_cI - \tfrac{1}{2} I^2 R - Q_{net})$$

and differentiated with respect to I and equated to zero, we obtain the current which will make $T_h - T_c$ a maximum. The result is

$$I_{(T_h - T_c)max} = ST_c/R \qquad (7)$$

Of equal interest is current which will make Q_{net} a maximum. If Eq. 1 is differentiated with respect to I and equated to zero, we find,

$$I_{Qmax} = ST_c/R \qquad (7)$$

Here we see that the current which produces a relative maximum $(T_h - T_c)$ also produced a relative maximum Q_{net}. The absolute maximum $(T_h - T_c)$ occurs when $Q_{net} = 0$ and the absolute maximum Q_{net} occurs when $(T_h - T_c) = 0$

TABLE I—COMPARISON OF THERMOCOUPLE CHARACTERISTICS

Column	A	B	C	D	E
N	1	128	1	128	1
L	¼"	¼"	¼"	¼"	¼"
A	1" x ½"	$\frac{1}{16}$" x $\frac{1}{16}$"	1" x ½"	$\frac{1}{16}$" x $\frac{1}{16}$"	$\frac{1}{16}$" x $\frac{1}{16}$"
$L{=}A$	0.197	25.2	0.197	25.2	25.2
Q_{max}	21.2 w	21.2w	0	0	0
ΔT_{max}	0	0	78 C	78 C	78 C
I	328 amp	2.56amp	242amp	1.9amp	1.9amp
V	0.129v	16.5v	0.129v	16.5v	.129v
P	42.4w	42.4w	31.2w	31.2w	.246w
COP	0.5	0.5	0	0	0

N = number of couples connected in series

TABLE II—SINGLE VS SERIES

N	1	4
L	¼"	¼"
A	0.196" dia.	0.138 x 0.055"
L/A	3.24	12.95
ΔT_{max}	78.6 C	75.4 C
I	15.5amp	3.9amp
V	0.135v	0.56v
P	2.1w	2.2w

60 amp to 18.6 amp. The bottom stage was electrically insulated from the top two stages by a thin sheet of anodized aluminum which resulted in a negligible temperature drop between stages. The current unbalance in the second stage was overcome by decreasing the L/A ratio of the outer two legs. The series electrical connection between the second and bottom stages was made from the outer legs at the hot junctions on the second stage, to the cold junctions of the bottom stage.

Test results for this three-stage cooler show that the current peaks at 16.5 amp instead of the calculated 18.6 amps with a resulting temperature differential of 144 C instead of 122 C. This indicates a change in the material parameters with the reduction in temperature. Further testing verified that the material parameters do change, and in such a manner that Z increased with decreasing temperatures.

Using the test data from this hybrid unit, a low-current, low-power, three-stage cooler was designed with all three stages connected electrically in series.

Design parameters for the cooler were: the load on the top stage was 0.125 w; the cell must be cooled to −78 C from an ambient of +25 C; and the device current should not exceed 4 amp.

Two considerations dictated that the top stage should consist of two couples. First, since the cell was 15 mm in diameter the use of two couples would provide a more substantial mounting base for the cell. Second, to realize a useful temperature differential across the top stage it was necessary to reduce the top stage couple loading. An L/A ratio of 12 had been chosen. With a load of 0.125 w, a single junction would not produce a large enough temperature differential. By using two couples, the load per couple is one half the former top stage load and a satisfactory temperature differential is produced.

To reduce the tooling to fabricate the couples the same L/A was used for all stages. This introduces some degradation since it does not permit optimizing each stage. This degradation is offset, however, by the increase in Z with decreasing temperature. The value of $I_{(Th-Tc)max}$ for the top stage was calculated and used for the other two stages.

With the top stage cold junction at 190 K and an L/A of 12, the $I_{(Th-Tc)max}$ for this stage is 3.52 amp. By rearranging Eq. 1.

$$(T_h - T_c) = (T_c I - \tfrac{1}{2} I^2 R - Q/N)/K$$

$(T_h - T_c)$ for the top stage is 32 C so (T_c) for the second stage is 222 K. The input power to the top stage can now be calculated from Eq. 2. This power, 0.517 w, plus the top stage load gives a second stage load of 0.64 w. Under these conditions top stage COP is 0.24. In a multiple stage cooler maximum efficiency is obtained when all stages have the same COP and for this reason a COP of 0.24 was used for all stages.

To calculate (T_h) for the second stage the following equation is derived

$$T_h = \frac{\frac{1}{2}(ST_c)^2 + (k_p+k_n)(\rho_p+\rho_n)\,T_c}{S^2\,T_c\,COP + (k_p+k_n)(\rho_p+\rho_n)} \quad (8)$$

Using this equation, T_h for the second stage is found to be 252 K giving a temperature differential of 32 C across this stage. The heat pumping capacity of a couple in the second stage is 0.103 w using Eq. 1. Since the load on this stage is 0.64 w seven junctions are required. The input power is 1.808 w giving a bottom stage load of 2.45 w.

Equation 8 is used again to calculate the bottom stage T_h which is 296 K giving a temperature drop of 44 C across this stage. The heat pumping capacity of a couple in the bottom stage is calculated to be 0.115 watt and since the load on this stage is 2.45 watts, the stage requires approximately twenty-one junctions. Twenty-five junctions were used to provide a margin of safety. The input power to this stage is 6.85 w and the load into the heat sink is 9.3 w.

Under test, this cooler reduced the temperature of the infrared detector cell to −77 C from an ambient temperature of +25 C at a current of 2 amp and a voltage of 2.5 v.

TABLE III—DESIGN PARAMETERS 3-STAGE COOLER

	Top Stage	Middle Stage Innercouple	Middle Stage	Middle Stage Outercouple	Bottom Stage
N	1	1		1	8
L	0.250	0.201		0.201	0.294
A	0.120" x 0.120"	0.135" x 0.150"		0.196" dia	0.196" dia
L/A	6.78	3.9		2.6	3.08
T_c	−83 C		−53 C		−14 C
T_h	−53 C		−14 C		+39 C
I	6.2 amp	12.4amp		18.6amp	18.6amp
V	0.097v		0.114v		1.1v
P	0.599w		3.532w		20.5w
COP	0.209		0.205		0.209

Measuring Frequency Stability Of Pulsed Signals

The phase difference is measured as a pulse-to-pulse rms deviation, without synchronization or frequency reference from a signal source

By R. H. HOLMAN
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THE USUAL WAY to measure short-term frequency stability, known as incidental f-m, of pulsed r-f systems is to measure the stability of the c-w drive to the pulsing amplifier. However, the pulsing stages are power amplifiers, either klystrons or traveling wave tubes for microwave signals, and pulsing and amplification adds to the phase or frequency instability of the signal. Thus, the final stability is not determined by measuring only the c-w before pulsing. This points to the need for a technique to measure short-term frequency stability of pulsed signals.

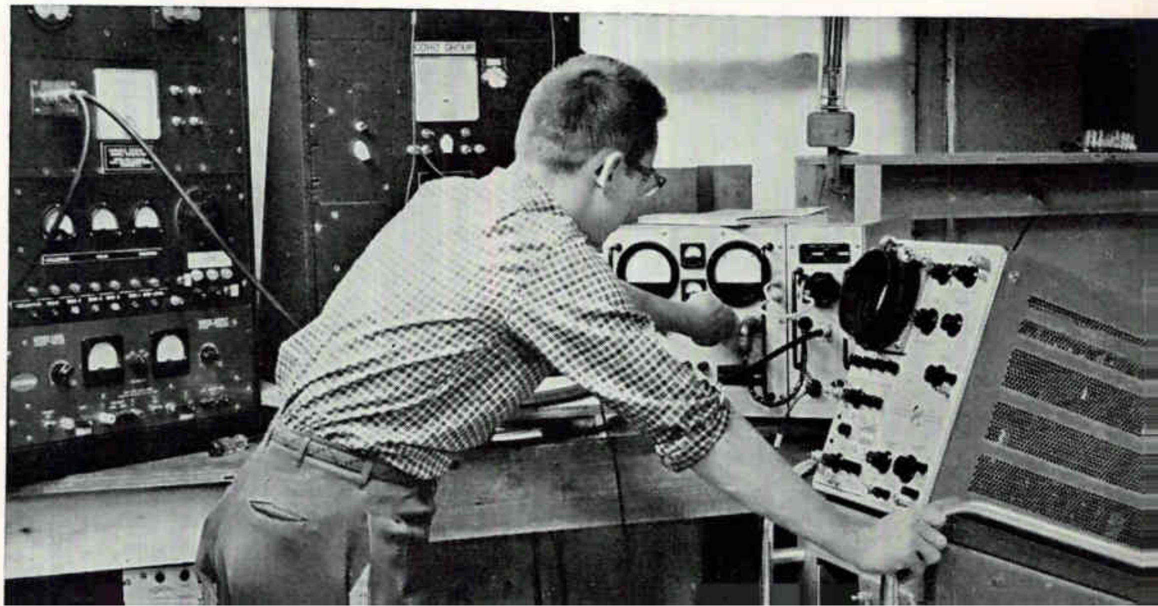
A time-domain measurement of pulsed signals is suggested because a frequency instability results in a pulse-to-pulse phase variation. (The variation from linear phase progression is the phase change referred to here.) Since a stable reference at the correct frequency is not always available, a pulse-to-pulse phase shift measurement without a c-w reference is desirable. A measurement of pulse-to-pulse phase change per interpulse period can be interpreted as the first approximation of the derivative of phase modulation. This measurement is that of the frequency modulation function. Thus, if successive incidental phase changes are measured, an f-m waveform can be reconstituted. A measurement of this type furnishes a time-domain record of the short-term frequency instability which can be spectrum analyzed if a frequency domain interpretation is desired.

To measure pulse-to-pulse phase change, the phase of each r-f pulse must be remembered between pulses to be compared with the next pulse. In the circuit of Fig. 1A the phase of signals from two free-running cohos (coherent oscillators) oscillating at an intermediate frequency are continuously compared in a phase detector. (The i-f signal is obtained by mixing the unknown signal with a stable local oscillator signal.) The pulsed i-f is then switched so that the pulses are alternately connected to the two cohos. Thus, the first pulse locks the phase of coho A, the second pulse locks the phase of coho B, the third locks the phase of coho A again, and so on. The phase detector output is a continuous measure of the pulse-to-pulse deviation. The data hold-over during the interpulse period is done by the cohos and phase detector. An rms meter indication of the phase detector output gives a measurement of the rms phase-deviation.

It is desirable to use the pulse-to-pulse phase shift measurement to obtain the derivative of the incidental phase modulation, which is by convention the incidental frequency modulation. The frequency modulation function is approximated by

$$f = \frac{1}{2\pi}\frac{d\phi}{dt} \simeq \frac{1}{2\pi}\frac{\Delta\phi}{T}$$

where $\Delta\phi$ is the pulse-to-pulse phase shift and $1/T$ is the pulse



Equipment on the table consists of the variable coherence signal generator, pulsed signal coherence tester and stability tester. Under the table is the pulse generator for the signal generator

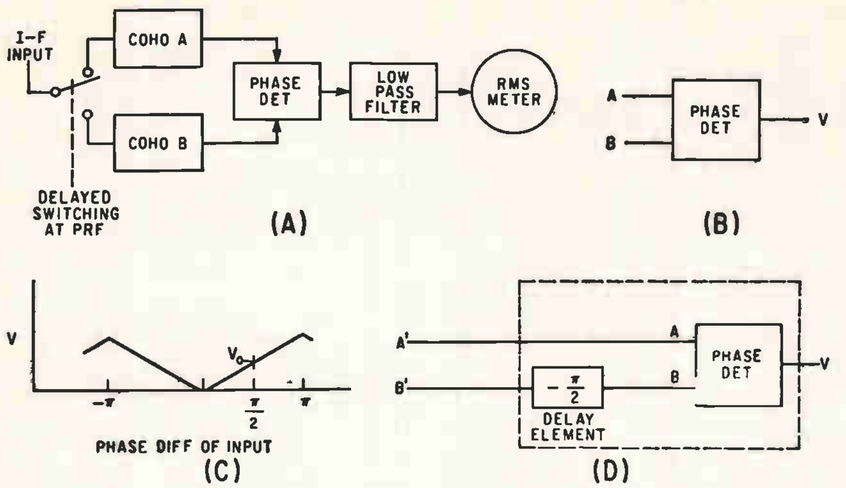


FIG. 1—Block diagram of system for measurement of rms pha e deviation using cohos for phase memory (A); unipolar phase detector (B); response of unipolar phase detector (C), with V_o indicating the operating point of bipolar phase detection; and bipolar phase detection from a unipolar phase detector (D)

repetition frequency. The frequency modulation, *f*, is an algebraic quantity, the sign of which is determined by the sign of $\Delta\phi$. This sign indicates whether the instantaneous r-f frequency has deviated plus or minus from the average frequency. If it is found that the phase of a received pulse leads that of the remembered phase of the previous pulse, then the r-f frequency has deviated and is higher than the average frequency. Thus, to obtain a frequency demodulation of the instability it is necessary to measure both the magnitude and direction of the pulse-to-pulse phase shift.

This requires the use of a bipolar phase detector. The response of a unipolar phase detector (Fig. 1B) is shown in Fig. 1C. Such a phase detector cannot measure whether the phase of an r-f pulse leads or lags the remembered phase of the previous pulse. Figures 1C and 1D show how a unipolar phase detector is used for bipolar phase detection. By introducing a delay in one of the phase detector inputs the operating point is shifted on the phase detector response curve and the output voltage V_o corresponds to this operating point, indicating a zero pulse-to-pulse phase shift. Plus or minus phase shifts are indicated by voltages higher or lower than V_o. Voltage V_o can then be subtracted out by a d-c block and the resulting phase measurement is bipolar.

When cohos are used for phase memory, the immediate i-f pulse and the remembered pulse alternate between the phase detector inputs. This means that for a train of pulses where the phase of each pulse leads that of the last (a progressive increase in pulse-to-pulse phase), the phase detector output would indicate that there was first a lag. To correct for this switching of the immediate and remembered phases at the input of the bipolar phase detector, the output of the phase detector must be inverted on alternate r-f pulses.

A system for stability measurement of pulsed signals using these techniques was built in breadboard form.

A functional block diagram of the pulsed signal coherence tester is shown in Fig. 2A, together with a stalo (stable local oscillator) receiver. A stalo receiver is a receiver with local-oscillator stability (coherence) such that deviations in this oscillator phase (or frequency) over the sampling interval will not be significant in terms of those encountered in the incoming signal. This condition is necessary because the phase deviations of the receiver local-oscillator are inherently added to those of the incoming signal in any superheterodyne receiver. In this discussion it will be assumed that the stalo receiver converts the incoming signal frequency to a 30-Mc intermediate frequency without degradation of signal coherence.

The pulsed signal coherence tester consists of a control group, coho group, and meter group. The control group provides an automatic gain control that functions so that the i-f pulses arrive at the coho group with a constant amplitude, switching voltages that allow the cohos to be locked alternately by the i-f pulses, and sampling-time triggers for the boxcar, which is a part of the meter group. The coho group accomplishes the pulse-to-pulse phase memory and phase comparison. The meter group processes the phase-detector output, provides an oscilloscope display and recording of the pulse-to-pulse deviation, and presents its rms value on a panel meter.

The control group provides a constant amplitude injection or lock pulse required for proper phase locking of the cohos along with timed i-f switching voltages and boxcar sampling triggers. This timing is such that the i-f switching and boxcar detecting is done during the interpulse period, that is, at some time other than when a coho is being locked. Figure 2B is a block diagram of control group and Fig. 2C, a waveform diagram. Letters on the two diagrams establish a correspondence between the waveforms and their location in the circuit.

To obtain an agc that responds to i-f pulse amplitude, the i-f pulses are first video-detected. The video pulses are then lengthened by a pulse stretcher, amplified and rectified to obtain the agc feedback bias to the i-f amplifier.

The video is also used to obtain a variable delay trigger that generates the switching voltages and boxcar triggers. The video first triggers a blocking oscillator. The constant-width pulse out of the blocking oscillator renders the remaining part of the circuit independent of the original i-f pulse width. The blocking oscillator pulse triggers a one-shot multivibrator, the output of which is differentiated and rectified so that a single delayed trigger is obtained. This delay is variable from six to forty μsec to accommodate a range of pulse widths and prf's. The delayed trigger is then amplified and supplied to the switching voltage

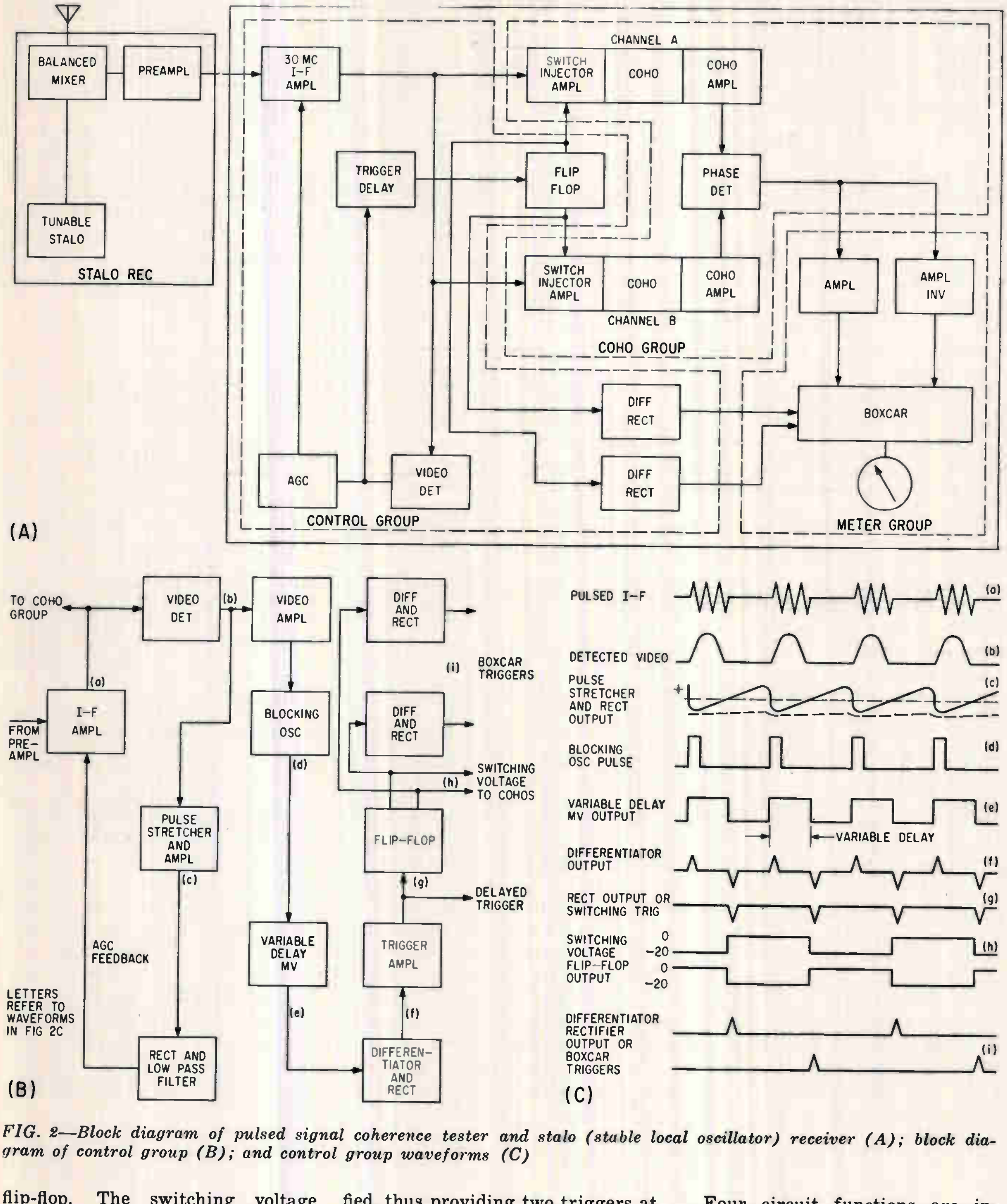


FIG. 2—Block diagram of pulsed signal coherence tester and stalo (stable local oscillator) receiver (A); block diagram of control group (B); and control group waveforms (C)

flip-flop. The switching voltage flip-flop is a bistable multivibrator whose two outputs are either zero or −20 volts. The outputs, which reverse with each trigger incident on the flip-flop are fed to the coho group to perform the i-f switching and are used to obtain the boxcar sampling triggers. For this, each output is differentiated and rectified, thus providing two triggers at half the prf. One trigger lags the other in time by the pulse repetition interval.

Shown in Fig. 3A is a detailed block diagram of the coho group. This group consists of two identical channels, each containing a switch-injector, coho and switch amplifier.

Four circuit functions are incorporated in the coho group: i-f switching, locking-pulse injection, use of a stable i-f oscillator with locking ability, and phase detection.

Switching of i-f signals can be done with a 6AS6 pentode in which both the first grid and suppressor grid have sharp cutoff character-

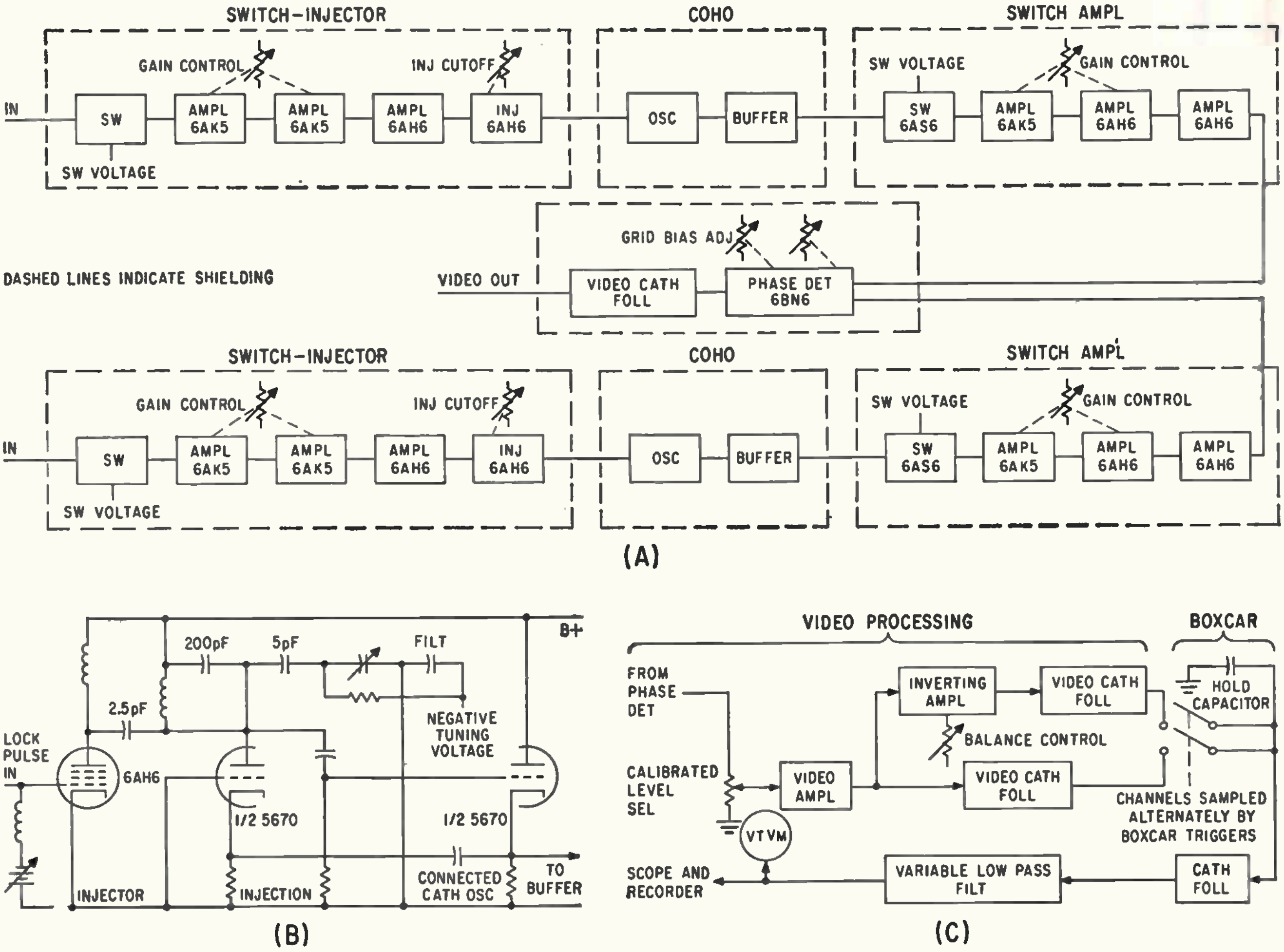


FIG. 3—Block diagram of coho (coherent oscillator) group (A); schematic of injector and coho (B); and block diagram of meter group (C)

istics. The signal is applied to the first grid and the switching voltage to the suppressor grid. With an incident i-f signal of two volts peak-to-peak or less into the switch, a negative switching voltage of 20 volts d-c will bias the tube off.

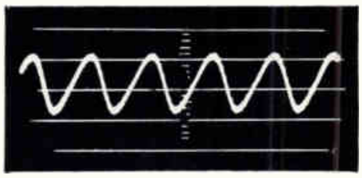
The injector as shown in Fig. 3A isolates the coho from the input in the absence of a locking pulse, and in the event of a locking pulse furnishes enough energy to lock the coho. A high degree of input isolation is required so that the coho stability is not degraded by input noise. The isolation is obtained by biasing a 6AH6 pentode to cutoff and supplying a locking pulse with sufficient amplitude to allow the pentode to conduct during the positive swings of the signal. Injection is at a high impedance level from the plate circuit of the injector to the plate of the coho.

Two requirements dictated coho design: short-term frequency stability and locking ability. Short-term frequency instabilities in the cohos limit the sensitivity of the tester. Locking ability, or ease of locking, governs the amplitude of injection signal, the pulse widths that can be accommodated and the allowable i-f tuning error. A high-Q crystal oscillator would best satisfy the stability requirement but is difficult to lock.

The connected-cathode oscillator shown in Fig. 3B was chosen as a compromise between stability and locking ability. These oscillators have stabilities of less than 5 cps deviation at 30 Mc. If the tester were used against a signal at 1,000 Mc, 5 cps deviation on the coho implies that only stabilities of less than 5 parts in 10^9 could be measured.

The connected-cathode oscillator can be locked with pulse widths of less than one μsec for small tuning

FIG. 4—Sample measurement, showing tester output (A) with horizontal scale of 0.2 v per cm, and tester phase detector calibration (B) with horizontal scale of 2 v per cm; waveforms demonstrating the tester as an f-m detector, with sawtooth (C, top) and square wave (D, top) phase-modulating voltages, demodulation by the pulsed signal coherence tester (C and D, center), and demodulation by the stability tester (C and D, bottom)



(A)

errors and with 2-μsec pulses for tuning errors of 10 Kc.

The cohos are tuned by varying the bias on a voltage-tunable capacitor in the tank circuit of the oscillator.

A 6BN6 coincidence tube is used as a phase detector. The tube conducts only when both grids are positive. It switches rapidly from zero conduction to full conduction so that, with signals applied to the grids, the tube current is a series of constant amplitude pulses whose width is proportional to the distance between zero crossings. These pulses are averaged; the resulting d-c value is proportional to π radians minus the phase difference between the signals applied to the grids.

To demonstrate and calibrate the response of the phase detector, two nominal 30-Mc signals whose difference is an audio frequency are fed to the phase detector. Since the phase difference between these two signals is a linearly increasing function of time, the phase detector output is a sawtooth wave at the audio difference-frequency, as shown in Fig. 1C. The amplitude of this sawtooth wave represents π radians.

It is desired that the phase detector not only measure the magnitude of the pulse-to-pulse phase difference but also its direction. It should determine if the phase of a received pulse leads or lags that of the preceding pulse. To get bipolar response, the phase detector is operated at the $\pi/2$ point for coho group input signals with the same phase. This is done by creating a delay unbalance in the coho group channels of approximately $\pi/2$ radians. Thus a lead or lag in one of the inputs will result in the phase detector output becoming less than or greater than the output at $\pi/2$.

Since the average pulse-to-pulse phase difference is zero, the d-c operating point of the phase detector is $\pi/2$ radians, which is then d-c blocked. The phase detector output is a bipolar video, the direction of which is indicative of the direction of each pulse-to-pulse phase shift.

However, this presupposes that one channel is taken as the reference, which is not the case, since each channel alternately contains the phase of the received pulse and previous pulse. The result is that the phase detector output must be inverted for every other pulse. This processing is accomplished by the meter group.

Figure 1C shows that the phase detector response becomes ambiguous for peak phase differences at its input greater than plus or minus $\pi/2$ radians. For signals whose pulse-to-pulse phase deviation exceeds this limitation it can only be said that the stability is less than a certain value.

Figure 3C shows a functional block diagram of the meter group. The video from the phase detector of the coho group is processed for the boxcar. The boxcar requires this video along with its inversion at convenient levels from low impedance outputs. Thus, the video patible signal which permits through a calibrated level selector and amplifier. Then it is inverted, with the inverted video balanced in level with the uninverted. These videos go through cathode followers to obtain low impedance inputs to the boxcar. The boxcar samples the two videos alternately at the prf. The boxcar output is then low-pass filtered at one half of the prf, and displayed on the meter.

To demonstrate accuracy, the tester was used to measure a known instability of a signal from a variable coherence signal generator as monitored prior to pulsing by a Laboratory for Electronics model 5004 stability tester. The measurement was made of peak deviation since this is what the stability tester measures. Although the stability tester measures the variable coherence signal generator output before it is pulsed, the low-level pulser does not degrade the stability of the signal generator output so that the stability tester and the coherence tester measurements should agree reasonably well.

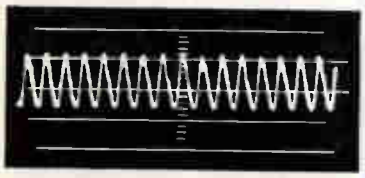
The coherent signal was modulated with a 500-cps sinewave with an amplitude such that its peak deviation as measured by the stability tester was also 500 cps. Figure 4A shows a display of the tester measurement, and Fig. 4B, the tester phase detector calibration.

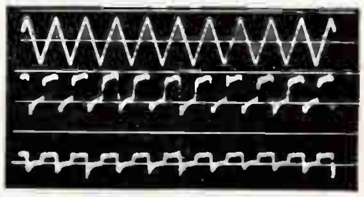
Peak-to-peak deviation is $D_{p\text{-to-}p} = \Delta\phi/2\pi T$ where $\Delta\phi$ = the peak-to-peak deviation, and T = the pulse repetition period.

The peak-to-peak phase deviation is measured from the waveform as 0.39 volts and phase detector calibration as π radians per 3.8 volts. The pulse repetition period is the reciprocal of 20 Kc, the prf. Thus the deviation is calculated to be 1,020 cps peak-to-peak or 510 cps peak.

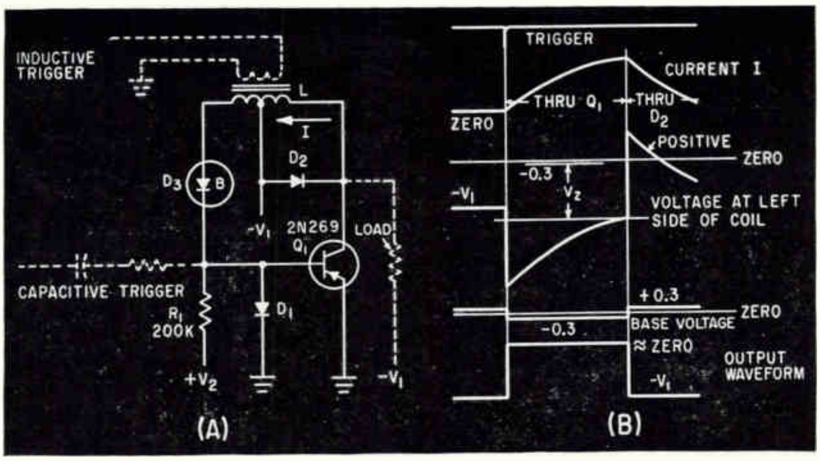
Figures 4C and 4D illustrate the ability of the tester to frequency demodulate. For the sawtooth and square wave phase modulations of the variable coherence signal generator, waveforms are shown of the modulating voltage, the tester, and stability tester outputs. The coherence tester and stability tester are both frequency demodulators and so their outputs are the derivatives of the phase-modulating voltage. The distorted square wave results from nonlinearities in the phase modulator of the variable coherence signal generator.

The measurement technique used in the pulsed signal coherence tester was conceived by T. F. Curry of the Syracuse University Research Corp. E. M. Williams of Carnegie Institute of Technology contributed many suggestions.


(B)


(C)


(D)



Delay is obtained by time constant of inductor L in (A). Waveforms (B) show how Zener breakdown controls base drive and output

One-Transistor Single-Shot

Components in single-shot multivibrator can be decreased in one-transistor circuit. While not necessarily cheaper, circuit may be more reliable and simpler to manufacture than the conventional type

By T. F. HEITING,
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THE SINGLE-SHOT, sometimes called one-shot, monostable or delay multivibrator, is one of the building blocks of digital computers. With either capacitor or inductor control, the circuit normally uses two amplifying devices, usually transistors, to generate a rectangular output pulse. The schematic in the drawing above, however, shows a single-shot that needs only one transistor, thus reducing components by 50 percent and giving higher reliability and, in some applications, lower cost.

Transistor Q_1 is normally off because I_{CBO} is supplied through R_1 to the base. The voltage at the base is the drop across clamping diode D_1, about +0.3 volt. The other clamping diode, D_2, shunting half of coil L, is not conducting at quiescence because there is no voltage difference across it. Zener diode D_3 is backward biased and does not conduct either. Its Zener voltage V_z is chosen so that $V_z > (|V_1| + 0.3)$; a satisfactory value is $V_z = 1.2\ (|V_1| + 0.3)$.

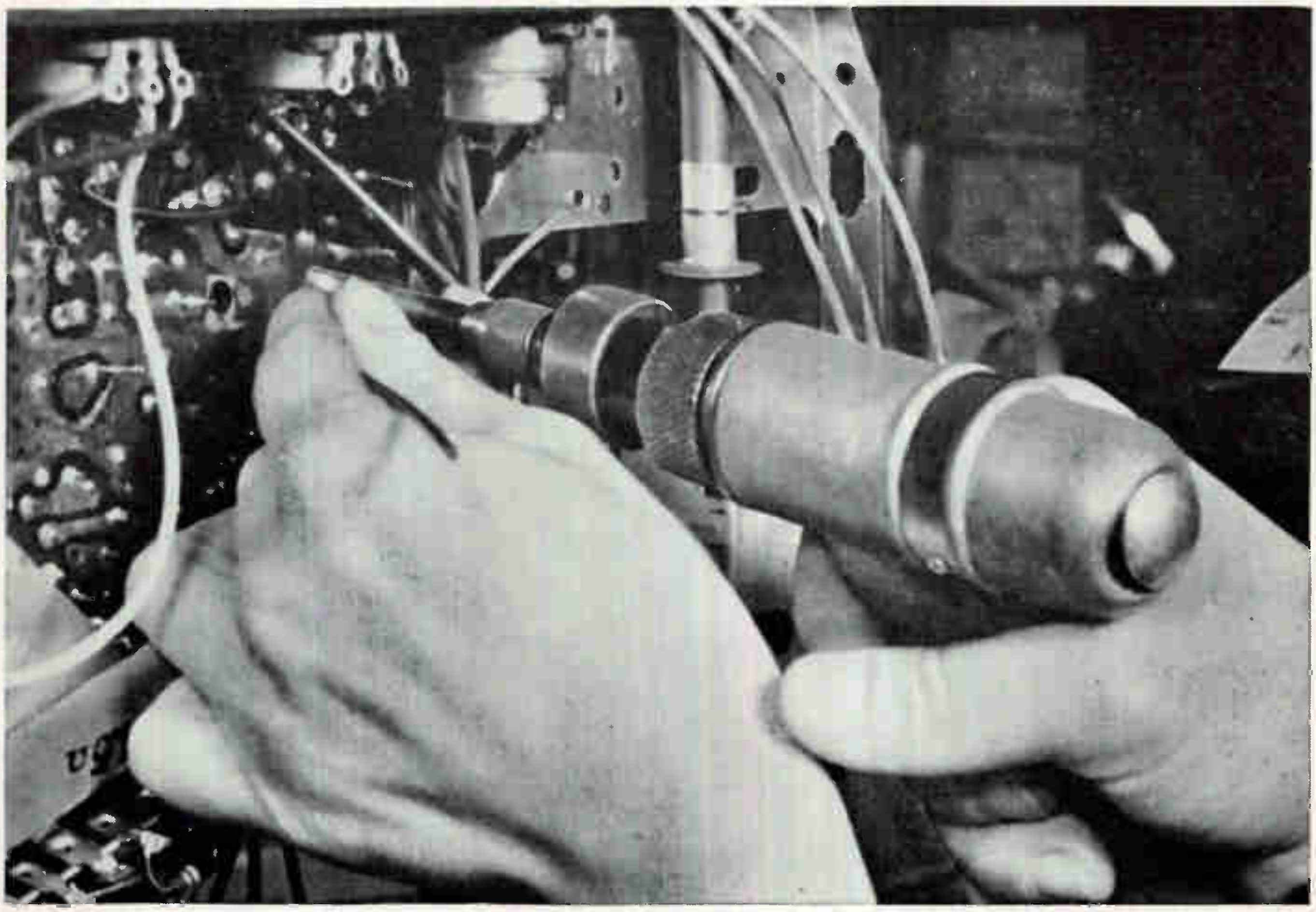
When a negative trigger is applied to the base, Q_1 turns on, and collector voltage goes from $-V_1$ to nearly zero as shown in (B) of the figure. Current through L increases slowly toward its saturation value. A high negative voltage develops on the left half of the coil, adding to $-V_1$. The total negative voltage is high enough to punch through the backward biased Zener diode, producing a drop of V_z across D_3 and increasing and sustaining base current. The feedback speeds the rise time of the output.

The negative voltage at the base is now about −0.3 volt, the voltage drop across the base-emitter junction. Clamping diodes D_1 and D_2 are not conducting. The negative voltage at the left side of the coil moves slowly positive toward $-V_1$ as the current in the right side of the coil approaches saturation; finally the Zener diode suddenly blocks base current flow.

Current I_{CBO} is now fed to the base from the positive supply, turning Q_1 off. Collector voltage goes from nearly zero to $-V_1$, while the left side of the coil goes positive and supplies additional I_{CBO} through D_3, which is now forward biased. This feedback causes a fast fall of the output waveform. The collapsing magnetic field of L is dissipated by clamping diode D_2. The presence of diodes on both sides of the coil prevents ringing at the output. Therefore, the output waveform is rectangular and without spikes or slopes.

Triggering can be accomplished through a capacitor or through the coil. Duration of the output pulse is $T \approx L/R'$ sec, where L is inductance in henries, and R' is resistance of the feedback path in ohms. For a given coil, T can be decreased by adding resistance in series with the coil.

The core of the coil is not square-loop type material, thus the coil can be a relay. But typically the external load is connected between collector and the negative supply. Load current does not pass through the coil and thus can be much higher than coil current.



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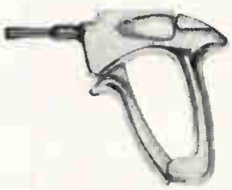

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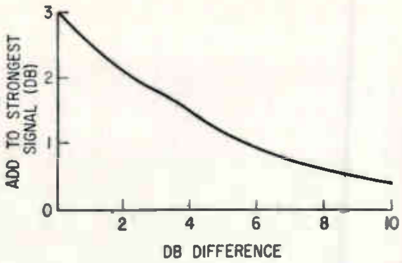

FIG. 1—Addition of two same frequency signals

Predicting Spurious Transmitter Signals

By JAMES G. ARNOLD,
Defense Electronics Products,
RCA, Camden, New Jersey

RAPID INCREASE in spectrum use makes control of spurious output an important characteristic in any r-f equipment. The need to insure interference-free transmission from transmitters has often been ignored in initial design stages by the substitution of a few rules of thumb and heavy reliance on good fortune.

In a string of cascade amplifiers, or amplifiers and multipliers, it is usually assumed that the input spectrum consists only of the driving frequency. After the first amplifier or multiplier, the spectrum can no longer be considered to consist only of this single-frequency signal but must be considered as a spectrum of many components. The output of any driven stage is composed of driving components plus harmonics, and components due to the mixing of the driving spectrum components. This indicates that a vast amount of calculation will be involved in any prediction. This process can be simplified by making basic considerations and adopting a step-by-step procedure.

In a number of cascade stages of amplifiers and multipliers, the output will consist of components harmonically related to the initial input frequency. Three processes will produce the output spectrum; amplification, harmonic generation and mixing. The energy at any point can be tabulated and the three categories can be summed up for any frequency. When any component is found to be below the required level with reference to the main frequency, it may be dropped from the calculations and need not be carried as a drive component of the succeeding stage.

A component due to grid mixing of two driving signals will be degraded by a conversion loss of 11 db or more. Its greatest amplitude is then at least 11 db below the weakest of the two driving signals being mixed. The output components due to amplification and harmonic generation will be tabulated. The input spectrum can then be examined for mixing components that produce each output frequency. For any given output frequency, all driving components equal to or less than the same frequency component produced by amplification or harmonic generation can be disregarded. That is, any products derived from two or more signals will be at least 11 db below its weakest component, and if the weakest signal is just equal to a same frequency component of the output, the sum of the two will not materially increase the amplitude of the stronger signal.

Addition of two same-frequency signals is shown in Fig. 1. When the difference between two signals is 10 db or more, the stronger signal is not significantly increased by the combination with the weaker signal. Simplification can be made by disregarding the summation of signals of more than 10 db difference. The stronger signal is taken as the sum.

TABLE I—TYPICAL VALUES OF MINIMUM PRACTICAL CONDUCTION ANGLE

Stage Function	Minimum Practical Conduction Angle
Amplifier	100 degrees
Mult X2	80 degrees
Mult X3	70 degrees
Mult X4	60 degrees
Mult X5	50 degrees

Before examining a system for its spurious output, it is necessary to set up values for the losses inherent in both the process of mixing and harmonic generation. Since all calculations should be conservative, the conversion loss of the mixing process is taken as the conversion loss of a grid mixer when operating at maximum conversion transconductance. This value is approximately 11 db.

Harmonic generation is treated in an equally generous manner. Output current pulse in class B or C operation is not a perfect replica of grid voltage above cutoff. The shape of this pulse is between that of a linear transfer characteristic, and that of a squared transfer characteristic, depending on the tube geometry.

The power output available at any harmonic across a given load impedance is equal to $P_N = (I_N^2 R_L/2)$ where I_N is the peak value of the N^{th} harmonic current and R_L is the load impedance at the fundamental frequency. Power output at the fundamental frequency is $P_1 = (I_1^2 R_L/2)$.

The level of the N^{th} harmonic with respect to the carrier or fundamental is $P_N = 20 \log (I_N/I_1)$ expressed in db. The ratio of harmonic currents to fundamental current was derived for

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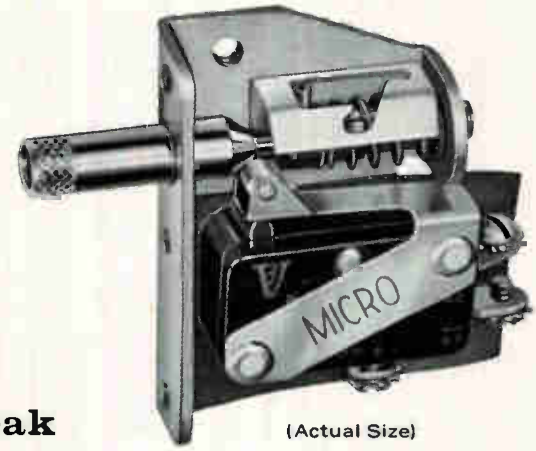

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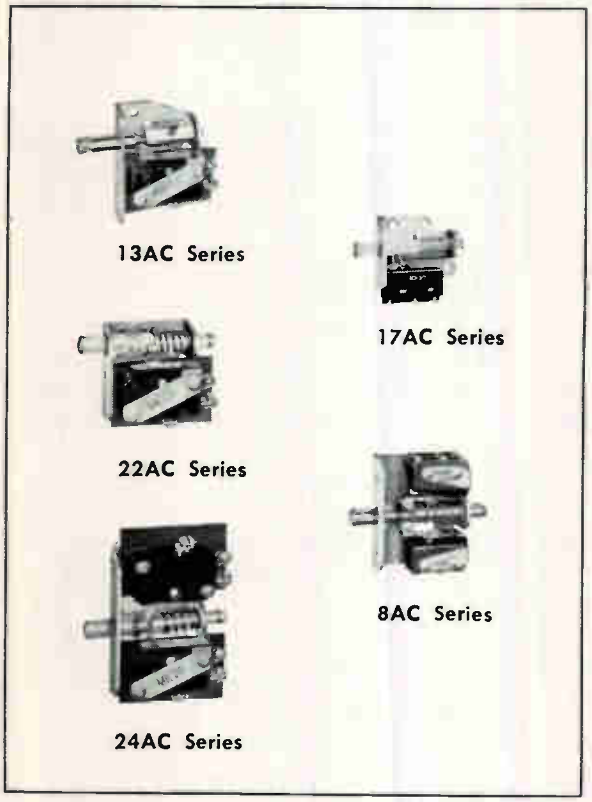

A few of the many different door interlock switches available. Write for Data Sheet 186 or see the Yellow Pages for the nearby MICRO SWITCH Branch Office.

A new model in MICRO's line of protective door interlock switches, the "13AC" is designed to eliminate that momentary power interruption when the interlock is re-set upon closing the door. This feature is particularly desirable on electronic equipment such as data processing consoles, transmitters or computers.

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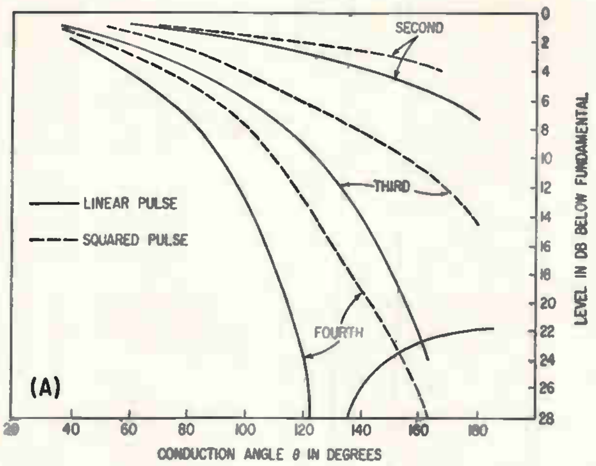
CIRCLE 69 ON READER SERVICE CARD



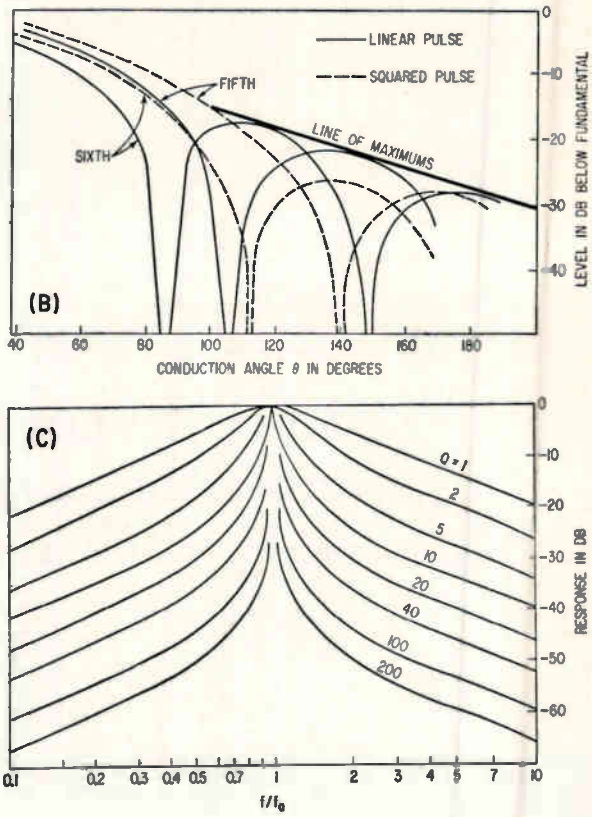


FIG. 2 — Resulting harmonic levels as function of fundamental conduction angle (A and B). Response of a single tuned circuit (C)

both a linear transfer characteristic and a squared transfer characteristic[1]. The harmonic levels are shown in Fig. 2A and 2B as functions of fundamental conduction angle. As shown in Fig. 2B, the level as a function of conduction angle becomes cyclic for higher order harmonics at large conduction angles. Since in amplifiers, neither the pulse shape nor the conduction angle are precisely controlled parameters, reliable predictions could not be made for higher harmonics and large conduction angles. Therefore it is necessary to draw a line of maximum for all higher-order harmonics in this region. This is not an overly conservative assumption because where an equipment must be tuned over a significant band with various tolerances of the voltages used, the line of maximums represents the values that must be expected.

Where the conduction angle is not known or not controlled, it has been the usual procedure to use a value of conduction angle that is the minimum practical for the type of operation of the stage. This minimum practical angle is dictated by experience and represents the lowest conduction angle that can usually be used after all the design compromises of an amplifier or multiplier are evaluated. These values are given in Table I.

In either case, the level of the harmonics can be read from Fig. 2A and 2B using the line of maximum values for all higher-order harmonics in the upper region of Fig. 2B. These values are the harmonic levels of plate current with respect to the fundamental.

When a stage is used as a frequency multiplier, the level of each harmonic is elevated by the ratio of the output frequency component to the fundamental to keep the zero db reference at the output frequency of each stage.

Determining the spurious spectrum of a small number of cascaded stages can become tedious, and because of the large number of components, it is best to use a mechanical process whereby each component is tabulated at each step. The format of Table II has been used with success in rapid computation.

The form shown in Table II is used as an example. For simplicity only five driving spectrum components are shown in the tabulation. This form is used for each stage. After the form for a stage is completed, the last column is transferred to the input column of the succeeding stage and so forth.

In the example, the input spectrum as seen from the relative amplitudes is the result of a doubling process in some previous stage. Since the stage being considered is also a doubler, all the components are corrected by +3.8 db in the plate current transfer level column, so that the reference level is transferred to the component which is the output frequency of the stage.

The frequencies are then considered for their harmonic levels in column 4. There is no driving frequency to produce harmonics at frequency 1. Frequency 2 is a second harmonic of 1 and is thus entered with a level of −3.8 db, −5.2 db or −9.0 db. Frequency 3 can only be a harmonic of frequency 1 and therefore is treated in the same manner. Frequency 4 can be a

Climaxing ITT's long history of pioneering in the traveling wave tube field are these new PPM types covering C and X bands and distinguished by the highest power output over the greatest bandwidths thus far available. The X-band TWT Type X-354 is rated at 5 watts CW from 8 to 12 kilomegacycles; the C-band TWT Type X-370 is rated at 10 watts CW from 4 to 8 kilomegacycles. Type X-368 serves as a driver for the X-354. As in other ITT traveling wave tubes, construction is exclusively metal and ceramic.

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CIRCLE 71 ON READER SERVICE CARD

TABLE II—SPURIOUS PREDICTION TABULATION SHEET

Stage: Doubler
Conduction Angle: 140°

Transfer Characteristics: Approximately linear
Output Circuit: Tuned circuit, Q = 20

1	2	3	4	5	6	7	8	9	10	11
Input Spectrum Component f/f_1	Input Component Level (db)	Plate Current Transfer Level (db)	Plate Current Harmonic Level (db)	Stronger of 3 or 4 Plus Adjustment	Mixing Components	Product Level (Weaker Component −11 db)	Add to Stronger Signal (db)	Plate Current Spectrum (Stronger of 5 or 7, + 8)	Plate Circuit Response (db)	Output Spectrum (db)
1	−9.0	−5.2	.....	−5.2	....			−5.2	−36.5	−41.7
2	0	+3.8	−9.0	+3.8	....			+3.8	−29.5	−25.7
3	−13	−9.2	−19.2	−8.8	2+1	−16.2	+0.7	−8.1	−21.0	−29.1
4	−26	−22.2	0	0	....			0	0	0
5	−38	−34.2	−26.2	−25.6	3+2	−20.2	+1.1	−19.1	−19.0	−38.1
6			−10.2	−10.2	....			−10.2	−24.3	−34.5
7			−22.7	−22.2	3+4	−33.2	0	−22.2	−27.5	−49.7
8			−17.2	−17.2	....			−17.2	−29.5	−46.7

harmonic of 1 and 2, but since 2 is overwhelmingly greater than 1, only the second harmonic of frequency 2 is computed. Thus the column 4 level of frequency 4 is +3.8 db, −3.8 db or 0 db. This is expected since the correction factor was used to reference all components to the doubler output frequency. Frequencies 5 and 7 can only be harmonics of frequency 1 and are treated accordingly. Frequencies 6 and 8 are considered as harmonics of driving frequency 2 only, since frequency 2 is much stronger than driving frequencies 1 or 4.

Column 5 is filled by taking the stronger signal of columns 3 or 4 and adding an adjustment referring to Fig. 1. If the difference between the two signals is 10 db or more, the adjustment is neglected and the stronger signal is entered in column 5. Adjustment was made only for frequencies 3 and 5.

The combination of drive components are then examined for products corresponding to each output frequency. These combinations are noted in column 6. Only components whose levels in column 3 are equal or greater than the values of column 3 or 4 for the frequency being considered are noted. Thus for frequency 1, no two frequencies in column 3 are greater than the frequency 1 level in column 3. No other two frequencies in column 3 are greater than frequency 2, so again no products are looked for. Only frequencies 1 and 2 are greater than 3 in column 3 and these can produce frequency 3, that is 2 + 1 = 3. No two frequencies in column 3 are equal or greater than frequency 4 in column 4. Products are looked for in frequencies 6, 7 and 8, but only in frequency 7 is a pair available in column 3 which can produce that frequency and have levels exceeding the frequency being examined.

The three products found in column 6 are centered in column 7 by subtracting 11.0 db from the weaker of the two signals.

The correction factor in column 8 is found by referring to Fig. 1 for the difference between the column 7 level and the level of the same frequency component in column 5.

Column 9 is filled by taking the highest level of column 5 or 7 for each frequency and adding the adjustment of column 8. Column 9 then is a representation of the output plate current spectrum.

The response of the plate circuit is entered in column 10. This response is the ratio of the circuit impedance at the frequency under consideration to the impedance at resonance in db. These values are known in the early design stages of an equipment. In unusual circuit arrangements they may be measured values. For a single tuned circuit, the values are readily found from the value of loaded Q. A family of response curves for a single tuned circuit are presented in Fig. 2C to facilitate rapid derivation of these values. The output circuit is tuned to frequency 4 and therefore the response at frequency 5 corresponds to f/f_o of 1.25 on the curves of Fig. 2C.

The combination of columns 9 and 10 will then give the output spectrum of the stage with reference to the level of the output frequency.

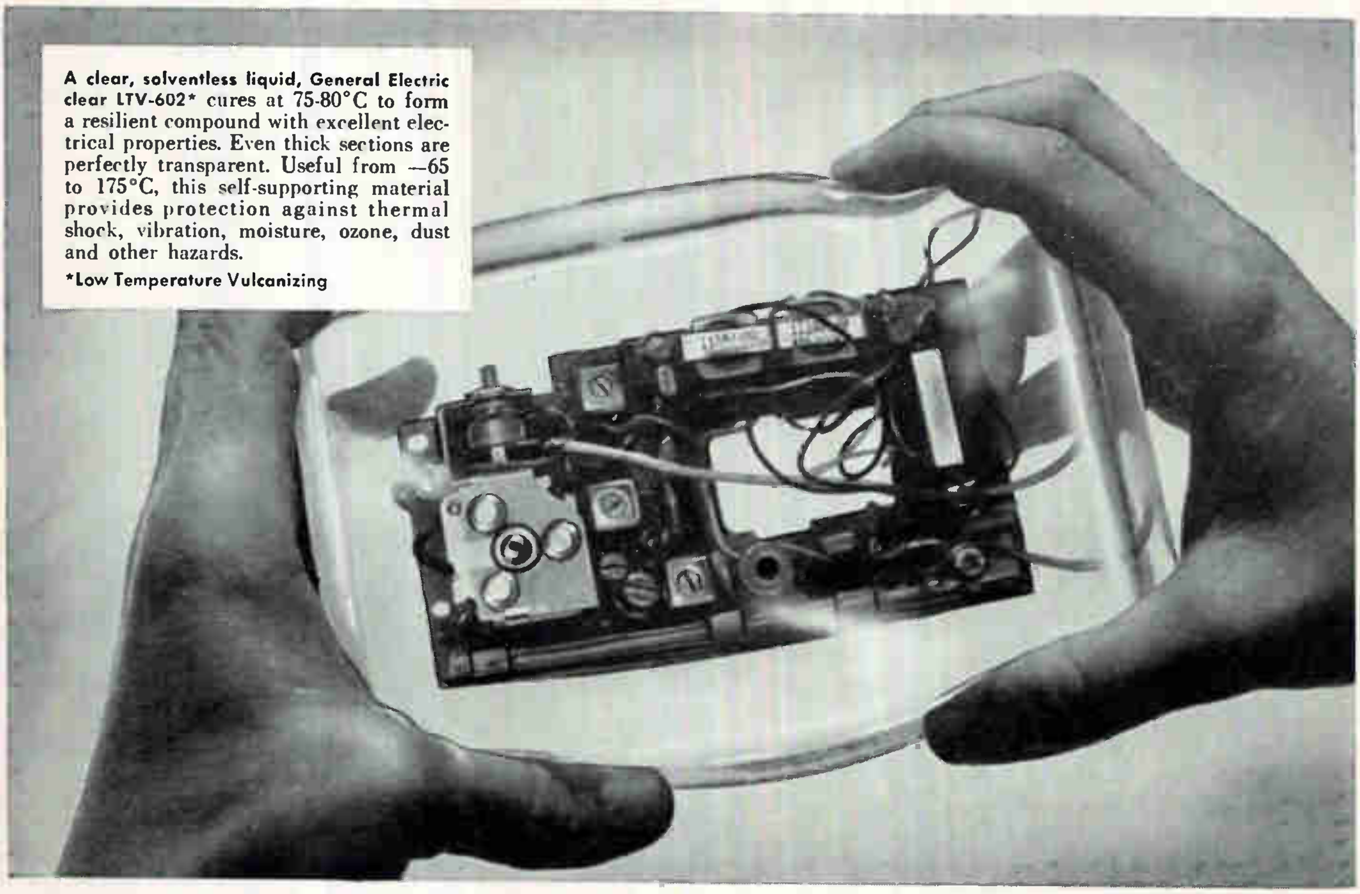
This procedure is readily extended to the case where heterodyning actions are involved in the derivation of the final output frequency.

Where intentional mixing is used the degradation due to mixing may be quite different from 11 db. In this case this figure will be known and can be applied as in grid mixing.

The accuracy of those predictions are proportional to the accuracy of the information, especially the data required in column 9.

REFERENCE

(1) F. E. Terman and J. H. Ferns, The Calculation of Class C Amplifier and Harmonic Generator Performance of Screen Grid and Similar Tubes, *Proc IRE*, 22, p. 359 March, 1934.



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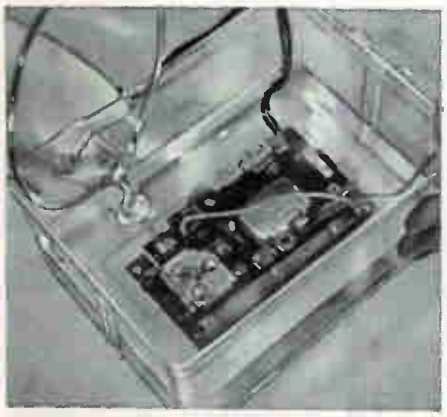

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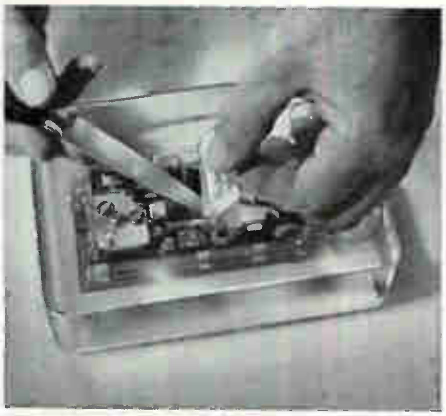
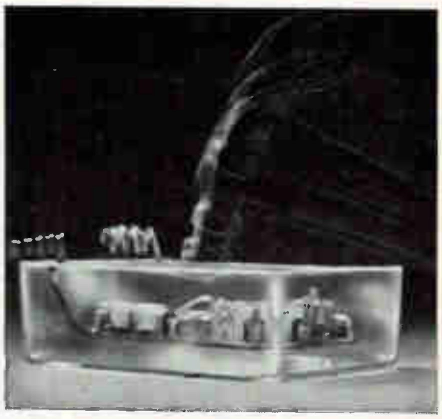


LTV-602 is easy to work with and easy to repair. To repair parts embedded in LTV, merely cut out and remove section of material, repair or replace defective part, pour fresh LTV into opening and cure. Pot life, with catalyst added, is approximately 8 hours and may be extended with refrigeration. When desirable, LTV may also be cured at room temperature.



Resiliency offers excellent shock resistance. LTV-602 easily meets thermal shock tests described in MIL-STD-202A test condition B which specifies five temperature cycles from —65 to 125°C. Tests indicate that LTV retains protective properties even after 1800 hours aging at 175°C. Other tests confirm LTV's resistance to moisture and water immersion.

LTV-602 is the newest addition to the broad line of G-E silicone potting and encapsulating materials which also include the RTV silicone rubbers. For more information, write to General Electric Company, Silicone Products Department, Section N140, Waterford, New York.

GENERAL ELECTRIC

Tests Find Hidden Data on Magnetic Tapes

By D. F. CLARK,
Field Service Coordinator, Mincom Div., Minnesota Mining and Manufacturing Co. Los Angeles, Calif.

MAGNETIC recordings made with standard instrumentation tape recorders contain considerably more detailed information than had been realized. The added data became apparent in a series of experiments in which a variety of signals were taped with standard instrumentation recorders. For comparison, the tapes were then played back on both a standard instrumentation recorder-reproducer and on the newer video instrumentation recorder-reproducer.

The greater recording capability of the standard instrumentation recorder can be significant to many users of this type of equipment. Information stored on magnetic tape by such recorders can now be recovered. Obtaining additional information from existing tapes can sometimes eliminate the need for costly repetition of events so that more detailed information can be recorded with the improved video instrumentation recorders. Valuable added data can also be obtained from existing tapes about events that cannot be repeated.

Standard instrumentation recorders can also be used in applications for which they had been assumed unsuitable, with the recorded information recovered by a video instrumentation reproduce system. These possibilities do not affect the applications for which the capabilities of standard instrumentation record-reproduce systems are completely satisfactory.

Conditions for the tests include making all recordings at 60 ips on a standard instrumentation recorder—the Mincom C-100 constant-current recorder. The tapes were played back on both the C-100 and the Mincom CM-100—a constant-flux video instrumentation recorder-reproducer. It is assumed that results would have been similar had other recorders with comparable characteristics been used.

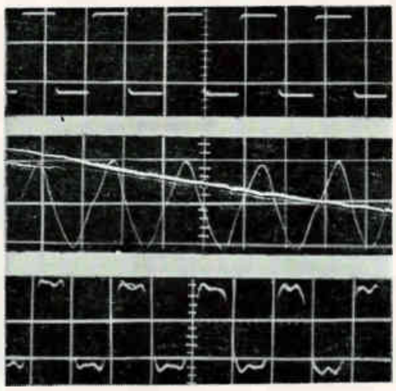


FIG. 1—Recorded pulses (top) have poor rise time (center) when played back with standard recorder but are recovered by video reproduce system (bottom)

Input levels to the recorder were at the nominal levels of 1 volt rms for sine waves and 1½ volts peak-to-peak for pulses and square waves. Standard instrumentation tape (MMM #B159) was used for all experiments.

Frequency response of the CM-100 at the 60 ips used in the tests is within ±3 db from 400 cps to 500 Kc, although it exceeds 1 Mc at 120 ips. Some modifications of this system were required to play back tapes made with a constant-current recorder because it was designed to reproduce recordings made with a constant-flux recorder. The plug-in equalizer and filter were replaced by the standard 15-ips equalizer and the standard 30-ips filter. These units were found to be the best combination for flat frequency response and good signal-to-noise ratio, and they did not require use of a bias trap.

When tuned to the outer extreme, the 15-ips equalizer increases response at about 175 Kc. The 30-ips filter produces a Gaussian roll-off beginning at about 185 Kc, down 6 db at 250 Kc and down 28 db at 350 Kc. Bias frequency of the standard instrumentation recorder used to make the recordings is 350 Kc. Had the 60-ips filter been used, which has a Gaussin roll-off beginning at 375 Kc and down 6 db at 500 Kc, a bias trap would have been required.

Frequency response of the modified reproduce system in playing back tapes recorded with the standard instrumentation recorder was within ±4 db from 200 cps to 220 Kc. The ratio of rms signal to rms noise was 28 db. Bias beats appeared at about 175 Kc and became progressively worse as recorded frequency was increased toward bias frequency.

Pulse response of an analog tape recorder is adversely affected by three primary factors: limited frequency response, phase shifts (resulting primarily from the playback head) and excessive overshoot or ringing (resulting from a combination of phase shift and filtering). The tests demonstrate these effects in reproducing recorded data by the two systems.

The 10-μsec pulses shown in Fig. 1 were recorded with 10-μsec separation by the standard instrumentation recorder. The loss of high frequencies and resulting deterioration of rise time is apparent when the tape is played back on this system. The improved frequency response when the same tape is played back on the video instrumentation recorder-repro-

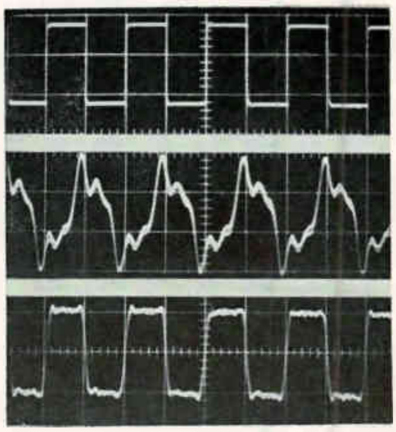


FIG. 2—Phase shift of recorded pulses (top) occurs when they are reproduced on standard unit (center), while playback on video system (bottom) is corrected by phase compensation

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PR 155-1M	0-155	0-1	1	3½	19	13⅞	$325.00
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PR 38-15M	0-38	0-15	2	7	19	13⅞	$475.00
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PR 155-4M	0-155	0-4	1	7	19	13⅞	$430.00
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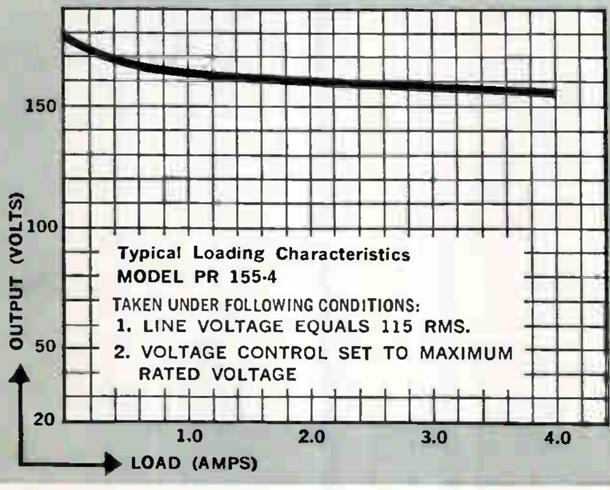

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kepco inc. 131-48 SANFORD AVENUE • FLUSHING 52, N. Y. • IN 1-7000 • TWX # NY 4-5196 ducer is evident in the more rapid 2-μsec rise time.

Phase distortion is evident when recorded 20-μsec pulses separated by 20 μsec are reproduced by the C-100. The higher frequencies in Fig. 2 appear sooner than the lower frequencies. However, phase-compensating circuits in the CM-100 maintain the correct time relationship for highs and lows.

A word-code generator produced the three 5-μsec pulses separated by 5-μsec in Fig. 3. After a 15-μsec space, another 5-μsec pulse was generated. Overshoot occurs when the tape is played back by the standard instrumentation recorder. The Gaussian characteristic of the filter in the video-type unit reproduces the pulses without ringing.

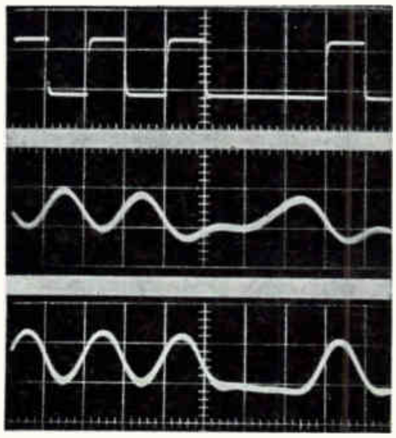


FIG. 3—Pulses followed by space (top) and reproduced on standard unit (center) show evidence of overshoot, while same tape reproduced on video playback system (bottom) is flat between pulses

When the video instrumetation recorder was used to reproduce an even more complex pulse-code word, ringing and phase distortion still did not appear. Three 2-μsec pulses were separated by 2μsec spaces and were followed by a 20-μsec space. Then two more 2-μsec pulses were produced with a 4-μsec space between them. Rise time of the 2-μsec pulses was 1 μsec.

Loss of data when tapes are played back on a standard instrumentation recorder is evident in Fig. 4. A 10-μsec pulse was followed after a 1-μsec space by a 4-μsec pulse. Amplitude of the 10-μsec pulse is three times that of the 4-μsec pulse. The only data reproduced by the C-100 was a single pulse of about 15-μsec duration. The same tape played back on the

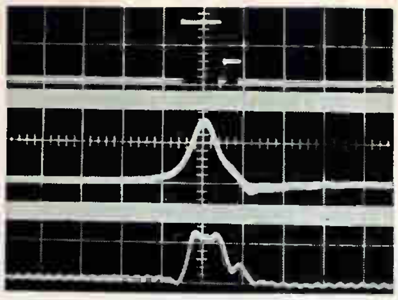


FIG. 4—Shorter pulse of lower amplitude (top) is lost in reproduction with standard recorder (center) but recovered by video reproduce system (bottom)

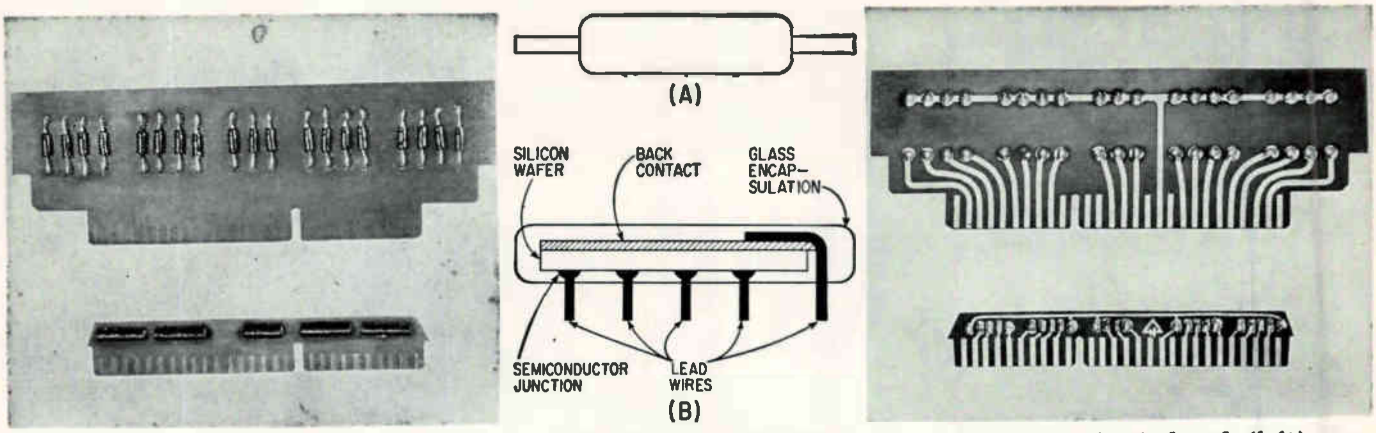
CM-100 results in a 10-μsec pulse followed by a discernable pulse of about 4 μsec.

Results indicate the different pulse recording and reproducing capabilities of standard instrumentation recorders. Although these systems were not specially designed for pulses, they actually do record pulses much more accurately than the playback heads and circuits in them can reproduce.

Video instrumentation recorder-reproducers can only play back data that is actually on the tape. Several factors can limit the amount of detail recorded by standard instrumentation recorders. For example, if pulses are recorded at an input level so high that the tape is driven into saturation, high frequencies will be erased. Reproduced pulses will therefore have poor rise time.

Bias frequency also limits the pulse recording capability of standard instrumentation recorders. As recorded frequency is increased to about one-half bias frequency in the C-100, beats begin to appear and become progressively worse as frequency is increased. To avoid bias beats, bias frequency should be about three time the highest anticipated frequency to be recorded. Had recorder bias frequency been higher, test results would have been even better.

The primary limiting factor in recording higher frequencies on a standard instrumentation recorder is the increasing losses in the record head core material as frequency is increased. A pre-emphasis network in the CM-100 compensates cores losses by providing more current at higher frequencies to maintain constant flux. In the constant-current C-100 recorder, however, losses occur above about 50 Kc.



Conventional diode (A) compared to diode cluster (B) that functions as a gate. Larger circuit board (left) uses standard 19-diode gating circuit. Smaller board performs same circuit function but needs only five Poly-Diodes. Same connector is used. Etched sides of boards (right) show 38 solder connections to individual diodes on larger board, only 24 connections to compact diodes on smaller board

Poly-Diodes Simplify Computer Logic

DIODE CLUSTERS WRAPPED IN SINGLE ENVELOPE

By J. G. HAMMERSLAG,
President.
Delta Semiconductors, Inc.,
Newport Beach, Calif.

THE SEMICONDUCTOR DIODE is now not much larger than its end solder connection. In a computer, tens of thousands of these diodes are used, individually mounted on circuit boards, often several dozen diodes per circuit board.

Further attempts at simplification of computer circuits by size reduction of the individual diode has reached the law of diminishing returns. Simplification of gating circuits through microelectronics requires complete redesign of the entire computer, and this appears far enough away to take care of immediate needs.

In this milieu, Delta Semiconductors[1] has designed a compact diode component that combines several individual diodes in one glass envelope. This construction cuts down the number of conventional diodes needed by as much as 80 percent, fits existing connectors, and the units can be interchanged with present computer components, without redesigning associated equipment.

The Compactode, or compact diode, represents a practical solution for designers who seek smaller, more reliable, circuits right now, while they await techniques that involve revamping of complete computer and logic systems.

Each Poly-Diode Compactode encapsulates whole clusters of conventional diodes, see diagram. Any reasonable number of junctions can be formed within a single glass capsule using techniques that require little or no individual hand assembly. The units lend themselves ideally to efficient and economical mass production methods.

Objectives in the design of these units were to decrease size and weight, and increase reliability of any electronic system that use diodes, specifically in computer and logic systems.

Several semiconductor junctions are encapsulated in a glass rod that only slightly exceeds the dimensions of the conventional single diode. Since all junctions within the package are formed on a single slice of silicon, no internal interconnections are necessary to obtain a standard gate configuration. All leads conform with the standard hole spacing presently used on etched circuit boards.

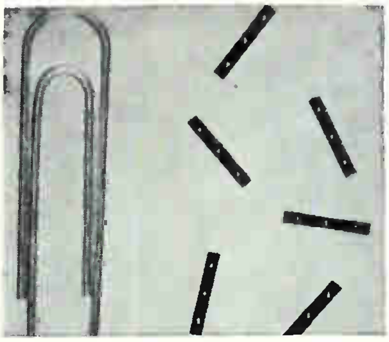
A conventional computer logic gate circuit consists of up to 19 diodes on one board 5¼ in. by 1$\frac{11}{16}$ in. By substituting the individual diodes with four four-junction compact diodes and one three-junction compact diode, the size of the board is reduced to 3$\frac{9}{16}$ in. by $\frac{9}{16}$ in. (see photos).

Manufacturing costs of the circuit boards is greatly reduced, material and labor is saved by reducing the number of solder connections. While the size of the board could be reduced even more, current configuration was adapted to fit existing connectors.

The construction utilizes established techniques wherever possible to ensure high reliability.

The basic element of the compact diode is a sliver of silicon approximately 0.050 in. × 0.010 in. × 0.5 in. Junctions are spaced 0.1-in. apart and any number can be made on a single sliver. Present diodes contain either 3, 4, or 5 junctions. These junctions are made by established alloy or diffusion processes. Junction slivers could be mass produced by the foot, with the material clipped off at any length to provide the number of junctions required.

Once the junction is made on the silicon sliver, leads are attached to each individual junction and a



Silicon slivers with junctions are the basic elements of the Poly-Diode Compactode. These slivers are used for a triple-diode unit

common lead to the sliver, providing anode and cathode connections. Connections are made with existing transistor welding techniques, and the entire assembly is glass encapsulated. All leads come out from one side to allow through-board connections and flush mounting of the entire unit.

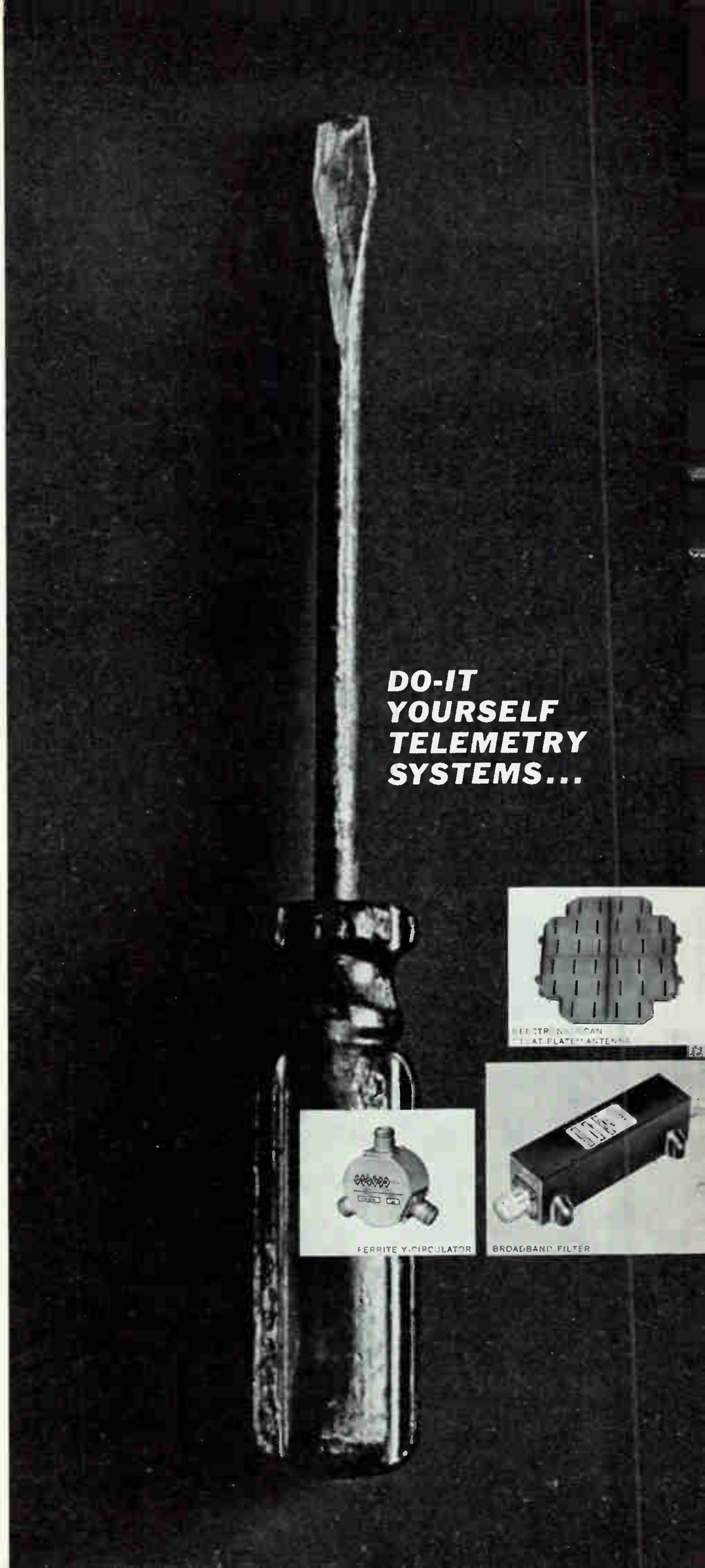
The operation of the Poly-Diode is exactly the same as individual diodes and the parameters are equivalent to individual diodes. Built-in interconnections through the use of a common silicon sliver give greater uniformity than could be accomplished through the use of individual diodes.

Junction characteristics have been proven out in every respect. Uniformity of each junction is extremely high due to simultaneous manufacturing processes.

Since the silicon sliver is taken from a relatively small section of the original silicon ingot, the necessity of matched pairs is often eliminated. Thermal characteristics are excellent due to compatibility of the silicon junction and the encapsulating glass. These diodes also have excellent environmental characteristics.

The compact diode is adaptable to any computer logic system and is presently being considered in several programs that will make use of this diode configuration as a circuit function component.

It is anticipated that use of the multiple diode in place of conventional diodes will reduce the overall size and weight of the logic section of computers by as much as 40 percent without changing the circuits at all. Identical connectors are used throughout, but with slight wiring modifications, the space between connectors can be



greatly reduced because of the great reduction in the size of the individual circuit boards.

Each step in the construction of the new diodes utilizes proven techniques that are fully debugged to provide maximum reliability and adaptability to economical mass production.

REFERENCE

(1) Delta Semiconductors, Inc., 835 Production Place, Newport Beach, Calif.

Tiny Resistor

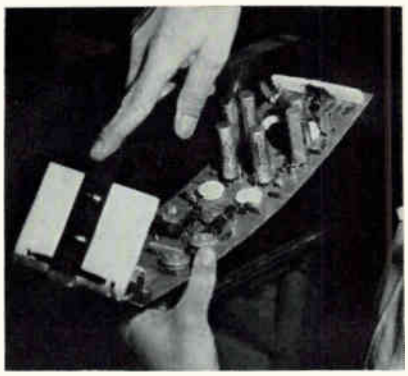
SIZE REDUCTION continues in resistors with news that a unit, measuring only 1/16 x 1/16 in. (ELECTRONICS, Mar 31, p 69), has been developed by Reon Resistor Corp. Yonkers, N. Y. for micro-miniature circuits used in space programs.

The micro-miniature resistor is available in resistive values from one ohm to 50 K. The units can be manufactured with power ratings 0.02 watts.

The concept of the new resistor is simple; however, great care is exercised during all manufacturing operations. Fine resistance wire (as small as 0.00045 in. diameter) is wound on a spindle until the correct number of turns have been completed for the desired resistance value. An epoxy bonding agent, applied to the coiled wire provides the required structural strength. The ends of the wire are then attached to appropriate circuit terminals. The unit can be suitably bonded to a printed wiring board to prevent damage from shock and vibration.

In conventional wire-wound resistors, the resistance wire is wound on a bobbin and connected to heavy electrical leads which are terminated in the bobbin. The two extra elements—the bobbin and leads—add considerably to the size and weight of the unit.

Rolling large boards keeps the solder surface hot and prevents tailing and bridging



Strap bows board when ends are inserted in Teflon plates

Rolling Circuit Boards Improves Soldering

QUALITY OF SOLDER JOINTS in large, dip-soldered, printed wiring boards is improved if the entire board is not dipped into the solder pot at one time. Rolling the board over the solder surface minimizes cooling of the solder surface and also helps prevent solder tailing.

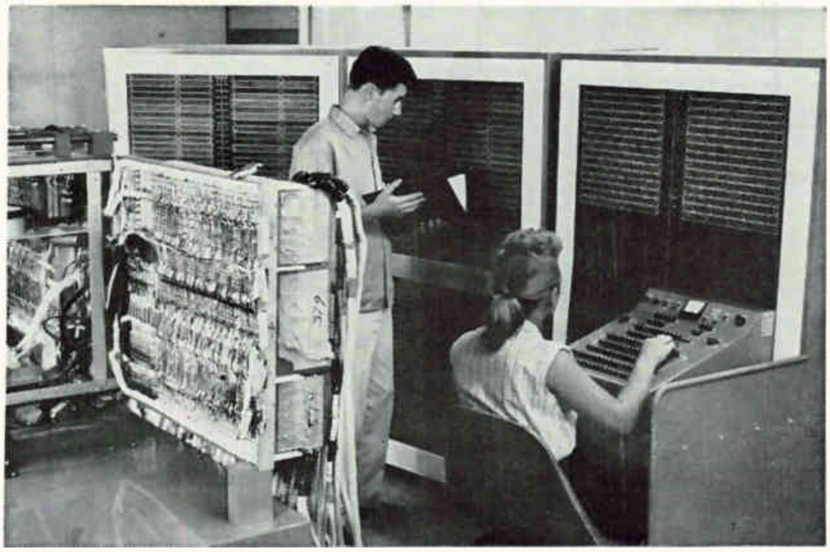
This technique is used by Electronic Associates, Inc., Long Branch, N. J. The boards are arced for rolling by a fixture which doubles as a convenient handle for dipping the assembly. The fixture is a metal strap with Teflon plates at each end. The strap is short enough to bow the board and hold it securely. Plates grip the board ends in slots, connector cutouts, etc., depending on board design.

The operator puts one end of the board on the solder and slowly rotates the holder. The dipping cycle is set at eight seconds, by a timer alarm, so each portion of the board is only in the solder for a few seconds. The rolling action withdraws the board at an angle, preventing tailing and minimizing bridging and waste of solder. The principle is similar to that used in wave soldering machines.

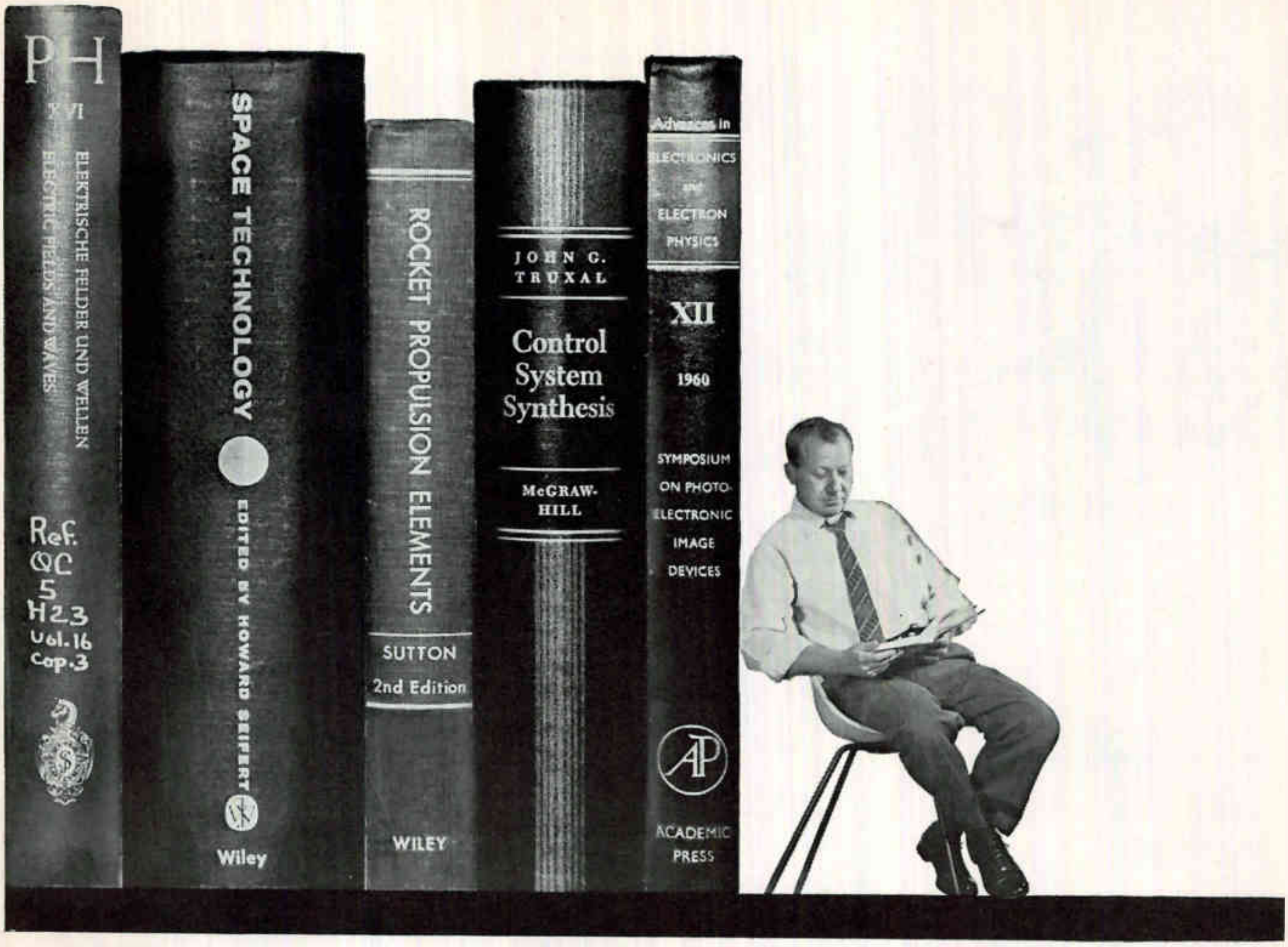
Dross is cleared from the dipping area before each dip, but allowed to remain over the rest of the solder. The wiper blade is an L-shaped plate of Teflon slightly wider than the boards. The bulk of the dross is swept into a dross trough. After the blade has been used for a while, stray particles of dross will adhere to it, assuring a clean solder surface. Teflon blades last over three years.

These operations should be per-

High-Capacity Continuity Tester



Wiring continuity tester recently introduced by Autonetics Division of North American Aviation, Downey, Calif., will test one to 20 wires per second, depending on number of wires to a connector pin. It uses a master, does not need programming. Consoles can be ganged



electronic and electromechanical engineers in a unique role

The engineers and scientists of Aerospace Corporation are in the forefront of a rapidly advancing state-of-the-art in sensing and information systems. Their unique role: a critical civilian link uniting government and the scientific-industrial team responsible for development of space systems and advanced ballistic missiles. In providing scientific and technical leadership to every element of this team, they are engaged in a broad spectrum of activities, from formulation of new concepts to technical review and supervision of hardware development by industry. Specific areas of interest include inertial and radio guidance, automatic control, communications, instrumentation, space- and ground-based computing, telemetering, tracking, auxiliary power, infrared, television, optics, and photography. Now more men of superior ability are needed; highly motivated engineers and scientists with demonstrated achievement, maturity, and judgment, beyond the norm. Such men are urged to write Mr. George Herndon, Aerospace Corporation, Room 116, P. O. Box 95081, Los Angeles 45, California.

Organized in the public interest and dedicated to providing objective leadership in the advancement and application of space science and technology for the United States Government.

AEROSPACE CORPORATION

formed in an exhaust hood or in a well-ventilated area to dissipate any fumes which might be given off by the heated plastic.

Coating and Bonding Copper by Diffusion

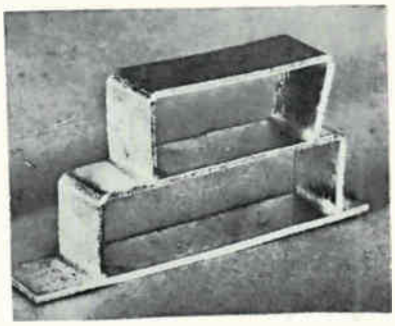
DIFFUSION BONDS of copper to copper and some other alloys can be made by a new technique announced by Chase Brass & Copper Co., Waterbury, Conn. Joints are reported to be as strong or stronger than the base metal and to retain electrical and thermal conductivity. When made under proper conditions, the bond has no interface.

The copper is coated with a dispersion of finely-ground phosphorous copper in a lacquer-type vehicle. This can be applied to fabricated parts or to copper strip before it is rolled to finished gauge. Coated strip can be annealed in non-oxidizing atmosphere and blanked, deep drawn, bent or stamped.

Coated parts are bonded by placing them in contact and heating at 1,700 F to 1,800 F in a hydrogen or inert atmosphere for a short time, usually five to 15 minutes. The vehicle evaporates.

The Chase Research and Development Department has developed three joining methods. The coating can be placed on a copper mill product or fabricated part before bonding. Second, at least one of any two parts to be joined is made of copper strip coated before final rolling. Third, an insert of thin strip, precoated on both sides, joins two uncoated parts.

At its present stage of development, the process has some limitations. After bonding, the base metal is fully annealed. Some applications will permit mechanical working to

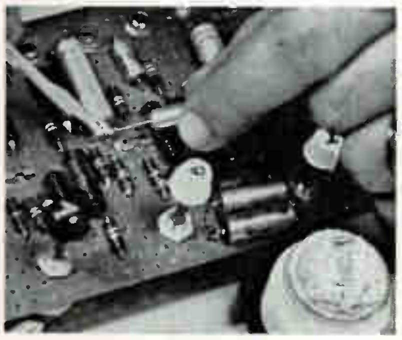


Sample edge-to-surface joints were made with coated strip with uncoated edges increase hardness and tensile properties. The process is suitable for some copper alloys, particularly those with high copper content.

True diffusion bonds have not been achieved yet with brass containing more than five percent zinc. However, braze type joints have been obtained by the process with brass containing up to 30 percent zinc. These joints have a separate phase at the bond line.

Anticipated applications include motors, generators, transformers, switchgear, relays, control equipment, electronic tubes, microwave devices, semiconductors and heat exchangers. Experimental samples are available.

Conductive Epoxies Solder Without Heat



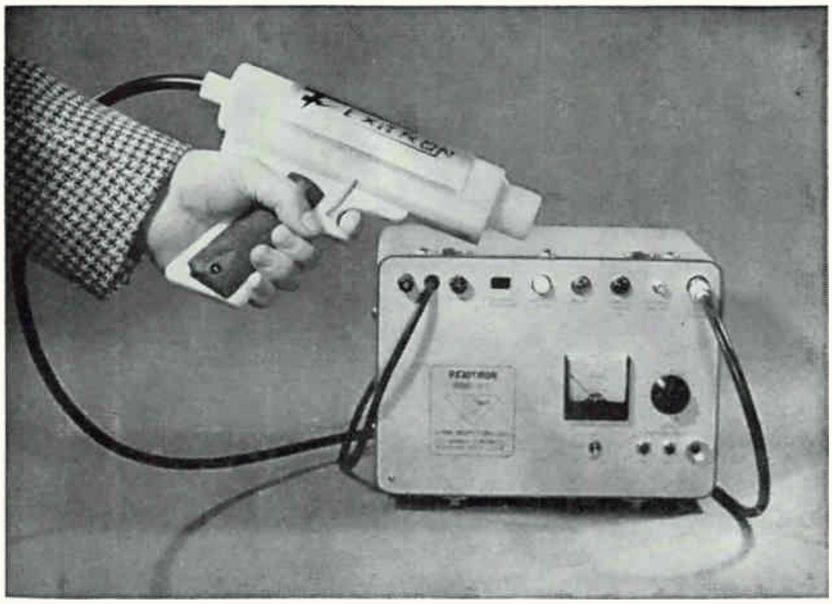
CONDUCTIVE SILVER EPOXY that can be used as a low-temperature, fluxless "solder" is announced by Epoxy Products, Inc., Irvington, N. J. After curing, it can be plated and soldering can be performed on the plated surface.

Bonds with a shear strength of 3,200 psi have been obtained on steel-to-steel, according to the firm. Aluminum will tear before the bond fails and good bonds are also obtained with dissimilar metals, it reports.

Suggested applications include field repairs on printed circuits, bonding electron tube caps to glass tubes, bonding tantalum slugs to capacitor cans, connections to heat-sensitive semiconductor devices and ground aluminum capacitors to steel chassis.

The epoxies have resistivity between 0.01 and 0.0001 ohms-cm. They are made as paste which cures at temperatures as low as 125 C, or two-part paste which cures at room temperature.

New On The Market



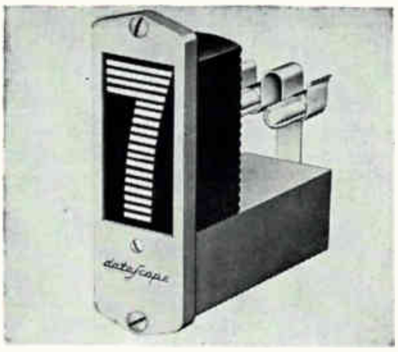
X-Ray Flash
0.03 μSEC EXPOSURE

SMALL flash X-ray unit weighing 40 lb and less than a cubic foot in volume is announced by Field Emission Corp., McMinnville, Oregon. The instrument has applications in research and nondestructive testing. In medicine, its portability allows the X-ray device to be brought to the patient; its short exposure time prevents motion blur.

Model 210 Flexitron has a peak power of 140 million watts and exposure time of 0.03 μsec. The X-ray tube is housed in a hand held pistol grip about the size of a .45 automatic.

CIRCLE 301 ON READER SERVICE CARD

Digital Readout
SELF-DECODING



SELF-DECODING readout is announced by Datascope Corp., 4023 Irving Place, Culver City, Calif. Designed as a complete package, unit mounts in a 1 × 3.1 inch panel, extends 2.5 in. behind panel.

Instrument decodes either binary inputs or pulse trains, and displays information in digital form. Sixteen $\frac{3}{4} \times 1\frac{1}{4}$ alpha-numerical characters are displayed at up to 50 characters per second. Ten symbols are the normal decimal digits and six are to customer specification. Built-in memory keeps the last character without power.

Each readout is lighted by two incandescent bulbs, wired in parallel. A common light source can be used when units are mounted side-by-side.

Unit operates on either 12 or 28 volts d-c; power requirement is 0.57 watt-second per bit; price is \$20 to \$50 depending on quantity.

CIRCLE 302 ON READER SERVICE CARD

Microwave Carrier System
USES TRANSISTORS

COMPLETELY transistorized microwave carrier system has been introduced by the Texas Division of Collins Radio Co., 1930 Hi-Line Dr., Dallas, Texas.

MX-106 microwave carrier system requires $\frac{1}{5}$ the rack space and consumes $\frac{1}{8}$ the power of similar tube equipment. The system handles up to 600 voice channels whose quality meets or exceeds toll circuit requirements. An initial low channel density system can be expanded easily and economically at any time.

The system uses frequency division with single sideband, suppressed carrier techniques. Frequency allocations, sideband allotment, and carrier levels are compatible with Collins MX-103 carrier, Western Electric L-type carrier, CCITT and others. Multiple modulation techniques are used to form a composite baseband signal for broadband transmission.

CIRCLE 303 ON READER SERVICE CARD

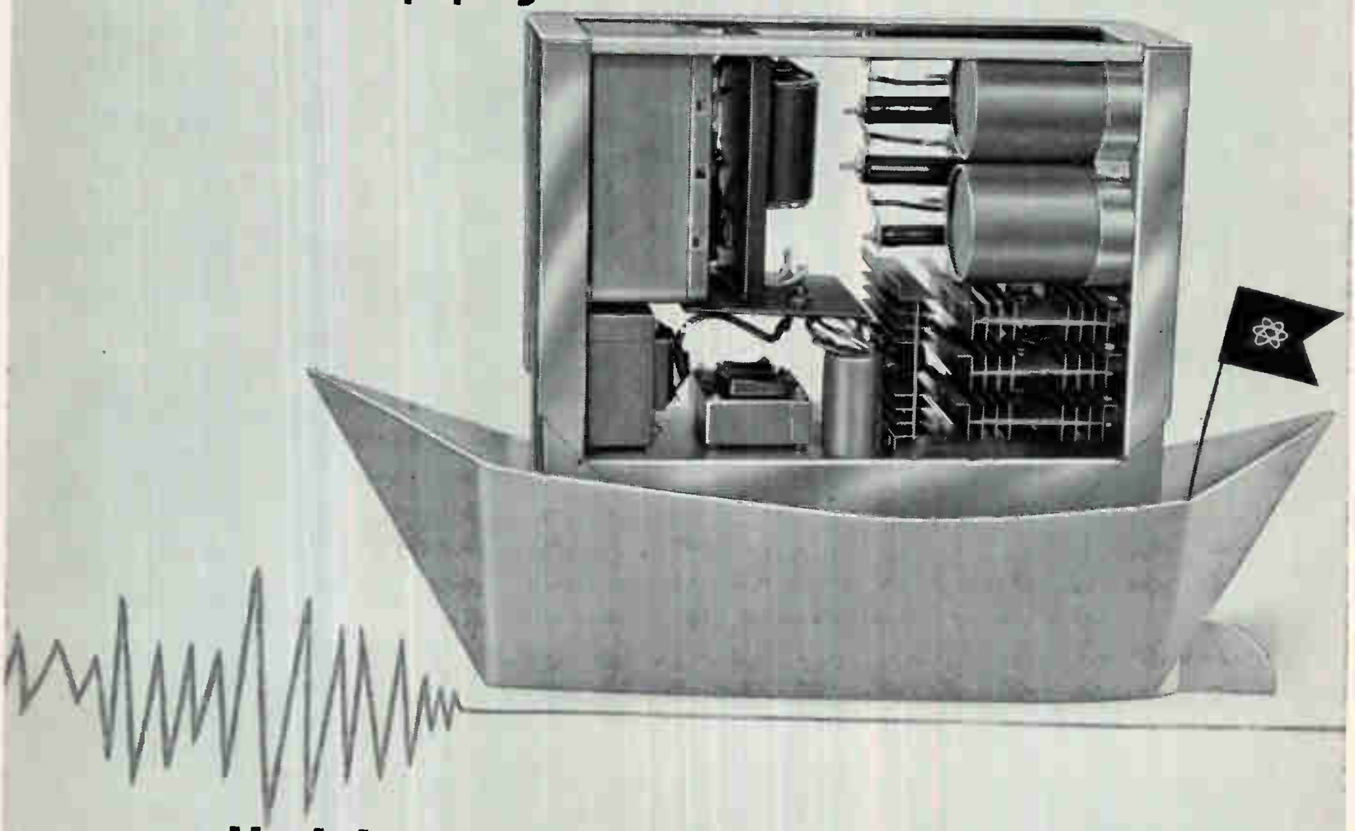
Video Amplifier
PASSBAND TO 11 MC

TRANSISTORIZED video amplifier was designed to transmit television signals from missile launching pads. It gives high resolution and permits tv cameras to be placed at greater distance than was heretofore considered possible. The unit also serves as a general-purpose wide-band video amplifier. Construction is to military specifications—government source inspection if required.

Technical specifications include:

new SOLA transistorized d-c supply...

140×10^6
3×10^{-8}
420×10^{-2}



reliably regulates d-c voltage — right down to the last "**ripple**"!

New highly sensitive SOLA "CVQ" provides transistor-regulated d-c output ideal for computers and other *voltage-sensitive equipment*. Response to voltage change is so rapid the CVQ even attenuates 120-cycle ripple! Yet, with it all, this new d-c supply introduces a revolutionary circuit simplicity — providing significant savings in sizes . . . more watts per dollar!

CVQ combines exclusive transistorized shunt regulation with SOLA's inherently self-protecting, static-magnetic transformer . . . easily meets the most taxing demands of dynamic loading. Voltage holds in spite of widely fluctuating loads. The result is longer equipment life, more trouble-free operation. Contact our area representative for complete specifications and prices. Or write today for literature on CVQ.

- Standard models available at 5, 6, 10 and 12 volts d-c (100-130/181-235/200-260 volt input).
- Output regulated within ±0.04% for line voltage variations ±15%; 0.2% static-load regulation, 0 to full load.
- Excellent transient response.
- Inherent protection against output over-voltage safeguards both supply components and external circuitry.
- Short-circuit proof design.
- Compact mechanical layout — only 12¼ x 5¼ x 19″

SOLA

Division of Basic Products Corp.

B P C

SOLA ELECTRIC CO.
Busse Road at Lunt, Elk Grove Village, Ill.
HEmpstead 9-2800.
IN CANADA, Sola-Basic Products Ltd., 377 Evans Ave., Toronto 18, Ontario

CIRCLE 87 ON READER SERVICE CARD

bandpass from 15 cps to 11 Mc ± 3 db, 20 cps to 8 Mc ± 0.5 db; gain of 18 db, 1 volt peak-to-peak input, 10 volts peak-to-peak output maximum; impedance, 75 ohms in and out.

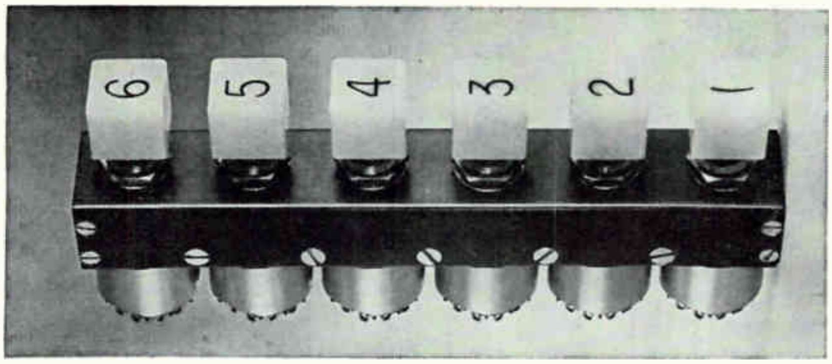
Amplifier model 1011 is equalized for up to 2,000 ft RG-11/U coaxial cable ± 1½ db from 20 cps to 8 Mc; it is manufactured by Community Engineering Corp., 234 East College Ave., State College, Pa.

CIRCLE 304 ON READER SERVICE CARD

transmission is accomplished over a single coax line or a single radio-frequency channel. Input voltage is 0 to +5 v dc, input impedance is 100,000 ohms, frame rate of 100 per sec. Accuracy (including display) is 2 percent of full scale, crosstalk is better than 50 db and input power (less display) is 35 watts, 115 v, 60 cps.

The data are displayed as a series of bar graphs with applications to go/no-go checkout of complex systems, display of data telemetered from aircraft and missiles, and display of data obtained from uninhabitable locations such as high powered radars and nuclear reactors. Manufacturer is Sierra Research Corp., 240 Cayuga Road, P. O. Box 22, Buffalo, N. Y.

CIRCLE 307 ON READER SERVICE CARD



Small Push-Switch

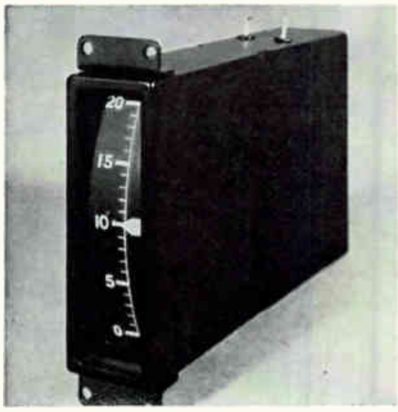
INTERLOCKED GANGS

PUSH-SWITCH that can be used individually or in interlocked, ganged groups has been announced by Pepco, Inc., 2080 Placentia Ave., Costa Mesa, Calif.

The individual snap-action switch is 1¾ inch long, and occupies less than 1 inch behind the panel. Solid silver alloy contacts provide 100,000 cycles at rated load. For low-level switching, gold-plated contacts are available. The unit can also be provided with O rings and seal to meet MIL spec 6743.

Switch load is 5 amp resistive, 3 amp inductive. Contacts to 6-pole double-throw; a variety of interlocking modes is available.

CIRCLE 305 ON READER SERVICE CARD



Edgewise Meters

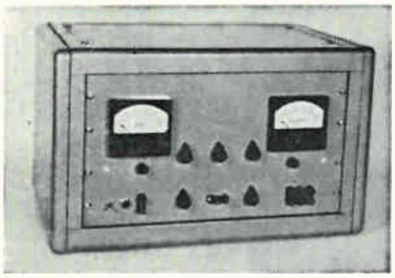
HERMETICALLY SEALED

LINE of long scale, three inch edgewise d-c and a-c meters has been developed by Minneapolis-Honeywell Precision Meter Div., Grenier Field, Manchester, N. H.

The hermetically sealed instrument is available for d-c voltage and current (200 microamperes and up) and uses rectifiers for a-c. Mechanism is shielded and panel material has no influence on calibration.

The instrument, MDE-3, may be mounted horizontally or vertically.

CIRCLE 308 ON READER SERVICE CARD



h Parameter Tester

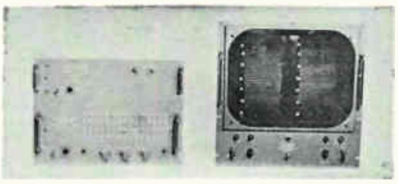
HIGH-SPEED OPERATION

PARAMETER TESTER will test the four *h* parameters of any signal transistor to an accuracy of 2 percent, over wide operating ranges, in either grounded base or grounded emitter configurations. Test equipment does not require d-c or a-c rebalancing when switching between grounded base and grounded emitter.

Designed for laboratory and production line, the equipment has instantaneous pushbutton calibration, mercury-wetted relays, 10 cps narrow band signal amplifier, and two separate power supplies.

Price is $1,500, less test oscillator and readout meter; delivery is 30 days; from Tenco Electronics, Inc., 108 Cummington St., Boston 15, Mass.

CIRCLE 306 ON READER SERVICE CARD



Oscilloscope Display

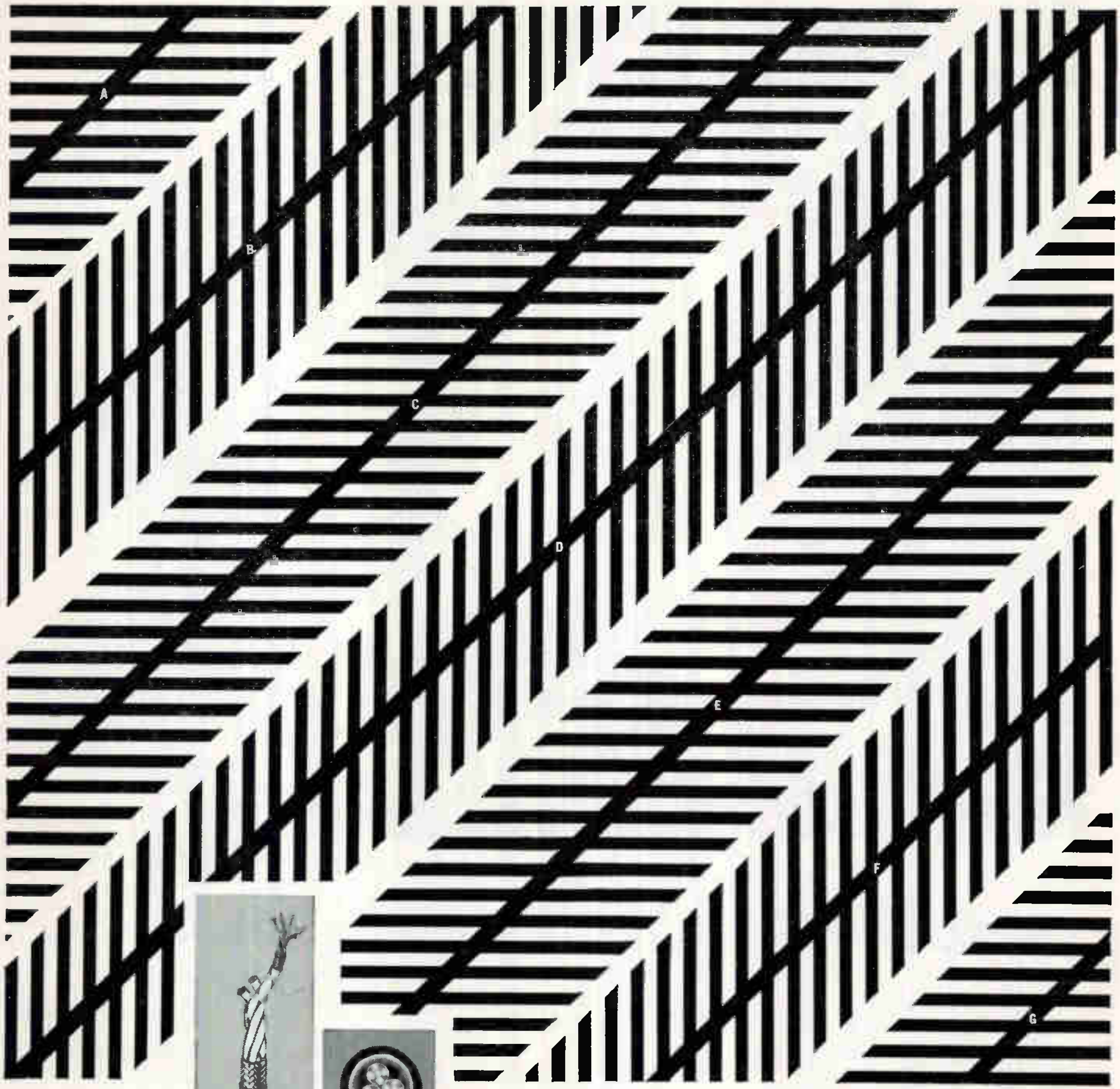
100 CHANNELS

ELECTRONIC commutator and monitor oscilloscope have been combined to produce a display of up to 100 channels of information. Data

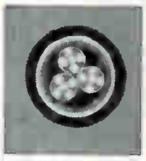
Signal Generator

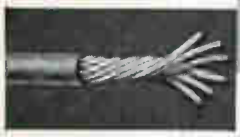
TUNING FORK CONTROL

FORK STANDARDS, INC., 1915 N. Harlem Ave., Chicago 35, Ill. Minia-

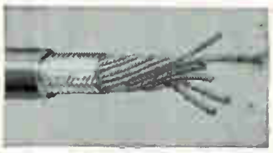


Are lines A thru G parallel?





At Hitemp–Quality is not an illusion



Pick up and examine several different brands of wire and cable. Almost identical, aren't they? Their similarity with regard to quality, however, is just as much an illusion as the art form above.

Although similar materials and equipment may be used in making all brands of wire and cable, one brand—Hitemp—will outlast, outperform the others.

Idle chest thumping? No! Hitemp has the greatest store of experience in the industry—two modern production facilities that are second to none—and more than one-fourth of its entire work force devoted solely to inspection and quality control.

Hitemp products are for you, the wire and cable user who requires quality and reliability that is fact, not illusion.

Hitemp is a Division of Simplex Wire & Cable Co.

HITEMP WIRES CO.

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

CIRCLE 89 ON READER SERVICE CARD

ture, precision signal generator has its frequency stabilized by a temperature compensated tuning fork, and provides 1 mw output in either a sine or square wave. Transistorized unit is potted and hermetically sealed in a box of approximately 6 cu in. Prices range from $110 for a 0.5 percent accuracy square wave unit, to $205 for a 0.002 percent accuracy sine wave unit.

CIRCLE 309 ON READER SERVICE CARD

Static Inverter
SOLID STATE

ADVANCED ELECTRONICS CORP., 2 Commercial St., Hicksville, L. I., N. Y. Model IPD-10 is a 100 v-a static inverter for missile and airborne applications. It converts a nominal 28 v d-c battery power to 400 cycle, a-c output, 25-115 v, with output regulation of ± 1 percent. Unit is capable of continuous operation over temperature range of − 35 C to + 75 C.

CIRCLE 310 ON READER SERVICE CARD

Insulation Measurement

ROHDE & SCHWARZ SALES CO., INC., 111 Lexington Ave., Passaic, N. J. Designed for resistance measurements, the Jahre teraohmmeters cover the range 2 megohms to 5,000 teraohms at potentials up to 1,000 v.

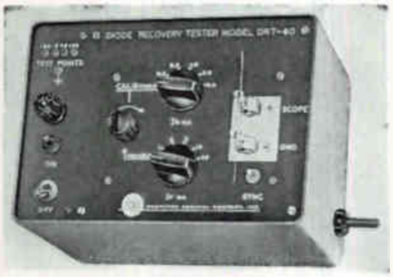
CIRCLE 311 ON READER SERVICE CARD

Miniature Dial
CONCENTRIC SCALE

BORG EQUIPMENT DIVISION, Amphenol-Borg Electronics Corp., 120 S. Main St., Janesville, Wisc. Only

1 in. in diameter, or 1 5/32 in. with addition of a finger-tip brake, the 3000 series Microdial projects from a panel of only 15/16 in. and can be grouped as closely as 1¼ in. centers. It is designed for accurate angular positioning of any precision pot or shaft-controlled device of 10 turns or less.

CIRCLE 312 ON READER SERVICE CARD



Test Instrument
FOR ULTRAFAST DIODES

COMPUTER CONTROL CO., INC., 983 Concord St., Framingham, Mass. Model DRT-40 provides fast and accurate answers in measuring semiconductor diode reverse recovery characteristics by means of a stored charge technique. It is designed for diode manufacturers, diode users and circuit designers.

CIRCLE 313 ON READER SERVICE CARD

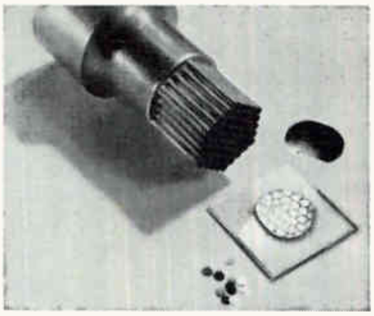
Digital Converter

WINSCO INSTRUMENTS & CONTROLS CO., 11789 W. Pico Blvd., Los Angeles 64, Calif. Used with digital frequency-period counters, the all solid state digital converter provides a means for direct measurement of temperature, pressure, and other process variables.

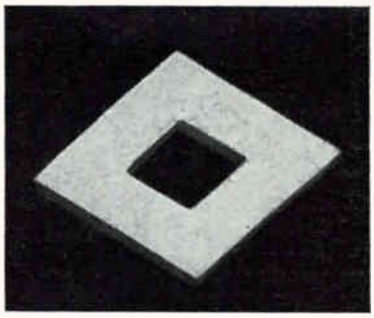
CIRCLE 314 ON READER SERVICE CARD

Subminiature Switch
EXTREMELY SENSITIVE

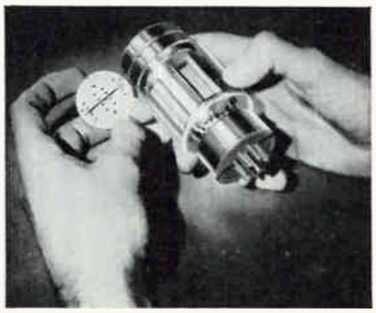
MICRO SWITCH, a division of Minneapolis-Honeywell Regulator Co., Freeport, Ill., announces a subminiature switch designed for temperature or pressure control for mili-



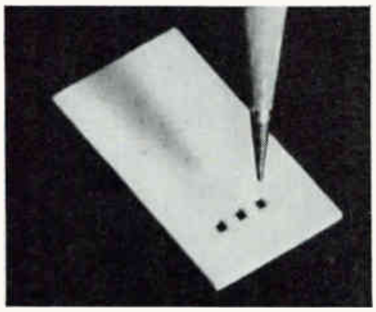
(1) SILICON



(2) FERRITES



(3) CERAMICS



(4) ALUMINUM OXIDE

ULTRASONIC MACHINING: 1. dicing silicon wafers; 2. cutting ferrite cores; 3. cutting holes and slots in ceramic tube spacers; 4. drilling holes in aluminum oxides.

Low-cost, high-speed PRECISION MACHINING of hard or brittle materials with ULTRASONICS

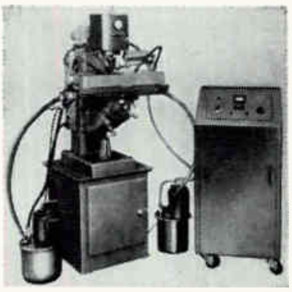
The delicate cutting operations shown above were all performed with Impact Grinders—Raytheon's ultrasonic machines that drill, slice, engrave, trepan or shape hard and brittle materials.

Design, materials and production engineers who have tried this remarkable technique agree that it is the optimum method for machining such materials as silicon, germanium, ferrites, ceramics, carbides and glass.

In impact grinding the tool is made to vibrate ultrasonically as abrasives are introduced between tool and workpiece.

Find out how one of these cost-saving, high-production-rate units can solve your machining problem.

SEND FOR BROCHURE No. 2-300 today. Address Raytheon Company, Production Equipment Operations, Commercial Apparatus & Systems Division, Technical Information Service, Waltham 54, Massachusetts.



MODEL 2-332 Raytheon Impact Grinder

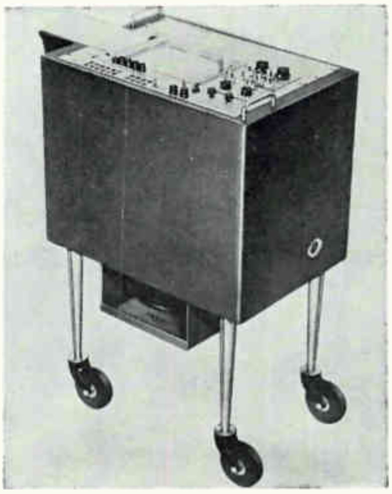
RAYTHEON

RAYTHEON COMPANY

COMMERCIAL APPARATUS & SYSTEMS DIVISION

CIRCLE 93 ON READER SERVICE CARD

tary, electronic or instrument applications. Operating force for the switch is a maximum 3½ oz., release force 1 oz maximum; differential travel 0.001-in. maximum; overtravel 0.003-in. minimum and a 0.008-in. minimum break travel.
CIRCLE 315 ON READER SERVICE CARD



Mobile Oscillograph
EASY TO HANDLE

SANBORN CO., 175 Wyman St., Waltham 54, Mass. Model 297 two-channel oscillograph recording system, which uses plug-in interchangeable "850" style preamplifiers, is housed in a 35-in.-high wheel mounted cabinet that permits easy movement between rooms or into and out of elevators. Frequency response to 125 cps, within 3 db at 10 mm peak-to-peak amplitude; gain stability better than 1 percent over 20 C temperature changes and 20 v power line variations; max nonlinearity 0.25 mm.
CIRCLE 316 ON READER SERVICE CARD

Alarm Scanner

THE BRISTOL COMPANY, Waterbury 20, Conn. A 200 point transistorized instrument scans up to 200 measured variables at the rate of one point per second.
CIRCLE 317 ON READER SERVICE CARD

Transformers
AND REACTORS

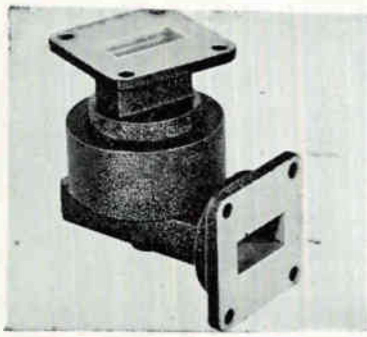
COMMUNICATION ACCESSORIES CO., Lee's Summit, Mo., can now supply design and production of transformers and reactors with ratings to 40 Kv and 1 Kva. These high voltage units are designed to customer specifications. Company has facilities for voltage breakdown and corona measurements which meet requirements for testing in accordance with MIL-T-27A. Delivery 4 to 8 weeks.

CIRCLE 318 ON READER SERVICE CARD

Filter

BURNELL & CO., INC., 10 Pelham, Parkway, Pelham, N. Y. A low transient response filter, possessing special time and steady state properties, developed through the use of exact network synthesis.

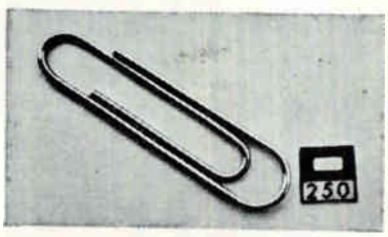
CIRCLE 319 ON READER SERVICE CARD



Rotary Joints
L-STYLE

MICROWAVE DEVELOPMENT LABORATORIES, INC., 92 Broad St., Babson Park 57, Wellesley, Mass. Eight different L-style waveguide rotary joints are now available in stock designs. They may be had in WR90 EIA waveguide sizes for operating ranges of 8,500 to 9,600 Mc and 8,500 to 10,000 Mc; in WR112 waveguide sizes for 8,500 to 9,600 Mc; and in WR187 waveguide sizes for 5,400 to 5,900 Mc.

CIRCLE 320 ON READER SERVICE CARD

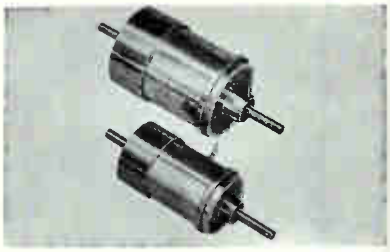


Miniature Label
SHOWS TEMPERATURE

PYRODYNE, INC., 11973 San Vicente Blvd., Los Angeles 49, Calif. Model

200 Temp-Plate is a miniature temperature indicating label. It is useful for instrumenting transistors and other miniature electronic components, inaccessible machinery areas, and general industrial or aviation equipment. The hermetically sealed device, a tiny plastic adhesive tab that sticks on almost any surface, turns black when its temperature reaches any desired value between 100 and 500 F.

CIRCLE 321 ON READER SERVICE CARD



Brake-Clutches
IN SIZES 8 AND 11

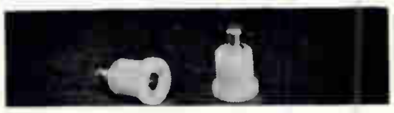
BOWMAR INSTRUMENT CORP., 8000 Bluffton Road, Fort Wayne, Ind., has developed electrically operated brake-clutch components in sizes 8 and 11 for servo applications. They have standard BuOrd mountings and are designed for use in motor-potentiometer, motor-gearhead or other control assembly configurations requiring fast stopping or starting.

CIRCLE 322 ON READER SERVICE CARD

Synchro Switch

CLIFTON PRECISION PRODUCTS CO., INC., 5050 State Rd., Drexel Hill, Pa. Mounted on the end of a size 8 synchro, the sector switch provides a closed circuit when the synchro position exceeds ±70 deg from electrical zero.

CIRCLE 323 ON READER SERVICE CARD



Test Jack
SPACE SAVER

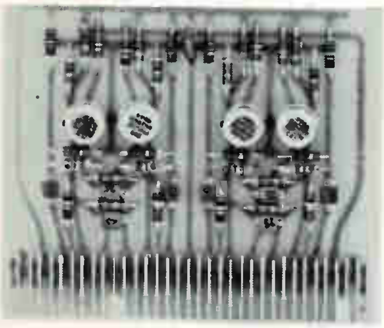
SEALECTRO CORP., 610 Fayette Ave., Mamaroneck, N. Y. Press-Fit SKT-37 Teflon-insulated test jack receives a 0.090 in. diameter probe, 0.140 in. long. Overall diameter, above the chassis, is 0.218 in.; overall height, including mounting shoulder and soldering stud, is 0.340 in. Test jack has a 0.170 in. diameter body for the through-chassis mounting. The electrical contact for the test probe is of beryllium copper, providing positive, low-resistance conductivity for accurate take-off measurements.

CIRCLE 324 ON READER SERVICE CARD

Indicator Tube

ELECTRONIC INDUSTRIES, INC., 18 Marshall St., South Norwalk, Conn. Subminiature indicator thyratron, designed for use as a readout device in miniaturized computer panels, measures a maximum of 0.210 in. in diameter.

CIRCLE 325 ON READER SERVICE CARD



Digital Modules
HIGH DENSITY

PACKARD BELL COMPUTER CORP., 1905 Armacost Ave., Los Angeles 25, Calif., announces a line of low cost 200-Kc digital modules featuring two to four times the circuit density of previously available units. The modules are contained on 4 by 4 in. glass based p-c cards incorporating an Elco 35-pin connector. Four identical but independent flip-flop circuits are provided on the model TF-101 typical of the line. This unit is priced at $110.

CIRCLE 326 ON READER SERVICE CARD

Recorder/Reproducer
INSTRUMENTATION TYPE

MINCOM DIVISION, Minnesota Mining and Mfg. Co., 2049 S. Barrington Ave., Los Angeles 25, Calif. The G-100 instrumentation recorder/reproducer features wide dynamic range, all-transistored electronics and bandwidth of 200 cps to 300 Kc at 60 ips with analog modules or d-c to 20 Kc with f-m modules. Selection of 6 tape speeds, 7 or 14 tracks.

CIRCLE 327 ON READER SERVICE CARD

Isolation Transformer
350-WATT UNIT

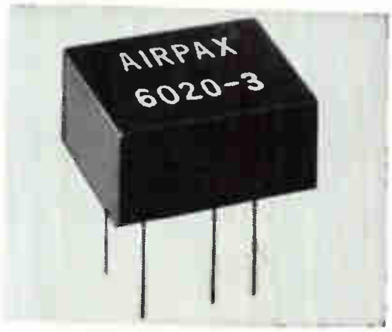
ELCOR INC., 1225 W. Broad St., Falls Church, Va. Model L131 power Isoformer is a 350-w isolation transformer featuring low distributed capacitance between the secondary winding and ground. Intended for general purpose laboratory use or for mounting as a component in equipment the unit permits isolating from ground a complete instrument or a component circuit.

CIRCLE 328 ON READER SERVICE CARD

Voltmeter

ORION ELECTRONIC CORP., 108 Columbus Ave., Tuckahoe, N. Y. Voltage scale is calibrated in rms voltage of a pure sine wave. Measures from 0.1 mv to 300 v in 12 ranges.

CIRCLE 329 ON READER SERVICE CARD



Transistor Chopper
FOR P-C USE

AIRPAX ELECTRONICS INC., Cambridge, Md. Type 6020-3 molded transistor chopper operates over a d-c to 100 Kc chopping range. Drive voltage may be 2 to 20 v peak square wave or 5 to 20 v peak sine wave. The units operate over a −55 C to +125 C temperature range. Peak signal voltage may be as high as 30 v; maximum signal current is 3.0 ma.

CIRCLE 330 ON READER SERVICE CARD

Diode Classifier
AUTOMATIC UNIT

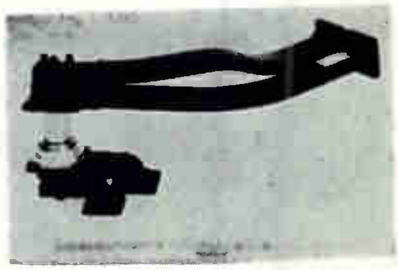
DYNATRAN ELECTRONICS CORP., 178 Herricks Road, Mineola, N.Y. Model 1820 automatically classifies diodes at a rate in excess of 1,200 per hr. The diodes are fed into a conveyor system in the oven unit where they are brought up to temperature and tested for reverse leakage characteristics at various reverse voltages. They are then automatically ejected into the correct bin and counted. Shorted and open diodes are also separated.

CIRCLE 331 ON READER SERVICE CARD

D-C Amplifier

UNITED ELECTRODYNAMICS, INC., 200 Allendale Rd., Pasadena, Calif. Fully transistorized and operating from unregulated 28v d-c, the differential amplifier performs under airborne requirements.

CIRCLE 332 ON READER SERVICE CARD



Rotary Joint
DUAL CHANNEL

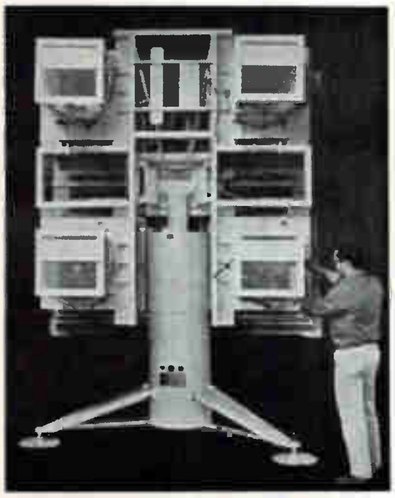
CANOGA CORP., P.O. Box 550, Van Nuys, Calif. Model RJXD-1C dual channel microwave rotary joint, both channels of which propagate X-band energy, consists of sections of waveguide; waveguide to coaxial transitions and a coaxial noncontacting choke joint. The high power channel operates in a frequency range of 8.5 to 9.6 Gc; power handling of 250 Kw; vswr 1.2; insertion loss 0.4; vswr wow is 0.04 db; flanges UC-137A/U.

CIRCLE 333 ON READER SERVICE CARD

Photocells

CETRON ELECTRONIC CORP., 715 Hamilton St., Geneva, Ill. Subminiature lead sulfide infrared cells are all glass hermetically sealed.

CIRCLE 334 ON READER SERVICE CARD



Antenna Mount
LOW-WEIGHT

TEMEC, INC., 7833 Haskell Ave., Van Nuys, Calif. Designed for use in telemetry reception, as well as tracking aircraft, missiles and satellites, model 10 antenna mount is a servo-controlled pedestal, for shipboard and ground based applications, with an assembly weight of less than 600 lb. All servo components are housed within the pedestal. The solid state drive system, employed throughout, controls 2-phase, 60 cps a-c servo motors of 100 or 200 w which yield speeds up to 5 rpm.

CIRCLE 335 ON READER SERVICE CARD

L-Band Amplifier

MELABS, 3300 Hillview Ave., Palo Alto, Calif. A low noise L-band diode parametric amplifier for installation in AN/TPS-1D, AN/TPS-1G and AN/FPS-36 radar systems sets the system noise figure at 2 db or better.

CIRCLE 336 ON READER SERVICE CARD

CIRCLE 99 ON READER SERVICE CARD→

High range . . . low range –

BOTH OF THESE NEW CEC PRESSURE TRANSDUCERS FEATURE BUILT-IN SHUNT COMPENSATION

These new strain gage units are the most accurate and highly sophisticated pressure transducers ever built for rugged airborne use. They were designed to outperform every known similar type of instrument... and they do.

Their shunt calibration feature permits the system designer to provide—quickly and simply—a complete calibration of his data handling system for precise control of associated equipment.

Type 4-328 (square) is a low-range unit for pressure ranges of 0-15 psi through 0-99 psi absolute. Standard ranges are 0-15, 20, 30, 50 and 75 psi absolute. **Type 4-329** (tubular) is a high-range unit for pressure ranges of 0-100 psi through 0-5000 psi absolute. Standard ranges are 0-100, 150, 250, 500, 1000, 1500, 2500 and 5000 psi absolute.

Here are some of the specifications they have in common:

Rated electrical excitation: 20v dc or ac rms; carrier frequency 0-20 kc.

Sensitivity: 50 mv ±0.25 mv into a 50k load at rated excitation and 77°F.

Compensated temperature range: +30°F. to +250°F.

Weight: 5.5 oz. max. exclusive of mating electrical connector.

Input Impedance: 700 ohms minimum.

Output impedance: 350 ohms ±10% at 77°F.

Shunt output: 33,270 ohms keyed across negative input and negative output pins at zero applied pressure, rated excitation, and 77°F., produces an electrical output change equal to the sensitivity within a tolerance of ±0.355%.

For more information and complete specifications, call your nearest CEC sales and service office or write for Bulletin CEC 4328-X4 or 4329-X4.

Transducer Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

A SUBSIDIARY OF **Bell & Howell** · *FINER PRODUCTS THROUGH IMAGINATION*

Literature of the Week

SCREEN ROOMS Erik A. Lindgren & Associates, Inc., 4515 N. Ravenswood Ave., Chicago 40, Ill. Twelve-page folder describes double electrically isolated r-f rooms built in demountable sections.

CIRCLE 337 ON READER SERVICE CARD

MICROWAVE EQUIPMENT PRD Electronics, Inc., 202 Tillary St., Brooklyn 1, N. Y. A 4-page, 3-color, bulletin 600 categorizes the company's complete line of waveguide and coaxial bolometers, thermistors and mounts.

CIRCLE 338 ON READER SERVICE CARD

MICROVOLT MODULATOR James Electronics Inc., 4050 No. Rockwell St., Chicago 18, Ill. A 4-page catalog covers the Micro-Modulator, a solid state magnetic modulator for low level a-c and d-c instrumentation.

CIRCLE 339 ON READER SERVICE CARD

WIRE MARKING Kingsley Machine Co., 850 Cahuenga Blvd., Hollywood 38, Calif., has published a folder on its equipment for marking insulated wires and sleeving.

CIRCLE 340 ON READER SERVICE CARD

PACKAGED AMPLIFIERS Watkins-Johnson Co., 3333 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif. A technical bulletin describes the WJ-111 and WJ-112 packaged wideband amplifier units covering the 2 to 4 Gc and 1 to 2 Gc regions respectively.

CIRCLE 341 ON READER SERVICE CARD

TRANSFORMERS Precision Electronics, Inc., 48 Merrick Road, Rockville Centre, N. Y., has published a 4-page facilities brochure describing its "assured reliability" concept for the production of transformers, coils, and inductive components.

CIRCLE 342 ON READER SERVICE CARD

P-C BOARDS & ASSEMBLIES Komak, Inc., 2632 W. Cumberland St., Philadelphia 32, Pa. Various stages of manufacture of printed circuits and subminiature precision parts are described in an 8-page brochure.

CIRCLE 343 ON READER SERVICE CARD

WIRE WOUND RESISTORS International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Close tolerance power wire wound resistors are described in a two-page bulletin (P-8).

CIRCLE 344 ON READER SERVICE CARD

TUNNEL DIODE CIRCUITS Transitron Electronic Corp., 168 Albion St., Wakefield, Mass., has prepared a 16-page handbook, AN-1359A, on circuit design of the tunnel diode.

CIRCLE 345 ON READER SERVICE CARD

CIRCUIT MODULE-AMPLIFIER Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif. Bulletin DPS/A8 contains an illustration and specifications for the CM-114 circuit module-amplifier.

CIRCLE 346 ON READER SERVICE CARD

CARTRIDGE RECTIFIERS Electronic Devices, Inc., 50 Webster Ave., New Rochelle, N. Y. A technical bulletin on a line of silicon SerieSil high voltage cartridge rectifiers is available.

CIRCLE 347 ON READER SERVICE CARD

GERMANIUM DIODES Ohmite Mfg. Co., 3668 Howard St., Skokie, Ill. Bulletin 164 lists stock MIL and commercial glass-enclosed germanium diodes with net quantity prices.

CIRCLE 348 ON READER SERVICE CARD

VARIABLE INDUCTORS Corning Electronic Components, Bradford, Pa. Reference data sheets are available on 11 models of standardized variable inductors.

CIRCLE 349 ON READER SERVICE CARD

SWITCHES Hamlin Inc., Lake and Grove Streets, Lake Molls, Wisc. Bulletin covers hermetically sealed, magnetic reed switches.

CIRCLE 350 ON READER SERVICE CARD

TRANSISTOR GUIDE Philco Corp., Church Road, Lansdale, Pa., has published a "Transistor Guide for Communications Circuit Designers". It will be mailed to those requesting under company letterhead.

Librascope Erecting New Facility

LIBRASCOPE DIVISION, General Precision, Inc., Glendale, Calif., announces work has begun on a new facility specially designed for development and production of equipment for aircraft, missiles, and space vehicles.

The building is being constructed on a 30-acre site in San Marcos, Calif., and will become the new headquarters of the company's Aerospace Branch, according to W. E. Bratton, Librascope president.

Scheduled completion date for the 24,000-sq-ft building is September 1.

Construction of the new building, company says, is part of a major expansion program initiated to keep pace with Librascope's current and future growth.

The building will facilitate development and production of Librascope's growing line of miniaturized, airborne digital computers and associated devices.

The facility will include a metal-plating laboratory, an electronics laboratory, a completely equipped machine shop, and precision equipment for fabricating computer memory devices. In addition, facilities will be provided for design, drafting, assembly and administration activities.

The facility will be staffed by approximately 200 people.

Key Aerospace Branch personnel will move from Glendale to San Marcos to form the nucleus of the staff.

General Electric Promotes Bennett

E. C. BENNETT has been appointed manager-Naval operations product planning in GE's heavy military electronics department in Syracuse, N. Y. He joined the company in 1960 as a systems planning engineer for Naval surface operations.

Titan Transformer Acquires New Plant

TITAN TRANSFORMER CO. has moved from Watertown, Mass., to a new 12,000 sq ft manufacturing plant in Cambridge.

The company, organized about six months ago, specializes in the design and manufacture of transformers and other magnetic devices for critical military electronic and missile system applications.

Bendix-Pacific Appoints Gerrard

JOHN A. F. GERRARD has been named director of electronics engineering for Bendix-Pacific division, North Hollywood, Calif.

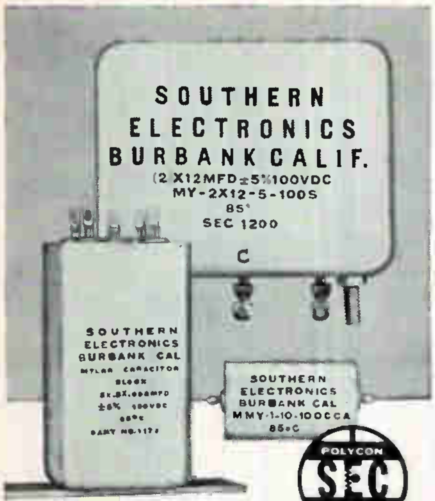
Gerrard was formerly associated with Texas Instruments, Inc., where he directed a research department involved in projects including signal generation, detection and analysis, antisubmarine warfare, and transducers. He has been a consultant to the President's special assistant for technology and a member of the President's panel on seismic improvement.

Transco Products Hires Project Engineer

WILLIAM STUCKEY has joined Transco Products, Inc., Los Angeles, Calif., as project engineer. He comes to Transco after 9 years with Lockheed Aircraft Co. in electronic design.

Kieran Dunne Joins Computer Devices

COMPUTER DEVICES CORP., Huntington Station, N. Y., announces that Kieran R. Dunne has joined the company's top management. As vice president, he will take full charge of the organization and administration of the company's engineering and manufacturing facilities which are exclusively



Capacitors for

NO COMPROMISE

Circuit Design

Unusual requirements in capacitance, tolerance, case size or configuration no longer need compromise your circuit designs. **SOUTHERN ELECTRONICS'** engineers are experienced in solving these problems to the extent that non-standard capacitors have become routine at **SEC**.

SEC has developed multiple block capacitors that are now saving space and weight in a production missile. Two 12mfd capacitors were designed to take less space than one, with improved electrical characteristics. In another application, **SEC** eliminated 6 tubular capacitors, utilizing a single can, 6 terminals and a common ground. **Result:** Room for additional components, easier wiring, and a less expensive component.

SEC, in addition to designing special capacitors to save weight and space, has developed dual-dielectrics to solve unusual temperature coefficient problems, and has introduced special dielectrics and oils for extreme high temperature and high voltage applications.

This engineering know-how has resulted in the use of **SEC** capacitors in twelve U.S. missiles, analog computers, and many radar and communications services.

SEC capacitors are manufactured in a wide range of capacitance to meet your needs from 100mmf to any higher value, with tolerances as low as 0.1%. They are made under unusually critical quality control standards, and meet or exceed the most rigid MIL-SPECS.

SOUTHERN ELECTRONICS *Corporation*

150 WEST CYPRESS AVENUE
BURBANK, CALIFORNIA

CIRCLE 213 ON READER SERVICE CARD

VICO POTENTIOMETERS

- Infinite Resolution
- .01% Linearity
- Low Noise
- Long Life
- Low Torque
- Low Inductance and capacitance

—— Unique design —— A precious metal brush of extremely light contact pressure, slides across a single helically wound length of resistance wire. The brush follows the exact helical path of the resistance wire, thus no sliding or helical error can occur. This insures extremely long wire life, true stepless output, high accuracy and low noise.

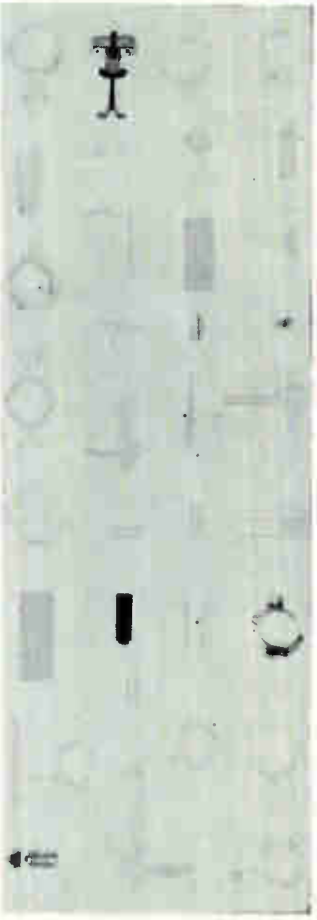
WIRE WOUND INFINITE RESOLUTION MULTI-TURN POTENTIOMETERS

For additional information write — Director of Sales.

VOGUE INSTRUMENT CORPORATION

2350 LINDEN BOULEVARD BROOKLYN 8, NEW YORK
NIGHTINGALE 9/8300 TWX NY 2/2072

CIRCLE 214 ON READER SERVICE CARD



GOT A PROBLEM OF TUBE OR COMPONENT RETENTION?

Birtcher produces more than 10,000 types and styles of tube and component retention and cooling devices. The solution to your tube, transistor and component cooling and retention problems can probably be found in the new Birtcher catalog. If not, send us your problem and we'll design number 10,001.

available from authorized Birtcher distributors

NEW! *Write today for your copy of the new comprehensive Birtcher Retention/Cooling Devices Catalog.*

THE BIRTCHER CORPORATION

INDUSTRIAL DIVISION

745 South Monterey Pass Road,
Monterey Park, California

CIRCLE 103 ON READER SERVICE CARD

geared to the design and production of electromagnetic and magnetostrictive delay lines.

Dunne has organized and headed delay line departments for such companies as Harnett Electric Co. (a division of Hazeltine Corp.), The Filtron Corp., and Control Electronics Co., Inc.

Viking Industries Appoints Beacham

EDWIN F. BEACHAM has been appointed to the newly created position of vice president of operations, connector division, of Viking Industries, Inc., Canoga Park, Calif. He will direct and coordinate activities of the engineering, marketing and manufacturing departments.

Previous to this appointment, Beacham was vice president of manufacturing at Viking.

Radiation Inc. Names Marketing V-P

RADIATION INC., Melbourne, Fla., has appointed John T. Hartley as vice president, corporate marketing.

Hartley became part of the company's research staff in 1956, then rose to staff engineer, technical advisor in the advanced programs department, and later assistant manager of that department. He was made director of marketing in 1959. Prior to being named marketing vice president, he served as executive assistant to the vice president, operations; and on special assignment as program manager for the company's Dyna-Soar project.

Raytheon Acquires New Subsidiary

TRANS-SIL CORP., manufacturer of modular silicon rectifiers used in atomic submarines, recently became a wholly-owned subsidiary of Raytheon Co. Acquisition of the Englewood, N. J., firm had been previously approved by Raytheon's board of directors and Trans-Sil's shareholders.

PEOPLE IN BRIEF

Boyce Adams, formerly of the Wayne Kerr Corp., appointed sales manager for Omnitronics, a subsidiary of Borg-Warner Corp. **William C. Otto** transfers from the Cornell-Dubiler Electric Corp. to Mallory Electromagnetic Co. as chief engineer. **George C. Rabin** advances at Consolidated Avionics Corp. to plant manager. **James E. Buescher** promoted to manager of the MEG Products Div. of Mandrel Industries, Inc. **Gerald D. Ewing**, ex-Rheem Semiconductor, joins the Schockley Transistor unit of Clevite Transistor as supervisor of application engineering. **Harley D. Peter**, formerly of Vitro Electronics, named senior electronic engineer by Communication Electronics, Inc. **Donald H. Scruggs**, ex-Television Associates, and **Joel Julie**, ex-University Loudspeakers, accept posts as project engineers in the military products division of Adler Electronics. **Raymond J. Morris** leaves Transco Products to join E & M Laboratories as manager of reliability and quality control. **Ewing Taylor** transfers from Ratigan Electronics to Vanguard Electronics as project engineer.

electronics
WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

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

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

STRICTLY CONFIDENTIAL

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

WHAT TO DO

1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
4. Circle the corresponding key number below the Qualification Form.
5. Fill out the form completely.
6. Mail to: D. Hawksby, Classified Advertising Div., ELECTRONICS, Box 12, New York 36, N. Y. (No charge, of course).

COMPANY	SEE PAGE	KEY #
A C SPARK PLUG The Electronics Div. of G. M. Milwaukee, Wisconsin	10	1
AVCO/RAD A Div. of Avco Corp. Wilmington, Massachusetts	134*	2
BENDIX-PACIFIC DIV. The Bendix Corp. North Hollywood, Calif.	48	3
BOEING AIRPLANE CO. Seattle, Wash.	37	4
BRENTON EMPLOYMENT AGENCY Newark, New Jersey	106	5
ERIE ELECTRONICS DIV. Erie Resistor Corp. Erie, Pa.	128*	6
ESQUIRE PERSONNEL Chicago, Illinois	128*	7
GENERAL ELECTRIC COMPANY Light Military Electronics Dept. Utica, New York	127*	8
HOUSTON INSTRUMENT CORPORATION Houston, Texas	106	9
LOCKHEED/MISSILES & SPACE DIV. Sunnyvale, California	34	10
McGRAW-HILL PUBLISHING CO., INC. New York, N. Y.	106	11
PERKIN-ELMER CORPORATION Norwalk, Connecticut	128*	12
TEXAS INSTRUMENTS INC. Semiconductor-Components Div. Dallas, Texas	98, 99*	13

* These advertisements appeared in the 4/14/61 issue

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electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

Personal Background

NAME ....

HOME ADDRESS..

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

HOME TELEPHONE..

Education

PROFESSIONAL DEGREE(S)..

MAJOR(S) ....

UNIVERSITY ....

DATE(S) ....

FIELDS OF EXPERIENCE (Please Check) 4211

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

CATEGORY OF SPECIALIZATION

Please indicote number of months experience in proper block(s)

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

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

INDEX TO ADVERTISERS

Audited Paid Circulation

* See Advertisement in the July 20, 1960 issue of Electronics Buyers' Guide for complete line of products or services.

* See Advertisement in the July 20, 1960 issue of Electronics Buyers' Guide for complete line of products or services.

■

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F. J. Eberle, Business Mgr.

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electronics

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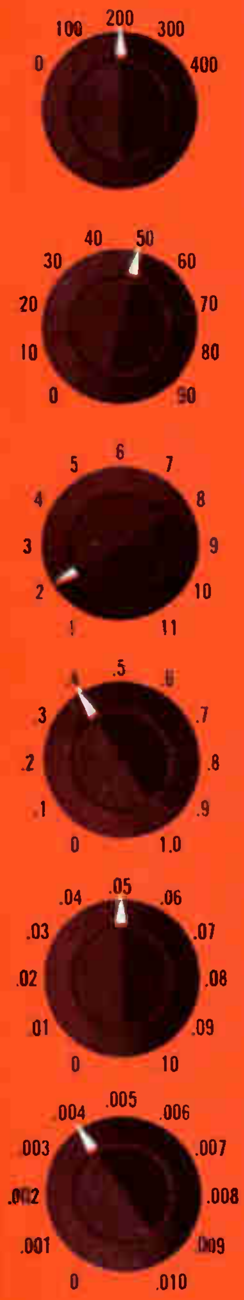
BRIEF SPECIFICATIONS

OUTPUT VOLTAGE	1.000 to 502.110 volts, variable in 100-, 10-, 1-, 0.1-, 0.01-, and 0.001-volt steps
OUTPUT CURRENT	Up to 20 ma
STABILITY	±0.0025%
OUTPUT VOLTAGE CALIBRATION	0.01% of setting ±0.0002V
LOAD REGULATION	0.002% or ±100 μV, no load to full load
LINE REGULATION	0.002%, 10% change in line voltage
METER ACCURACY	4% of full scale
OUTPUT Z	<0.01 ohm, DC
FLOATING OUTPUT	>1000 megohms resistance between chassis and either output terminal; current between either output terminal and chassis <0.5 μampere DC, <4 μampere at 60 cps
RESPONSE TIME	0.2 millisecond
PRICE	$1280.00



now! supply and measure 1 to 502 volts with 0.01% accuracy!

KIN TEL's Model 302 DC Voltage Standard and Null Voltmeter is an extremely stable, accurate, and compact source of variable voltage low-impedance DC.

Standard cell stability is obtained by using KIN TEL's chopper circuit which constantly compares the Model 302 output against an internal unsaturated mercury-cadmium cell. Short-term stability is better than 25 parts per million, and stability over a 30-day period is better than 50 parts per million. Both load and line regulation are maintained better than 0.002%, and ripple is less than 0.0001 volt.

Precision voltage adjustment is easy with six detented dials. Up to 20 milliamperes of current are available at any dialed output from 1.000 to 502.110 volts. Output voltage accuracy is within 0.01% of setting ±0.0002 volt.

Laboratory-accurate measurements are made by the self-contained null voltmeter which shows the difference between the 302 output and an unknown input voltage. The meter has four decaded ranges from 50 volts to 0.05 volt, full scale, and permits rapid measurement of DC voltage–with up to 6 digit resolution–to an absolute accuracy within 0.01% of the reading ±0.001 volt. The meter can also be used to indicate either the 302 voltage or an unknown input to a standard accuracy of 4% of full scale.

The floating output is isolated from chassis ground; resistance between chassis and either output lead is greater than 1000 megohms. The effective output impedance is less than 0.01 ohm for DC, less than 0.2 ohm at 1000 cps.

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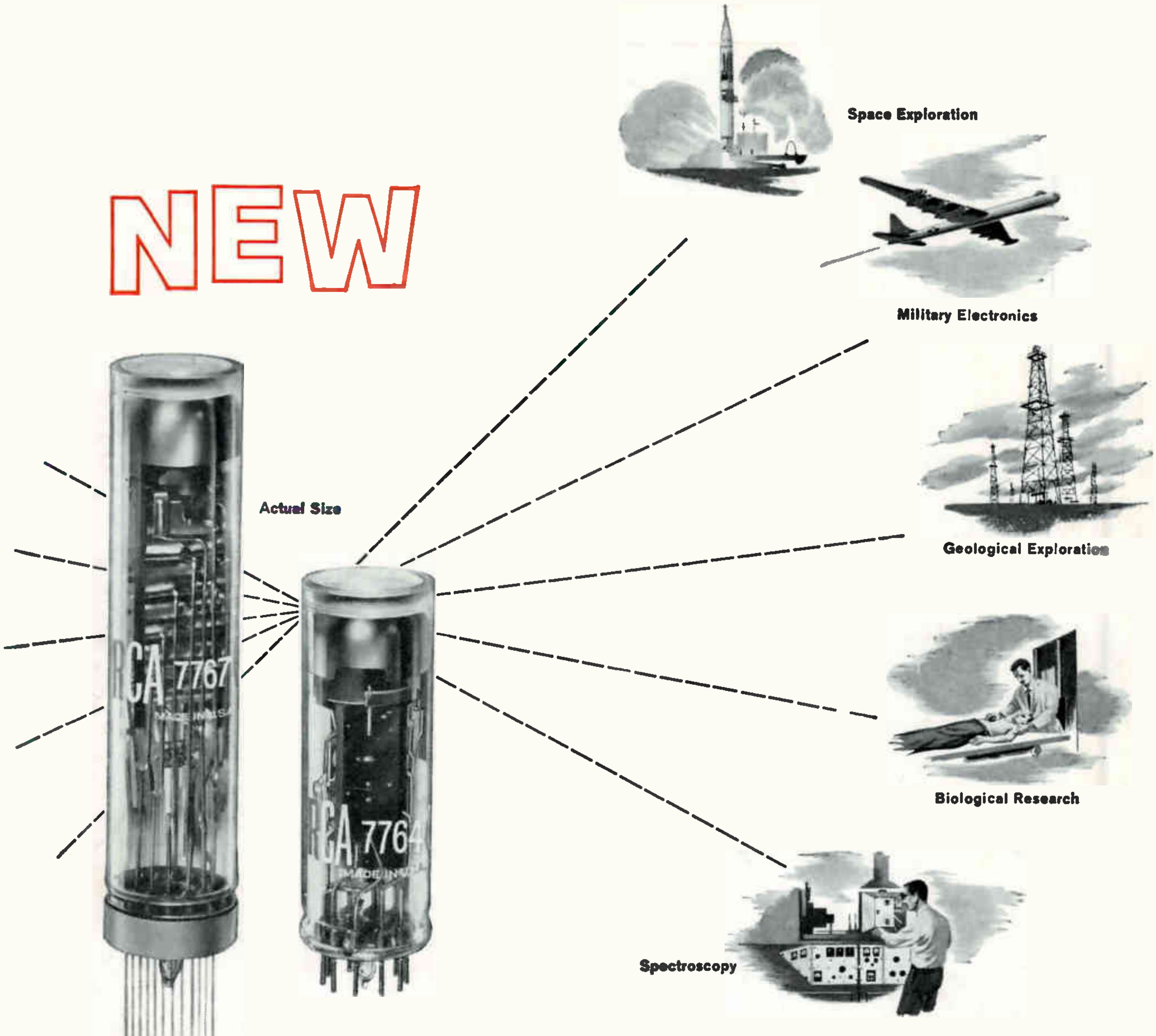

3/4" PHOTOMULTIPLIERS

—for applications where space is limited

Dramatically smaller multiplier phototubes with features heretofore found only in the larger types, the new RCA-7764 and -7767 shown here *actual size* offer significant advantages in radiation-detection applications, where *multiplier phototube performance is a must, but where small size is a necessity.*

Variations of these new types can be delivered to you "potted" with a voltage divider designed to meet your specifications. For more information, contact the RCA Field Office nearest you. Or write Marketing Manager, RCA Industrial Products Dept., RCA, Lancaster, Pa. For a free technical bulletin on the RCA-7764 or -7767, write: Section D19Q4, Commercial Engineering, RCA Electron Tube Division, Harrison, N. J.

THE FACTS

Item	RCA-7767	RCA-7764
Stages	10	6
Median Sensitivity (Amperes/lumen)	7.5	0.3
Current Amplification	125,000	5000
Voltage Supply (Volts)	1250	1200
Response Range (Angstroms)	3000-6500 (S11)	3000-6500 (S11)
Max. Response (Angstroms)	Blue 4400	Blue 4400
Max. Rigid Length	4.0"	2.75"
Max. Diameter	0.78"	0.78"

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