October 13, 1961

electronics

A McGraw-Hill Publication 75 Cents

Designing circuits using

THERMOELECTRIC COOLERS

See p 54

SIMULATING NERVES

with four-layer diodes, p 51

AUTOMATIC TUBE TESTER

makes 21 tests on 1,800 tubes an hour

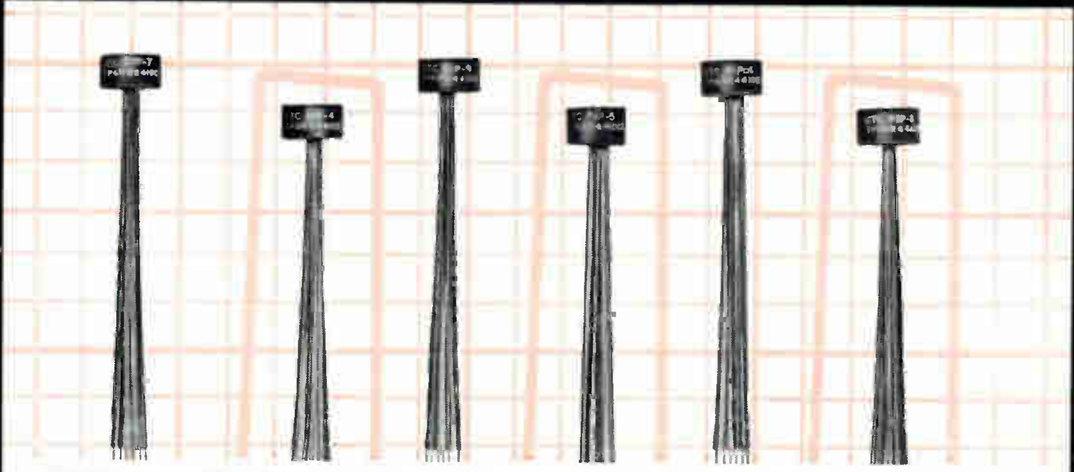
p 82

PIONEERS IN MINIATURIZATION

NEW PIP SERIES

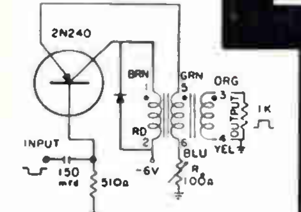
ULTRAMINIATURE TRANSISTOR

PULSE TRANSFORMERS



UNITS SHOWN ACTUAL SIZE—IMMEDIATE DELIVERY FROM STOCK

TRANSISTOR TEST CIRCUIT



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

DEFINITIONS

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

- MIL type TP6RX4410CZ — METAL CASED
- Manufactured & Guaranteed to MIL-T-21038
- 5/16″ Dia. x 3/16″ Ht.; Wt. 1/20 oz.
- Ratio 4:4:1
- Anchored leads, withstands 10 lb. pull test
- Printed circuit use, plastic insulated leads
- Can be suspended by leads or clip mounted

	APPROX. DCR, OHMS			BLOCKING OSCILLATOR PULSE					COUPLING CIRCUIT CHARACTERISTICS						
Type No.	1-Brn 2-Rd	3-Org 4-Yel	5-Grn 6-Blu	Width μ Sec.	Rise Time	% Over Shoot	Droop %	% Back Swing	P Width μ Sec.	Volt Out	Rise Time	% Over Shoot	Droop %	Back Swing	Imp. in, out,
PIP-1	.18	.20	.07	.05	.02	0	0	37	.05	9	.018	0	0	12	50
PIP-2	.47	.56	.17	.1	.025	0	0	25	.1	8	.02	0	0	5	50
PIP-3	1.01	1.25	.37	.2	.030	2	0	15	.2	7	.035	0	0	5	100
PIP-4	1.5	1.85	.54	.5	.05	0	0	15	.5	7	.06	0	0	0	100
PIP-5	2.45	3.1	.9	1	.08	0	0	14	1	6.8	.15	0	0	5	100
PIP-6	3.0	3.7	1.1	2	.10	0	0	15	2	6.6	.18	0	2	10	100
PIP-7	4.9	6.05	1.8	3	.20	0	0	14	3	6.8	.20	0	2	10	100
PIP-8	8.0	9.7	2.9	5	.30	0	0	3	5	7.9	.22	0	13	25	200
PIP-9	13.1	15.9	4.7	10	.35	0	5	12	10	6.5	.4	0	15	20	200
PIP-100	Transistor pulse transformer kit, consisting of PIP-1 thru PIP-9 in plastic case.														

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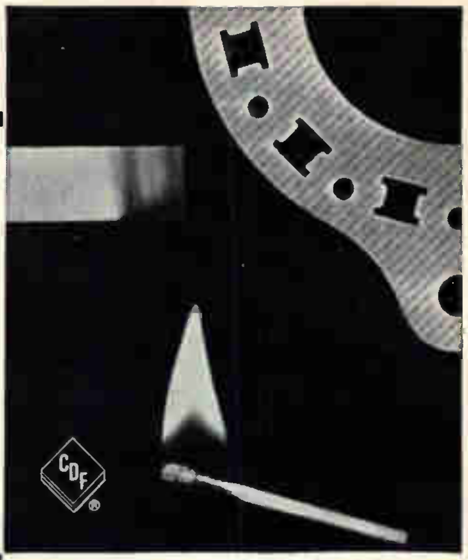
October 13, 1961

electronics

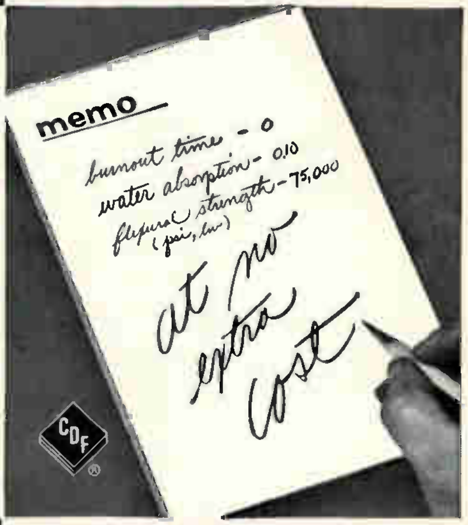
A McGraw-Hill Publication   75 Cents

W. W. MacDONALD, Editor

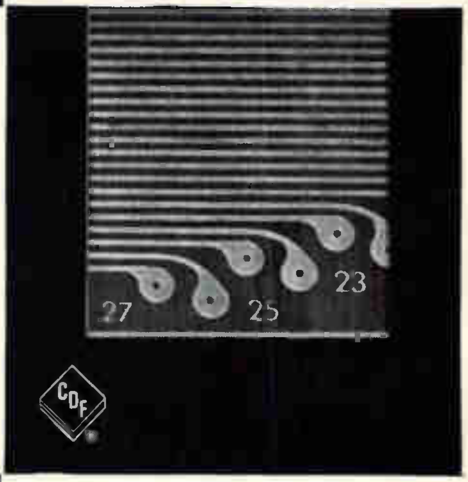
New Copper-Clad *Reliability*



In March, 1961, CDF Grade 614, glass-epoxy laminate, was announced . . . and met with almost overnight acceptance. Particular electronics and electrical manufacturers wasted no time in specifying this premium performance material with zero burnout and minimum "haloing."

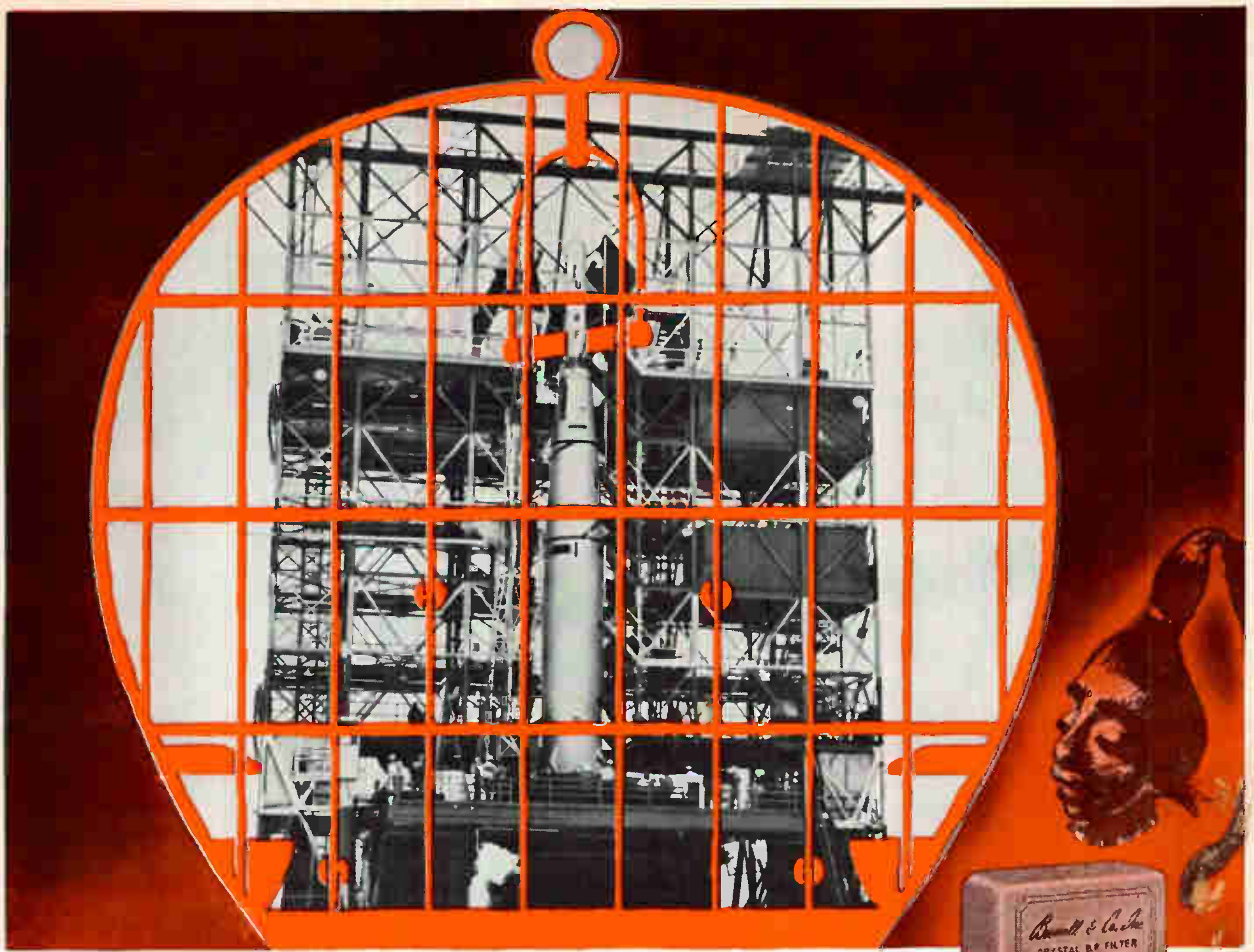


By June, 1961, CDF Grade 614 had become the new standard of comparison for applications in critical ground and air-borne circuitry. Designers like its specifications, production men like the way it handles, management likes its reasonable price.



Now, CDF Grade 614 Copper-Clad is setting a new pace among particular producers of printed circuits . . . offering a new high in reliability for high packaging densities . . . and offering researchers a new tool in the investigation of molecular and submicro-circuitry.

You can take advantage of 614 Copper-Clad's unique features right now . . . in research, development or production operations. Continental-Diamond Fibre Corporation, Newark, Delaware. A Subsidiary of the Budd Company.



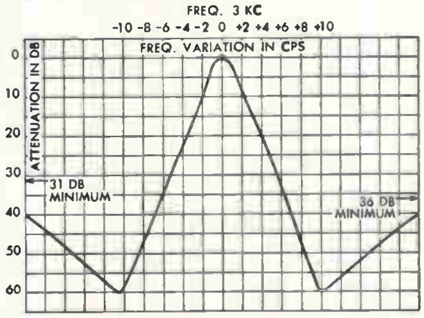
Only a Bird in a Gilded Cage

As succeeding generations of missiles penetrate the curtain of space that separates Earth from other planets, the importance of electronic guidance, control and airborne telemetry systems becomes obvious. For, without new engineering design techniques to provide reliable communication and control, the most advanced missile is but a bird in a gilded and very expensive cage.

As typical examples of what can be accomplished to insure maximum performance in missile telemetering, communication, data processing and other applications, Burnell & Co. has developed two new filters—a miniature 3 kc crystal filter and, employing modern synthesis techniques, a miniature 500 kc LC toroidal filter possessing low transient distortion characteristics.

TECHNICAL DATA
3 kc Crystal Filter

Attenuation—3 db B/W—2 cps
Shape Factor—30/3—5:1
Impedance—500K in and out
Temp. Coeff.—.021 cps °C
Size—3½ x 2$\frac{5}{16}$ x 1$\frac{7}{16}$
Insertion Loss—3½ db
Also available in any impedance from 500 ohms to 500K



TECHNICAL DATA
500 kc LC Toroidal Filter

Attenuation—B/W 40 kc at 3 db
—200 kc at 50 db
Impedance—50 ohms in and out
Insertion Loss—4.5 db
Over and undershoot—
(for a step modulated
500 kc carrier)—less than 1%
Size—⅞ x 3 x 1½

Other Burnell filters are available in frequencies up to 30 mcs over a wide range of impedances.

Write for new catalog.

Burnell & Co., Inc.

CIRCLE 3 ON READER SERVICE CARD

electronics
October 13, 1961 Volume 34 No. 41

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CROSSTALK

Antimissile Kill Systems

PROTECTION of American cities from nuclear tipped ICBMs calls for more than antimissile-missiles.

Thinking now has advanced beyond the amorphous concept of a force field, the popular science fiction gambit. For example, the idea of a laser-generated infrared beam providing the core of an antimissile kill system is now being espoused by reputable scientists.

Lasers such as this Minneapolis-Honeywell unit are being developed in laboratories across the nation

The laser, noted for its ability to produce coherent light of narrow spectral width, low divergence and high intensity, can perhaps be adapted to this new need. Experiments have demonstrated that lasers with simple lenses can burn holes in steel.

Laser beams have produced temperatures of 8,000 degrees centigrade in fractions of a millisecond when focused in a carbon plate. High power lasers had been operated with cooling systems that allow pulse firing rates of several per second.

One can conceive of orbiting satellite systems equipped with laser kill equipments and controlled by acquisition radar, course tracking microwave radar, and fine tracking and focusing optical radar.

Alternately, a laser system might be mounted inside an antimissile missile, and launched when needed. Or, since most of the attenuation in the atmosphere is produced in the first several miles above earth, a high power laser located on a mountain top might deliver enough power to destroy attacking missiles.

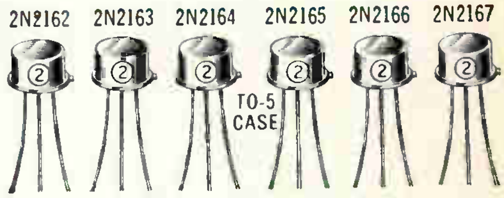
Actual destruction of missiles could perhaps be accomplished by punching holes in their skins, and allowing resulting vibration to shake the vehicles apart.

Coming In Our October 20 Issue

OPTICS. Time was when optical science concerned itself chiefly with phenomena observed when visible light interacted with matter. This classical definition has long been discarded. Optics has been freed from the artificial boundaries of visible light. It now encompasses the entire electromagnetic spectrum. Among branches of electronics that are dependent in no small measure on electron optics are such fast-developing fields as masers and lasers, microwave, fiber optics, infrared, plasma physics, ion and plasma engines—and a host of others. In our next issue, R. M. Benrey, of MIT, discusses optical techniques that are of fundamental interest to electronics engineers.

New from Sprague!

HIGH SPEED SILICON CHOPPER TRANSISTORS



Sprague Surface Precision Alloy Transistors are especially designed for low-level chopper applications. Their specifications have been tailored to meet your actual circuit requirements. Compare these standard Sprague units with ordinary alloy devices for the following haracteristics:

- **Low Offset Voltage**
- **Low Dynamic Resistance**
- **Low Output Capacitance**
- **Low I_{CBO}**
- **High Frequency Response**
- **Matched Pairs Available**

TYPE	Min. BV_{CBO} (Volts)	Max. I_{CBO} (μa)	Max. V_{EC} (mv)	Min. h_{fe}	Max. C_{OB} (pf)	Min. f_T (mc)
2N2162	30	.01	2	20 at 1 kc	10	14
2N2163	15	.01	2	20 at 1 kc	10	14
2N2164	12	.02	1.5	25 at 1 kc	10	24
2N2165	30	.02	3	2.5 at 4 mc	10	10
2N2166	15	.02	3	2.5 at 4 mc	10	10
2N2167	12	.02	2.5	4 at 4 mc	10	16

For application engineering assistance without obligation, write Transistor Division, Product Marketing Section, Sprague Electric Co., Concord, N. H.

For complete technical data, write Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

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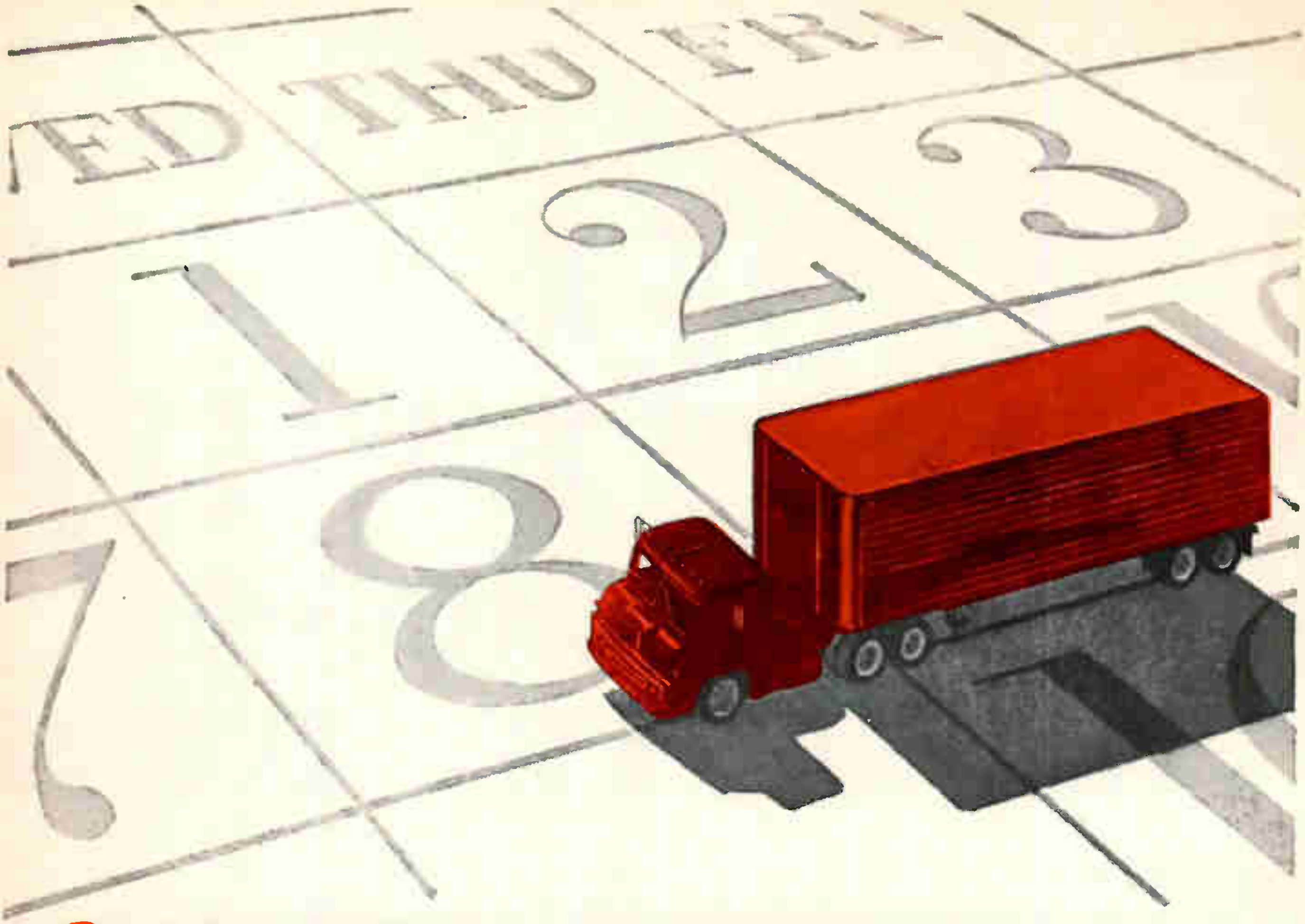

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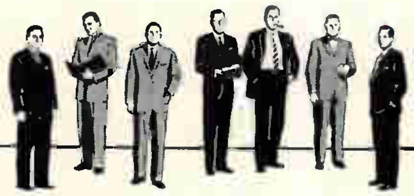
what a difference a day makes

...PARTICULARLY THE DECISION-MAKERS IN THE ELECTRONIC INDUSTRY. In no other industry are processing problems more complex, quality standards more demanding. Production chemicals *must* meet your specifications, *must* be shipped on time.

SAME DAY SHIPMENT OF HIGHEST PURITY ELECTRONIC CHEMICALS. The J. T. Baker electronic chemicals offer you the highest standards of purity and most precise labeling in the industry. J. T. Baker ships more than 90% of all orders the *same day* they're received. We keep our inventories high so you can keep yours low.

ACTUAL LOT ANALYSIS ON LABEL. Every 'Baker Analyzed' Reagent is labeled with an Actual Lot Analysis that defines purity to the decimal, more than 300 also with an Actual Lot Assay.

Highest purity . . . most precise labeling . . . same-day shipment. Surely three good reasons to discuss your requirements with J. T. Baker Co., Phillipsburg, N. J. See list of electronic chemicals on opposite page.



THE ELECTRONIC CHEMICAL USER BUYS MANY VALUES TO PLEASE MANY MEN

. . . he knows that bidding to specifications is only one measurement—he measures all the values. For example, when he buys chemicals he knows a precise definition of purity helps the Electronic Engineer. For the Plant Superintendent, consistently high quality means fewer variables and fewer rejections. For the Production Manager, fast on-time deliveries are important. Which values help the Quality Control Chief? the Cost Accountant?

The electronic chemical user knows! It's the reason J. T. Baker is preferred.

J. T. Baker Electronic Chemicals

COMMENT

Patent Royalties and Fees

Two items relative to patent legislation in the August 25 issue bear further comment.

First, Mr. I. Zakarias' suggestion relative to legislation (*Comment*, p 6), which would empower the Commissioner of Patents to collect royalties from all user companies for the inventor, provides an answer for a long-existing problem, buttressed by Mr. Zakarias' further suggestion that this program should be fully independent of evaluation by private industry.

That the costs of such programs should not be burdensome to private industry, is well illustrated by my experience as an independent inventor. For some 150 patents in radio and electro-musical electronics, my average royalty, based on the manufacturer's selling price to the trade, exclusive of cabinetry, was less than one-half per cent.

Second, in regard to Patent Office Proposes Higher Fees, Time Payment, (*Electronics Newsletter*, p 11): While these and prior proposals "for shortening processing time" in the Patent Office might relieve the ever-mounting work load on the examing staff, it would surely make good the death knell of the independent inventor, so long proclaimed by those who seek to corral all inventive talent in their own laboratories, on an assign-everything contract basis. Since about one-half of our patent output now originates outside of these laboratories, and since our really important inventions still, as in the past, originate in these outsiders, such proposals could only decimate. them. Rarely men of ample means, they could never afford the mounting fees which the Commissioner proposes, to keep their patents alive. Like ripe apples these would fall, royalty-free, into the laps of waiting industries.

BENJAMIN F. MIESSNER
Miessner Inventions, Inc.
Miami Shores, Fla.

Rectification Efficiency

The article Replacing Sine Wave Sources With Solid-State Inverters (June 30, p 80), is in error regarding the efficiency of rectification of a sine wave source.

The theoretical maximum rectification efficiency, that is, the ratio of d-c power out to total power in, is 100 percent for a full-wave sinusoidal single-phase rectifier, not 81.2 percent as quoted. But otherwise, no power is wasted in rectifying a sine wave with a perfect rectifier. Efficiencies close to 100 percent can be achieved in practice.

S. PINNELL
Pylon Electronic
Development Company
Montreal, Quebec

Medical Electronics

The author of your series on medical electronics ought to receive an M.D. Or maybe an M.E.D.

Sorry to find a fault, but there's a mistake in the second paragraph of Part V (July 21, p 63), about our developing, 30 years ago, devices that apply vibrations to the skin to permit the deaf to hear by their sense of touch. Would that we had developed vibration devices thirty years ago, but the referenced paper was authored by Robert H. Gault, Professor of Psychology, Northwestern University, (then) on leave with the National Research Council. None of our staff scientists had to do with the development. Your 1957 Franklin Institute entry on page 65, concerning the tonal braille system, is correct and represents our first and to date only activity in the tactile prosthesis field.

E. H. NELSON
The Franklin Institute
Philadelphia

Formed CRT Gun

We were pleased to see the section on General Dynamics Electronics new formed crt gun in Technical Preview of 1961 WESCON (August 11, p 141). We are the manufacturers of that gun, made of molded Mykroy, glass-bonded mica, with inserts and copper metallizing.

This application is an example of stability despite environment, including permanently precise dimensions, with metal-clad Mkyroy insulators. In addition, we perform no assembly operation on the gun halves; the inserts are molded in.

F. M. GRAFTON
Electronic Mechanics Inc.
Clifton, New Jersey

Shallcross precision circuit news

Delay-to-Rise-Time Ratio in Only 6 in^3

Total Delay	1.5 μsec
Rise Time	0.03 μsec
Impedance	500 ohms
PRF	2.5 mc
Attenuation	1 db
Distortion	5%
TC	+150 ppm, ±15 ppm (−10°C to +50°C)

Some of the toughest performance specs we've seen in 12 years of delay line engineering are crammed into the ½″ x 2″ x 6″ case of this lumped constant line. Used by a data processing equipment manufacturer, the unit requires uncommon care in component selection and in circuit layout to achieve the desired 50 to 1 delay-to-rise-time ratio in the space allowed.

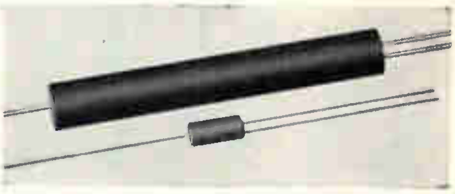
Special cores and toroidal winding techniques promote maximum Q, and, when coupled with custom miniature capacitors, desired LC characteristics are obtained within the specified space. An ingenious termination further reduces distortion at tapped outputs and appreciably enhances the pulse time characteristic.

Even if your delay line requirements are not so critical, this same Shallcross ingenuity may pay big dividends in reducing size, cost, or circuit complexity for you. Why not outline your needs to us?

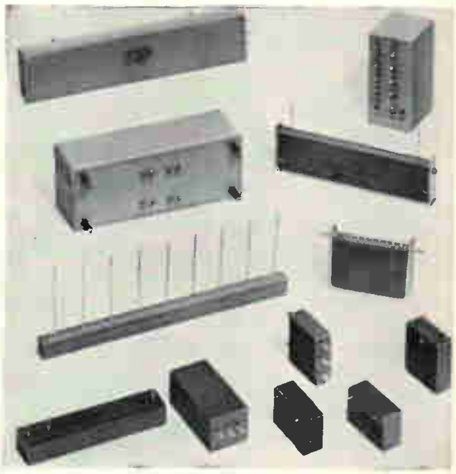
DELAY LINES

VARIABLE DELAY

Continuously adjustable delays from 0 to 0.5 μsec with 0.005 μsec resolution are attainable in this typical Shallcross unit. Maximum rise time is 0.06 μsec at maximum delay.

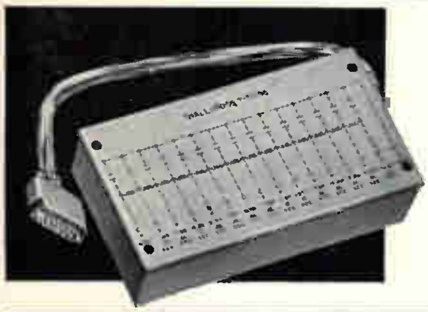


DISTRIBUTED CONSTANT



LUMPED CONSTANT

Shallcross' family of distributed constant and lumped constant lines utilize the latest refinements in inductors, capacitors, winding, trimming and packaging techniques.



STEPPING ACCURATELY

Typical of longer Shallcross delay lines, this variable lumped constant unit provides a total delay of 24.65 μsec in 15 steps calibrated to 0.05 μsec accuracy. Delay-to-rise-time is 100:1 —and in a hermetically-sealed package measuring only 2″ x 4″ x 7¼″.

Of course variations can be made for your requirements — in impedance, taps, rise time, attenuation and so forth. These are regular occurrences with the many hundred designs produced by Shallcross delay line specialists.

Shallcross Manufacturing Co. Selma, North Carolina

Precision wirewound resistors, Switches, Instruments, Delay lines, Resistance networks, Audio attenuators

ELECTRONICS NEWSLETTER

Blast Spotters: Seismic, Pressure, Radar

RAPIDITY with which the Atomic Energy Commission has been issuing its almost daily reports on USSR A-bomb tests indicate the extensiveness of the network of monitoring stations around the iron curtain.

AEC, Department of Defense and Weather Bureau are main participants in the monitoring program. None of these agencies will comment on methods or organization used in gathering Soviet test data. But here is how it is probably done:

A world-wide system of seismic stations detects shock waves. Directions recorded by a few stations locate the explosion by triangulation.

The explosion creates low-frequency radio waves and tremendous pressure variances. The magnitude of the pressure drop or the frequency of the electromagnetic radiation is used in calculating the size of the blast.

High-flying planes may also be used to scoop up radioactive samples after an explosion, and collect additional data.

R&D Information Retrieval Too Scanty, Says Senate

SENATE REPORT issued last week said costly and avoidable duplication in electronic research for defense has slowed the space science program. It blamed poor government facilities for exchange of information among electronic researchers.

A statement signed by Sen. Hubert Humphrey (D-Minn.), chairman of a special government operations subcommittee, said "the waste may add up to $200 million out of $2 billion currently expended for this type of work each year".

The report said space science has been slowed by absence of a reliable, comprehensive system for centrally indexed, broadly and promptly disseminated data on current and completed R&D contracts and subcontracts".

3,060-Mile Microwave Net To Span Mid-East

TURKEY, IRAN AND PAKISTAN will be linked in 30 months by 92 microwave relay stations between the capitals of the three nations. The 3,060-mile route crosses some of the wildest terrain in the world.

The route lies along a major earthquake fault in East Turkey, tremor areas in Iran and near a local earthquake fault in Pakistan. It passes through areas of migrating sand in Iran and Pakistan and through unstable bottom land in the Indus River basin. Some relay sites will be snowbound in winter, at altitudes of 10,000 feet. Others will be located in deserts.

A $16.4 million contract for the network has been awarded RCA by the International Cooperation Administration. The system will be called the Cento (Central Treaty Organization) Telecommunications Network and is part of the U. S. Mutual Security program.

Microwave Techniques May Extend Ultrasonic Range

MICROWAVE ULTRASONICS, neutron radiography and color x-radiography were discussed during the Second Symposium on Physics and Nondestructive Testing last week at Argonne National Laboratory, near Chicago.

Methods of extending ultrasonic frequencies into microwave regions were illustrated by Hans E. Bommel, of UCLA. Application is high-frequency sound wave detection of crystal defects. Deforming impurities become comparable in size to a wavelength. Bommel discussed using reentrant microwave cavities to help raise frequency above 10 Gc.

He also described the interaction of acoustic wavelengths in solids with the paramagnetic spin system of thin film transducers. Deposition by evaporation of thin film transducers eliminates coupling problems, he pointed out. But a disadvantage of use of such transducers at microwave frequencies is that a magnetic field of around 7,000 gauss is needed.

New Probe Makes Heart Surgery Less Dangerous

HEART SURGERY sometimes ends in death for the patient because the surgeon inadvertently damages the nerve which controls the heartbeat.

At the annual meeting of the American College of Surgeons last week in Chicago, Dr. William Bernhard, of Children's Hospital and Harvard, described a probe which he developed with Albert Grass, president of Grass Instruments. Pencil-sized, the probe lightly contacts the heart's interior. Dial settings and audio signals locate the nerve and its major branches.

Three Boston physicians reported that external electric shocks will restore to normal speed dangerously rapid heartbeats. Shocks of 250 and 350 volts, brought down one patient's heartbeat from 190 and 200 beats a minute on two occasions.

Experiments at Augusta, Ga., Medical College, showed electrical anesthesia permits pain-free surgery. It worked with all but three of 60 experimental dogs. Some dogs remained awake, but were insensitive to pain. Current is applied through electrodes.

Inertial System Guides Jet-Powered Flying Spy

SD-5, AN UNMANNED, jet-powered drone made its first flight last week with an inertial guidance system. It flew from the Army's test station at Yuma, Ariz., to Fort Huachuca, the southern border of the electronic proving ground near the Mexican border. Landing, with parachutes, was made on command from the ground.

In the test flight, the drone automatically took photographs every 30 seconds. When fully developed, it will transmit data gathered by radar, infrared and classified means, as well as cameras. In combat, it would land at a preselected site.

Drones normally employ radio guidance. Inertial guidance frees SD-5 from ground control and prevents enemy countermeasures from putting it off-course.

The AN/USD-5 system is being developed by Fairchild Stratos Corp. with guidance and sensory systems under direction of Fairchild Electronic Systems division. Minneapolis-Honeywell is furnishing the inertial system. Army Signal R&D Laboratory has overall technical direction.

Terrier, Tartar, Mauler Contracts Are Awarded

GENERAL DYNAMICS / POMONA has been awarded two missile contracts. Navy is paying $25 million for additional production of Terrier and Tartar antiaircraft guided missiles. An Army contract of $13 million provides for continued development of the Mauler weapons system. Mauler is a mobile battlefield weapon for defense against aircraft and short-range missiles. General Dynamics, in turn, stepped up orders for Terrier and Tartar components. Belock Instrument got a subcontract for more than $800,000 last week.

Probe Magnetic Effects On Cells and Psychoses

BIOLOGICAL EFFECTS of magnetic fields, a fairly new area of research called biomagnetics, will be discussed at the Air Force-sponsored International Conference on High Magnetic Fields, at MIT Nov. 1-4. One session will cover cellular and subcellular responses to magnetic fields and another sesssion, effects on organisms. Data will be submitted on exposure of terminal cancer patients to increased magnetic fields.

Also on the agenda is a study of the relation between natural magnetic field intensity and incidence of psychotic disturbances in humans. This study correlates changes in the geomagnetic environment, such as magnetic disturbances resulting from solar flares, with the number of psychiatric admissions to a veterans hospital.

NASA Changes Booster For 1962 Venus Flight

ATLAS-AGENA B rocket, instead of Centaur, will be used by NASA to launch its Mariner space probe on a flight to Venus in mid-1962. NASA said the switch is being made because a greater number of Atlas-Agena B's will have been fired. The flight will test basic equipment for later interplanetary flights. Instruments to measure magnetic fields in space, solar and extra-solar radiation, micrometeoroids and Venus' surface temperature will be carried in the 400-lb probe.

$65 Million in F-M Sets Ordered by Signal Corps

ARMY SIGNAL Supply Agency has awarded Avco Corporation's electronics and ordnance division a $65.8 million contract for AN/VRC-12 radio communications unit. The new contract follows $35 million in earlier orders. The unit is a lightweight, medium-powered f-m transceiver with 920 channels. It is designed to operate in vehicles and can communicate with other tactical f-m sets, including man-pack, airborne and ground radios.

Non-Conducting Coating Is High-Temperature Shield

SILICON NITRIDE, applied as a thin, adherent, nonporous film to electronic equipment and metals, protects metal surfaces at temperatures above 600 C. It retains its nonconducting properties to 600 C. Findings were reported by C. E. Geesner and C. R. Barnes at the Air Force Symposium on Science and Engineering in San Francisco last week.

In Brief . . .

ANIMAL NUTRITIONISTS in Canada let a computer figure out the best diet for pigs. New rations cost $75 a ton instead of $99 and are 10 percent more efficient.

AVIEN, INC., has a $58,000 Air Force contract to study use of array type antennas for missile tracking and telementry to 30 Gc. Company's basic design is series of discs on an axial rod.

MACHLETT LABS has agreed verbally to buy CBS Electronics' 160,000-sq-ft plant in Danvers, Mass., for tube production

MINNEAPOLIS - HONEYWELL'S new high-density magnetic tape systems for computers can pack 1,112 decimal digits per inch on tape and handle data at rate of 133,000 digits per second, company says.

COLLINS RADIO has four more Navy contracts, totaling $2 million, mostly for airborne radio transceivers.

BOEING is buying $600,000 in Pacific Semiconductor diodes for Minuteman ground equipment.

GULTON INDUSTRIES has delivered 148 sonar telephone systems to Navy as part of a $400,000 order.

MICROWAVE relay links for Sweden's air defense net will be supplied by Raytheon. Part of production will be done by Selenia, Raytheon's Italian affiliate.

IFF RADAR equipment designed by Wilcox Electric Co. will be used in France's Mirage IIIC fighters. Le Materiel Telephonique, ITT's subsidiary in France, will produce equipment under license.

ARGONNE National Laboratory next year will build a $6.9 million center for research in high energy physics.

USSR PLANS to install closed circuit tv instrument monitors in every major power station in and around Moscow, by 1965.

SOVIET scientists claim they have compiled a "map" of radiation zones in outer space, as preliminary to manned cosmic flight.


"Add this to the list of other things you didn't know about Borg-Warner Controls"
FACT FILE
BORG-WARNER CONTROLS
TRANSDUCERS & ACCELEROMETERS
...PROVEN RELIABILITY
underseas, underground and outer space!
Borg-Warner Controls' complete line of pressure transducers and accelerometers includes both variable reluctance and vibrating-wire types. For magnetic tape recording, FM/FM telemetering links, jet engine testing, underwater measurement, underground nuclear test monitoring, yaw control, rocket engine pressure measurement and a variety of other military, commercial and laboratory applications.
CENTAUR space vehicle
relies on accelerometers by Borg-Warner Controls for critical measurements!
Instruments designed and built by Borg-Warner Controls are used for measurement and control of flight parameters on some of the most advanced missile and space programs. An accelerometer for the new Centaur Space Booster is shown being installed at Convair (Astronautics) Division of General Dynamics Corporation.
For Engineering Aid...or Data Sheets—Contact:
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P.O. Box 1679
Santa Ana, California
Phone KImberly 5-5581
Teletype S Ana 5291

That's a strong statement to make. Yet if you've used an old-fashioned voltmeter, you may have been disappointed . . . the mechanical stepping switches . . . the marginal reliability . . . the great amount of time required between successive readings . . . the inconvenient operating techniques.

Let's take a look at the new Franklin Model 550. First off, here's a fast-reading digital voltmeter that's 100% electronic . . . and a voltmeter that's as easy to use as any moving-pointer voltmeter. More important, the Model 550 is one of the most stable and reliable instruments you'll ever use. That's because the Model 550 utilizes techniques and materials never before available to the digital voltmeter manufacturer.

For example, it utilizes the new Burroughs Corp. ®Beam-X Switching Tubes plus the new Burroughs Corp. Long-Life ®Nixie Indicators. This means one-quarter the number of parts of previous counters and a service life that is well over 50,000 hours. But there's more.

The use of up-to-date components in an advanced circuit design means freedom from instability owing to normal changes in circuit parameters. It means an order of reliability and ruggedness never before possible.

You can't know what a digital voltmeter is . . . unless you've used a FRANKLIN MODEL 550

Finally, there's no denying it, you **can** buy a less expensive digital voltmeter than the Franklin Model 550. On the other hand, if you need a substantial digital voltmeter . . . a digital voltmeter that must stand up under day-in and day-out abuse . . . then you'll do well to consider the superior performance of a Franklin Model 550.

Bulletin 311 contains a complete description, illustrations of the individual plug-in components, comparative data, specifications, and other useful data. Ask for it.

Franklin Model 550 Digital Voltmeter; ±.0001 to ±1200 V dc; ±1 count accuracy; effectively infinite input impedance; automatic polarity indication; all-electronic, modular, plug-in construction.

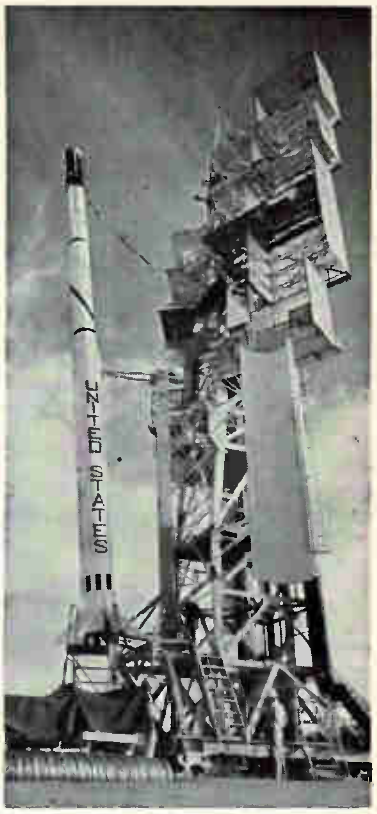
F 550

FRANKLIN
electronics, inc.
BRIDGEPORT • PENNSYLVANIA

®Beam-X and Nixie are trademarks of the Burroughs Corp.

CIRCLE 13 ON READER SERVICE CARD

WASHINGTON OUTLOOK



ION ENGINES currently under development include three funded by National Aeronautics and Space Administration. In addition to Hughes' engine (see p 28), NASA's Lewis Research Center is developing an engine using mercury as source material. Plasmadyne Corp. is working on an arc jet engine. Air Force is funding development of a cesium engine at Electro-Optical Systems, Inc.

Present plans call for flight testing all four engines by late 1962. RCA is building a flight vehicle to test two engines at a time. Boosted by a Scout rocket (at right, a Scout-6 in its gantry at Wallops Station), the engines will be sent on a 5,000-mile-high, one-hour, ballistic flight that will allow the engines to operate in space environment. NASA will use the engines to alter the spin rate of the flight vehicle.

Batteries will power initial tests. By 1965, NASA wants to flight test ion engines with a Snap-8 30-Kw power source under development with AEC. By 1966-67, NASA expects to send an ion engine on an actual flight mission. Boosted by an Atlas-Centaur rocket, a 60-Kw Snap-8 reactor will power an ion engine flight to Venus or Mars.

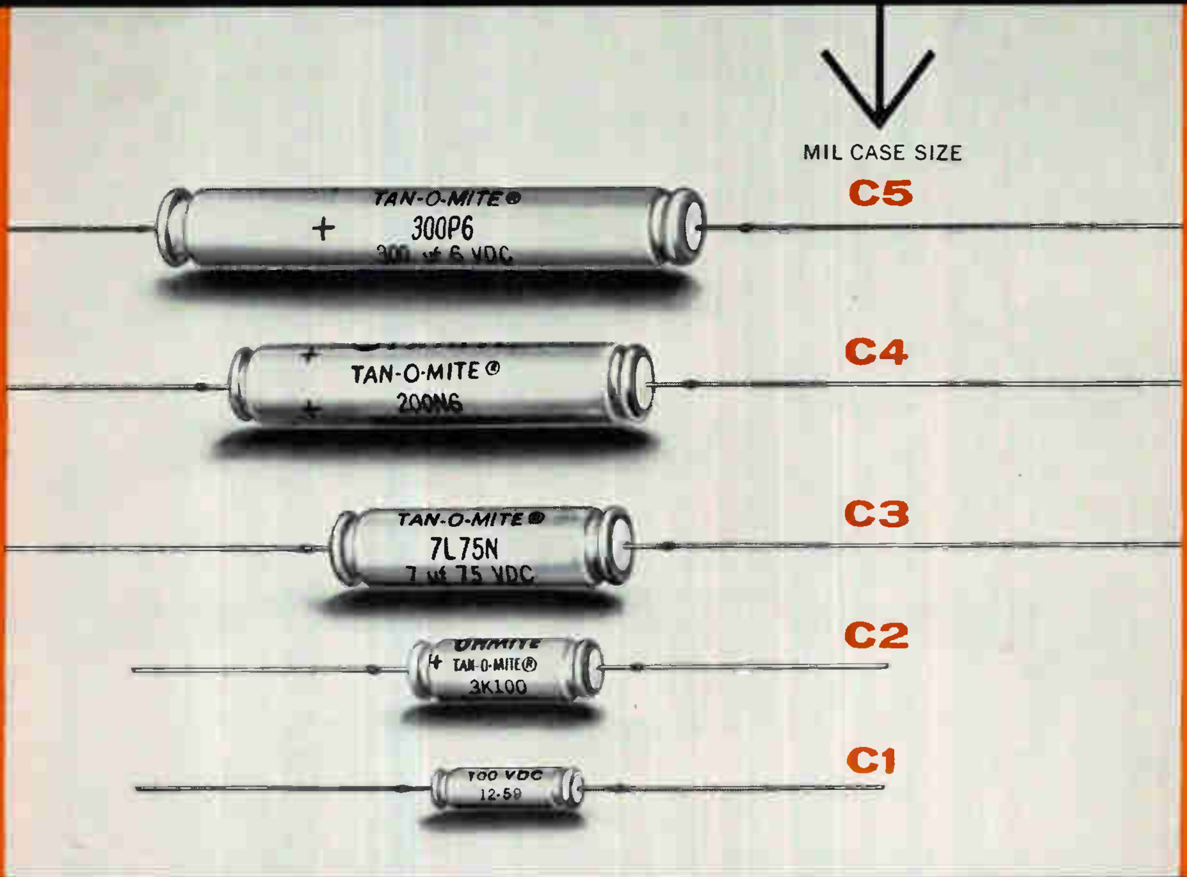
THERMOELECTRIC and thermionic systems for auxiliary space power will ultimately be used in combination rather than compete with each other, Office of Naval Research scientist Paul H. Egli told the Twelfth International Astronautical Congress in Washington, D. C., early this month. Thermoelectricity shows greatest promise with temperatures of 1,200 C and below while the thermionic process of electron emission is more promising in the 1,000 C to 2,000 C temperature range.

For short space missions requiring large amounts of power (100 to 10,000 Kw), Egli said thermionic emissions should be tried immediately, that it should be perfected for long-life use within the next few years. Thermionic generators have already been operated at 10 to 15 percent overall efficiencies in laboratory experiments, with efficiencies up to 25 percent expected in the next few years. New plasmas and design configurations are expected to ease the critical material problems now holding back progress in thermionics, Egli told the international symposium.

INTERAGENCY Committee on Oceanography, taking a new look at government's 10-year program, finds progress slow in many key areas. More feasibility studies of instrumentation are needed, for example. Cost estimates covering next 10 years are now over $50 million for basic facilities, instead of $16.5 million.

All 5 MIL Tantalum Foil Capacitor Sizes From OHMITE

MEET **MIL-C-3965B** —ALL VALUES IN STOCK



Plain and Etched

Whether you need *immediate delivery* from stock on prototypes, or production quantities of tantalum foil capacitors, Ohmite can handle your requirements.

Tan-O-Mite® Series TF foil capacitors now include all five MIL sizes in both plain and etched types, polar and nonpolar units, insulated and uninsulated cases—all in ratings to 150 VDC. Capacitance values for plain foil units range to 400 mfds; etched foil units, 580 mfds.

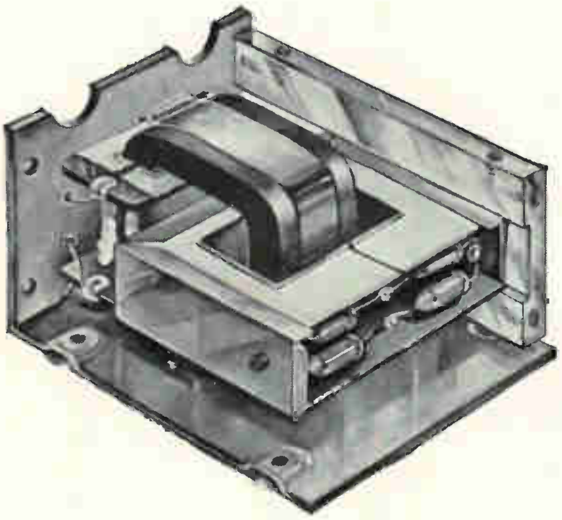
Write for Specification Bulletin 152G which lists 200 stock values, including all MIL values, and shows a *handy scale for conversion* between "equivalent series resistance," "power factor," and "dissipation factor."

OHMITE

Rheostats
Power Resistors
Precision Resistors
Variable Transformers
Tantalum Capacitors
Tap Switches
Relays
R.F. Chokes
Germanium Diodes
Micromodules

OHMITE MANUFACTURING COMPANY
3610 Howard Street, Skokie, Illinois

Unique construction of Elcor ISOFORMER® makes efficient isolated power supplies practical



The drawing shows the unique construction of the Isoformer (isolation transformer). This is the key element in new Elcor isolated power supplies... called ISOPLYS.

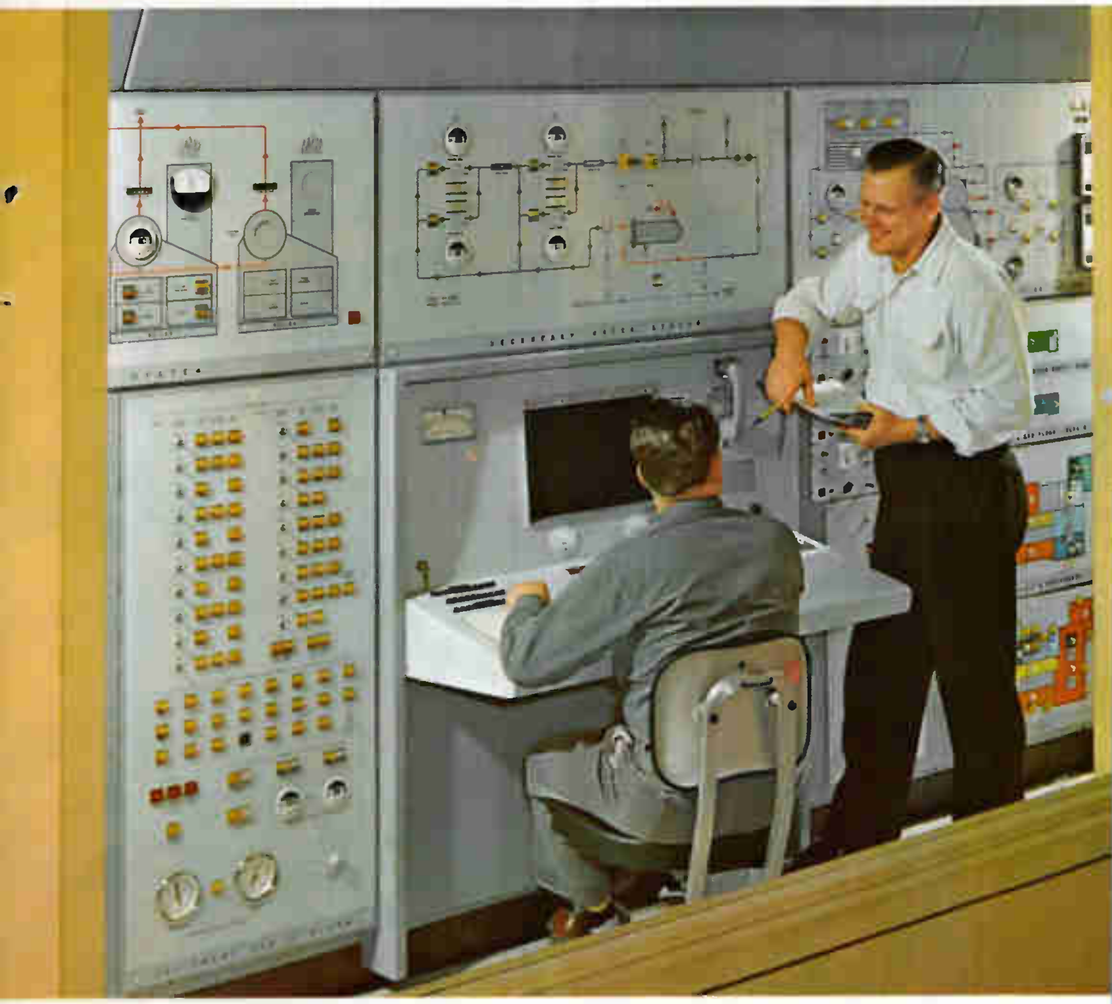
Significant features of the Isoformer are: (A) Tape-wound magnetic core (B) Shielded primary winding (C) Shielded secondary winding separated from core by air gap.

Results? Distributed capacitance between ground and shield of secondary winding is reduced to the order of 15 to 40 pf, depending on transformer power rating. And in spite of the air gap there is good magnetic coupling between primary and secondary winding. Efficiency is of the order of 90%. When used in D-C power supply, such as the Isoply, rectifiers are enclosed in same shield as secondary winding. With Isoplys you can now create simpler, less costly, and in many cases, better performing circuit designs in applications never before possible.

Elcor

write for full information: **ELCOR Incorporated**

Subsidiary of Welex Electronics Corporation
Sales / R & D Laboratory / Manufacturing
1225 W. Broad Street / Falls Church, Virginia
JEfferson 2-8850



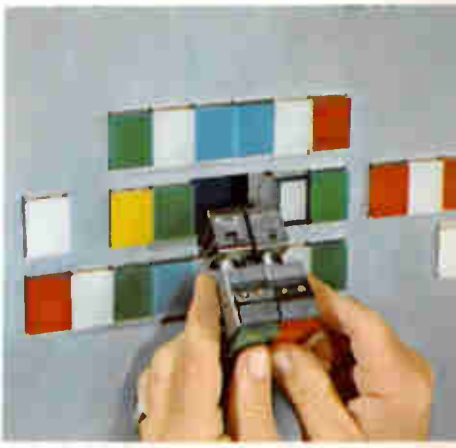
Save 50% on space. Indicator and switching unit are combined in one device to save panel space.

Start your panel design with the

Reliability, Styling and Flexibility of

MICRO SWITCH lighted push-button switches

The flexibility of MICRO SWITCH "Series 2" lighted push-button switches enables you to precisely tailor your control panel to your requirements. Hundreds of switch and indicator combinations can be assembled by simply snapping together the correct modular parts. Their clean, modern styling complements your panel design without dominating it. Most important, any of the 18 switch units you select has MICRO SWITCH reliability. That's why these "Series 2" switches serve on some of the most crucially important control panels in the world. Write for the colorful Catalog 67, or see the Yellow Pages for the nearby MICRO SWITCH Branch Office.



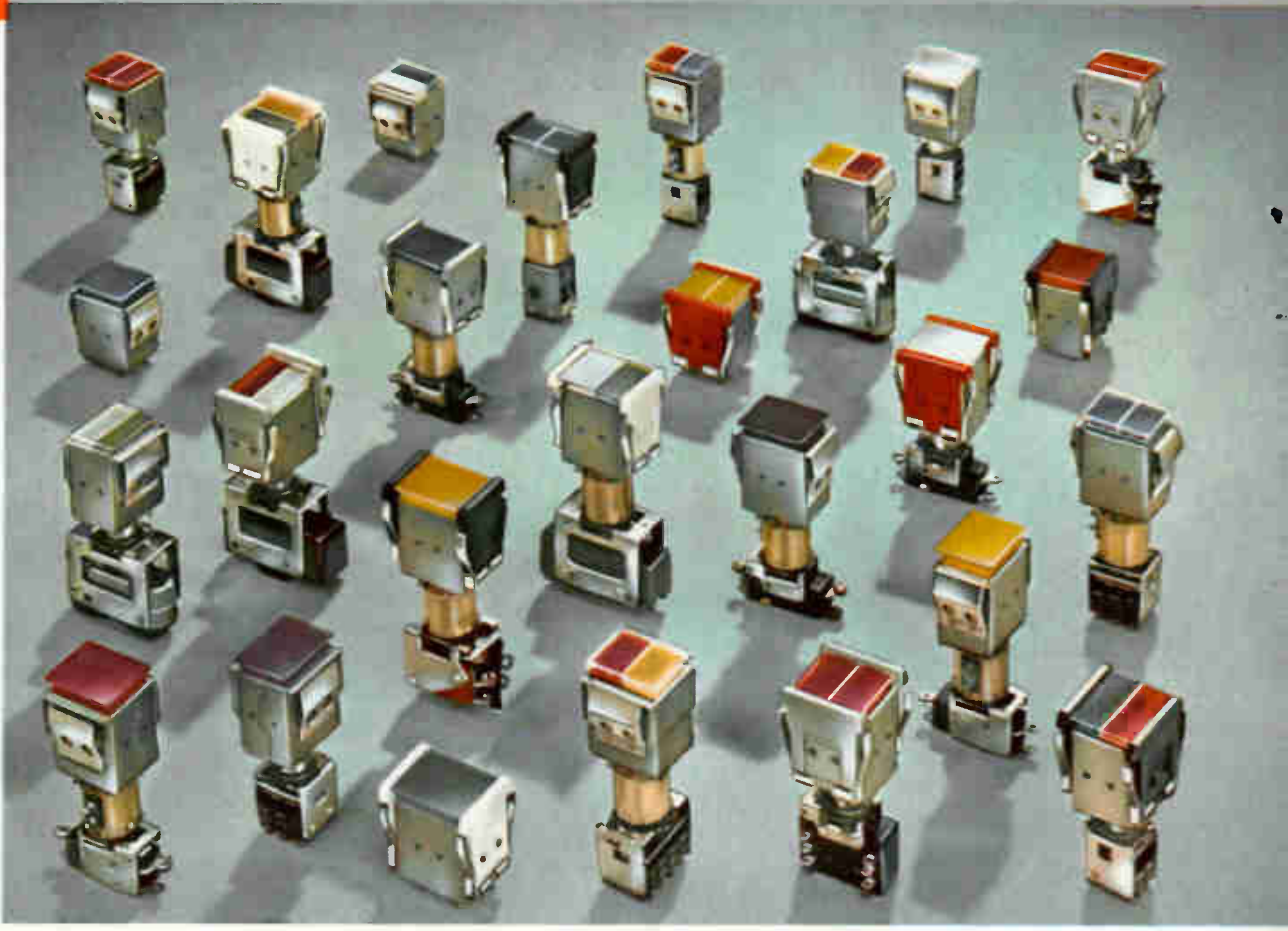
It's a snap! Modular parts snap together and then snap into panel slots without tools.

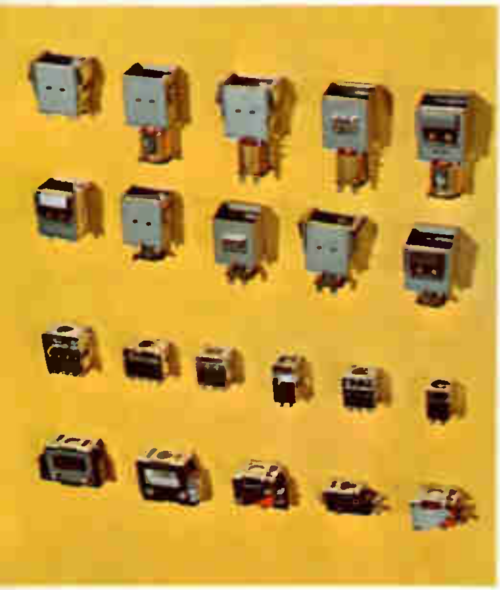
MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls, Limited, Toronto 17, Ontario

Honeywell
MICRO SWITCH Precision Switches

HONEYWELL INTERNATIONAL
Sales and service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

MICRO SWITCH Precision Switches





Eighteen different switching units are available to match virtually all circuitry requirements.

Hundreds of switch and indicator combinations ...with MICRO SWITCH reliability

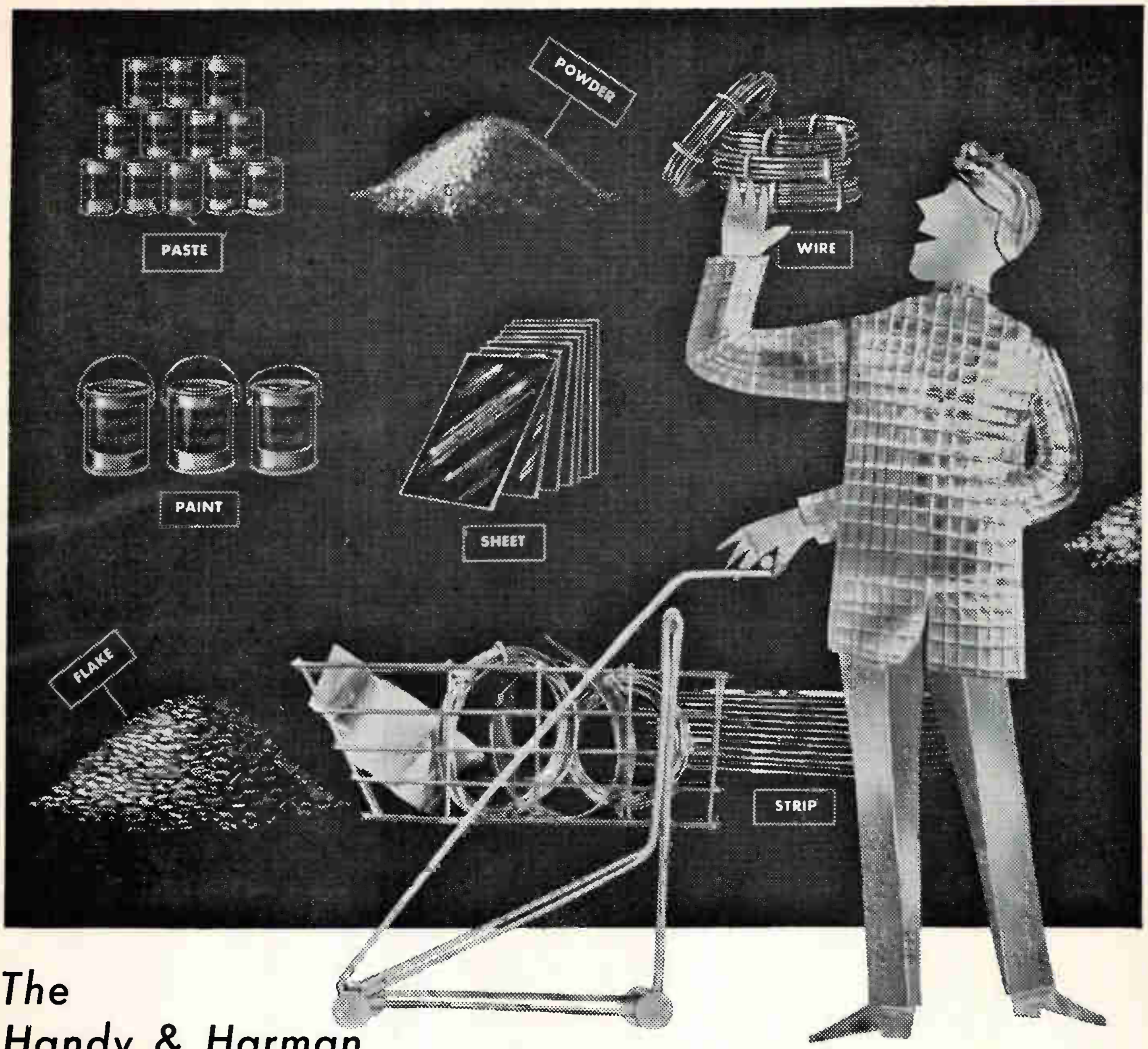
The functional color combinations on "Series 2" switches can be split laterally or longitudinally. Up to four colors can be used behind each display screen. Projected color makes it possible for the display screen to change color to indicate a change in the circuit.

Available switching units include hermetically sealed units, small but rugged long-life types and space-saving subminiature assemblies. Momentary-contact or alternate-action units are available in a choice of circuitry to exactly match requirements. Insist on MICRO SWITCH reliability by specifying "Series 2" push-button switches for your panel. You may obtain prompt engineering help by simply checking the Yellow Pages for the MICRO SWITCH Branch Office. Send for Catalog 67.

MICRO SWITCH ... FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls, Limited, Toronto 17, Ontario

Honeywell
MICRO SWITCH Precision Switches

HONEYWELL INTERNATIONAL
Sales and service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.



The Handy & Harman *Silver Supermarket*

Has <u>every</u> <u>form</u> of silver for your electronics applications

Silver, in many forms and alloys, is a necessity in the electronics and electrical industries. To meet this need on a high quality level, Handy & Harman manufactures powder, flake, paint, paste, sheet, strip, wire, etc., for printed circuits, wiring, resistors, condensers, thermistors, contacts, printed terminal strips on glass, ceramics, plastic laminates, etc.

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We have five Technical Bulletins giving engineering data on the properties and forms of Handy & Harman Silver Alloys. We would like you to have any or all of those that particularly interest you. Your request, by number, will receive prompt attention.

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General Offices: 850 Third Ave., New York 22, N. Y.

Two Dozen Companies Merge

MORE THAN two dozen electronics manufacturers have completed acquisitions of other companies during the last month. Among these are:

HEWLETT-PACKARD, Palo Alto, Calif., acquired Sanborn Co., Waltham, Mass., as a wholly-owned subsidiary. Sanborn, to operate as a separate corporation under its own name, will give H-P a base for development of electromedical equipment.

MAXSON ELECTRONICS, New York City, bought Hopkins Engineering, San Fernando, Calif., for an undisclosed amount of stock. Hopkins is a components manufacturer.

TEXAS RESEARCH AND ELECTRONICS, Dallas, has obtained Eastman Products, Plano, Texas, and its subsidiary in Louisville, Ky., for $1.7 million. Eastman, an electronic hardware manufacturer, will function as a division and retain its name.

JERROLD ELECTRONICS, Philadelphia, bought Technical Appliance Corp., Sherburne, N. Y., for $2.7 million. TACO makes antennas for consumer, microwave, space and missile markets. No management changes are contemplated at this time. Jerrold acquired Harmon-Kardon in February.

GENERAL RAILWAY SIGNAL, Rochester, N. Y., has purchased Budelman Electronics Corp., Stamford, Conn., a communications equipment manufacturer. Budelman, with annual sales over $1 million, will operate as a wholly-owned subsidiary with no changes in management. GRS obtained a controlling interest in Cardion Electronics, Westbury, N. Y., earlier this year.

BARNES ENGINEERING CO., Stamford, Conn., has agreed to acquire Connecticut Instrument Corp., Wilton, Conn. Barnes plans to use its new subsidiary as the nucleus of an expansion program in analytical instrumentation.

TAMAR ELECTRONICS, Gardena, Calif., has acquired two Daystrom companies: Daystrom Wiancko Engineering, a transducer and read-out device manufacturer, and Daystrom Pacific, which manufactures gyroscopes.

LABORATORY FOR ELECTRONICS, Boston, plans to acquire Tracerlab, Inc., Waltham, Mass. Stockholders are to vote Oct. 27. LFE says proxies voting more than two-thirds in favor of the merger have been received.

BURNELL & CO., Pelham, N. Y., has acquired 80 percent of the common stock of GLP Electronics, Bristol, Conn. GLP, which makes tantalum and aluminum capacitors, will operate as a subsidiary.

DYNAMIC ELECTRONICS, INC., has been formed by the combination of two New York companies. They are TKM Electric, Rochester, which makes permanent magnet generators, and Drake Manufacturing Co., Friendship, which produces generator castings and related equipment. Dynamic is now negotiating with a third company.

TRANSISTOR APPLICATIONS, INC., Boston, Mass., now owns New England Transformer Co., Somerville, Mass., and its affiliate, Transformer Model Shop, Inc., through a stock transfer. Combined sales of more than $1 million are anticipated this year.

BENSON-LEHNER, Los Angeles data processing equipment manufacturer has announced approval by California authorities for spinning off its wholly-owned subsidiary, Documentation, Inc. B-L shareholders will receive one share of the newly independent company for each share they hold. DI is located in Washington, D. C., and specializes in research.

CENTRALAB, Milwaukee, Wisc., division of Globe-Union has announced acquisition of Wilrite Products,

in Month

Inc., Cleveland, O. The Ohio company makes specialized resistors. Its present annual sales are in the $500,000 area. The acquisition involves some 5,000 shares of Globe-Union stock.

COMPONENTS CORP. OF AMERICA, Mt. Carmel, Ill. has acquired the assets of United Aircraft Supply Corp., Chicago, for an undisclosed amount of cash. It will operate as a wholly-owned subsidiary with no changes in management. The move is expected to give Components a greater scope in production and distribution of components.

DEFENSE CONTRACTING

	DEFENSE INDUSTRY SYSTEMS FOURTH QUARTER, FISCAL 1961
Aircraft systems	$1,642,410,000
Missile & space systems	1,147,020,000
Vehicles, ordnance, vessels	884,172,000
Mgmt, mntnce, svces	431,486,000
Electronic warfare	261,790,000
Communications	201,379,000
Navigation systems	165,364,000
Research programs	88,825,000
Data processing	42,886,000
Meteorology	3,795,000

The above figures represent prime military systems awards. They are recorded exclusively for ELECTRONICS by Frost & Sullivan, Inc., New York, defense market specialists

25 MOST ACTIVE STOCKS

WEEK ENDING SEPT. 29, 1961

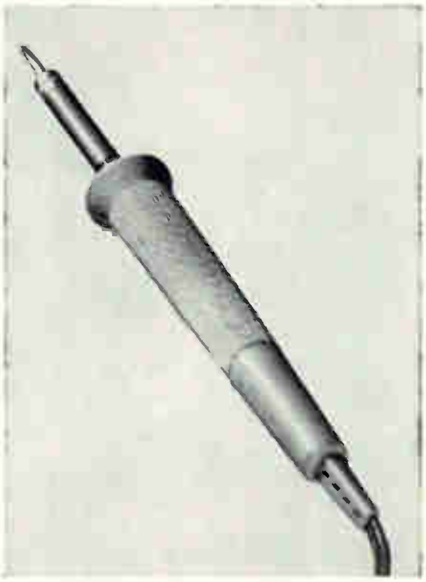
	SHARES (IN 100's)	HIGH	LOW	CLOSE
Transitron	1,668	19¼	16⅞	18¼
Sperry Rand	1,542	24½	23⅜	24
Gen Tel & Elec	1,131	25⅞	25¼	25½
Gen Electric	996	75¼	70½	75
Texas Instruments	965	118½	103¼	115¾
Avco	962	23⅜	22⅜	22¾
Ampex	891	19½	17⅛	19½
Gen Dynamics	742	29	27½	28½
Avnet Elec	683	27⅜	24⅛	26
Standard Kollsman	655	36¼	34¼	35¼
Westinghouse Elec	589	45⅜	43⅛	45
Magnavox	564	36¾	33½	34¾
Universal Controls	521	10¼	9¾	9⅞
U S Industries	513	15⅞	14¼	15⅝
I I & T	490	55¼	52¼	54¾
Zenith Radio	472	176¾	167½	173½
Raytheon	462	37¼	34⅞	36⅜
Gen Inst Corp	446	30⅛	28	29
Litton Ind	414	148	138	139⅝
R C A	410	54⅞	52¾	54⅝
Lockheed Aircraft	405	45⅜	42⅝	43⅝
Martin Co	404	34½	32⅝	32⅝
Elec & Mus Indus	394	5⅛	4⅞	5
Hewlett-Packard	390	29½	26	28¾
Ling-Temco Vaught	388	28½	26⅛	28

The above figures represent sales of electronics stocks on the New York and American Stock Exchanges. Listings are prepared exclusively for ELECTRONICS by Ira Haupt & Co., investment bankers.

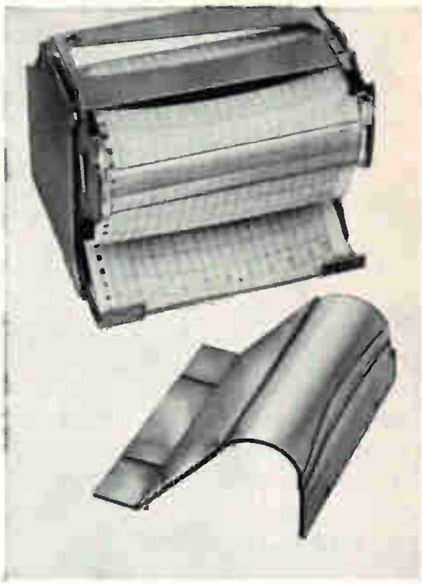
G-E LEXAN® POLYCARBONATE RESIN

GOOD DIELECTRIC—AND MUCH MORE!

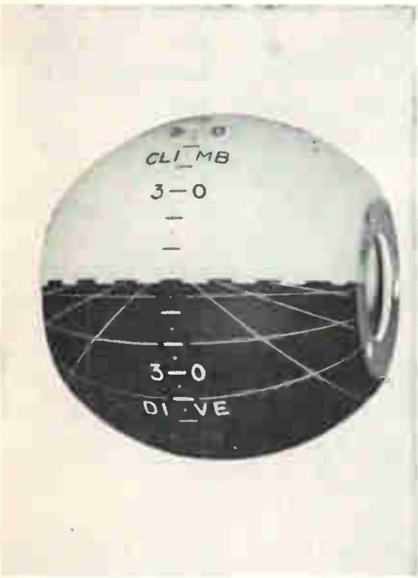
STABLE ELECTRICALS. Binding posts made of LEXAN resin retain electricals even under moist, hot conditions. They do not loosen, are molded in six attractive LEXAN colors for coding. Other features are: low loss and power factor, low dielectric constant, high voltage insulation, non-sink surfaces.
(Superior Electric)



HEAT RESISTANCE. Beautiful handles of LEXAN polycarbonate resin are used in rugged service on U.L. approved soldering irons. They resist the impact, heat and abrasion of daily bench work. The hard, glossy handles are light in weight. Molded in three pastel colors, they provide toughness and sales appeal.
(Ungar Electric Tools)



TRANSPARENCY of **LEXAN** resin is important in chart guide for recorder. LEXAN resin is the only transparent plastic able to withstand heat generated by internal lights. It is distortion-free at temperatures up to 270°F and self-extinguishing. Its extremely high impact strength eliminates cracking of guides.
(The Foxboro Co.)



DIMENSIONAL STABILITY. Maximum allowable change in this 5-inch aircraft instrument part is only 5 mils over a temperature range of —65° to 300°F! And it must maintain this tolerance under high humidity. Part is injection molded of LEXAN resin as half spheres which are solvent cemented, lathe-turned and painted. (Lear, Inc.)

TOUGHNESS. Press-fitted into metal gear used in an electric drill, bushing of LEXAN polycarbonate resin provides safety from electric shock . . . helps eliminate need for additional grounding. Strength and creep resistance of LEXAN resin enables bushing to withstand torque and load requirements of drill.
(Millers Falls Co.)

ARE YOU LOOKING FOR A PLASTIC THAT CAN REALLY TAKE IT?

To demonstrate the toughness of LEXAN resin, salesmen will sometimes slam and hammer a product made of the material. LEXAN has the highest impact strength of any plastic – amounting to 12-16 foot-pounds per inch of notch – and it usually emerges unscathed from encounters with such "merchandising stresses". It is a high-performance material, likewise, with regard to high-temperature behavior and dimensional stability.

Its many other advantages make it a priority material for thorough investigation by all designers, engineers and molders. We will be pleased to supply you with information on the properties, processing and end-uses of LEXAN resin. Don't hesitate to write to us. General Electric, Chemical Materials Department, Section E-51, Pittsfield, Mass.

LEXAN®
Polycarbonate Resin

GENERAL ELECTRIC

GM 6012

Broadband Millivoltmeter, type GM 6012

Frequency range: 2 c/s - 1 Mc/s
Measuring range: 1 mV (f.s.d.) - 300 V in 12 steps
dB scale: —80 dB up to +52 dB (0 dB = 1 mW into 600 Ω).
Input impedance: 4 MΩ in parallel with 20 μμF (up to 3 V)
10 MΩ in parallel with 10 μμF (in the other ranges).
Overall accuracy with respect to full scale:
within ± 2.5%, 5 c/s - 100 kc/s
within ± 5%; 2 c/s - 1 Mc/s
Pre-deflection: < 100 μV

High Frequency Millivoltmeter, type GM 6014

	without pre-attenuator	with pre-attenuator
Frequency range:	1 kc/s - 30 Mc/s	10 kc/s - 30 Mc/s
Measuring range:	1 mV (f.s.d.) - 300 mV in 6 steps	100 mV (f.s.d.) —30 V in 6 steps
dB scale:	—80 dB up to —8 dB	—40 dB up to +32 dB
Damping at 1 kc/s	1 MΩ	50 MΩ
1 Mc/s:	700 kΩ	10 MΩ
30 Mc/s:	50 kΩ	2 MΩ
Input capacitance:	7 μμF	2 μμF

Pre-deflection: Compensated by electrical zero setting
Variations of the frequency characteristic:
< 5% over the whole range, with respect to the response at the frequency of the calibration voltages.
Overall accuracy: < 3% with respect to full scale and with reference to the frequency characteristic.

meters

DC Microvoltmeter, type GM 6020

	Input I	Input II
Measuring range:	100 μV (f.s.d.) 10 V in 11 steps	10 mV (f.s.d.) 1000 V in 11 steps
Input impedance:	1 MΩ (±1.5%) in parallel with 20 μμF	100 MΩ (± 1.5%) in parallel with 10 μμF

Overall accuracy with respect to full scale: 3%
Pre-deflection: < 5 μV
Drift: < 1 μV per hour after 1 hour of warming-up
Automatic polarity indication doubles the effective scale length with respect to centre-zero instruments.
DC currents may be measured directly with this instrument due to the high accuracy of the input resistance:
Measuring range: 100 μμA (f.s.d.) – 10 μA
Accuracy: < 3.5%

GM 6014

instruments: quality ***tools*** for industry and research

PHILIPS

CIRCLE 25 ON READER SERVICE CARD

...IT GLOWS *when* *the* FUSE BLOWS!

NEW INDICATING 3AG FUSE POSTS

EXAMINE THESE FEATURES

1. New patented knob design to assure high degree of illumination for instant blown fuse indication.
2. Positive finger grip for knob extraction.
3. Quick service bayonet lock.
4. Constant tension beryllium copper coil & leaf spring for positive contact & lower millivolt drop.
5. Optional—at extra cost—neoprene "O" ring to assure splash-proof feature.
6. New high degree vacuum neon lamp for greater brilliance & visibility.
7. Impact black phenolic material in accordance with MIL-M-14E type CFG.
8. One piece brass hot tin dipped non-turning bottom terminal.
9. Double flats on body to permit mounting versatility.

SPECIFICATIONS:

LITTELFUSE

PART #	VOLTAGE RANGE
344006	2½ - 7 volts
344012	7 - 16 volts
344024	16 - 32 volts
344125	90 - 125 volts
344250	200 - 250 volts

Maximum current rating 20 amps.

PHYSICAL CHARACTERISTICS—Overall length 2⅜" with fuse inserted • Front of panel length 13/16" • Back of panel length 1 9/16" • Panel area front 15/16" dia. • Panel area back 15/16" dia. • Mounting hole size (D hole) ⅝" dia. flat at one side.

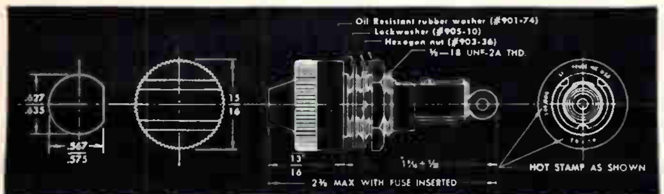
TERMINAL—Side—one piece, .025 brass—electro-tin plated • Bottom—one piece, lead free brass, hot tin dipped.

KNOB—High temperature styrene (amber with incandescent bulbs—2½ thru 32 volts—and clear with high degree vacuum neon bulbs—90 thru 250 volts) • Extractor Method—Bayonet, spring grip in cap.

HARDWARE—Hexagon nut—steel, zinc cronak or zinc iridite finish • Interlock lock washer—steel, cadmium plated • Oil resistant rubber washer.

MILITARY SPECIFICATIONS—MIL-M-14E type CFG. Fungus treatment available upon request per Jan-T-152 & Jan-C-173.

TORQUE—Unit will withstand 15 inch lbs. mounting torque.



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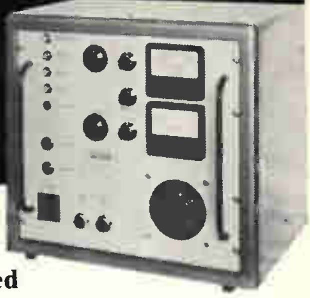

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CIRCLE 27 ON READER SERVICE CARD→

Ion and Plasma Engines Readied for

By WILLIAM E. BUSHOR,
Associate Editor

ELECTRICAL PROPULSION engine designers have nearly bridged the gap between theory—an idea proposed in 1929—and practice. Two new engines, each a flyable prototype model, were demonstrated within the past few weeks. Both power plants have passed vacuum chamber tests and will be further evaluated in rocket and space environments during flights scheduled for 1962. One is a plasma engine (ELECTRONICS, p 4 and p 29, Sept. 1, 1961) developed by Republic Aviation, the other is a Hughes Aircraft ion engine.

Although these electrical engines operate on fundamentally different principles, each is designed to propel or control satellites, interplanetary space vehicles and deep-space probes. Typical applications will be where low-thrust must be maintained over long travel times and where low fuel weight or economy in fuel consumption are important.

Republic's XE-1 pulsed plasma engine, developed for the Office of Naval Research and the Air Force's Office of Scientific Research, operates as it would in an actual spaceship or satellite. This was accomplished by designing a completely self-contained system carrying its own power source—a 28-v battery which is rechargeable by solar cells.

Thrust is produced by electromagnetically pinching an ionized inert gas and discharging it into space. As shown in the figure, the gas pressure is reduced by a pneumatic regulator system. Four pulses of low-pressure gas are supplied to the exhaust nozzle at rates up to 10 pulses a second by a control valve that is actuated by a transistor timer. To facilitate ground testing, a photocell-activated engine-control module turns the engine on and off remotely.

Ionization potential is developed from the 28-v battery by a transistor a-c-to-d-c converter-charger that builds the capacitor bank up to 3,000 volts by constant-current charging. When this voltage is applied across the nozzle electrodes, the four discrete pulses introduced by the control valve are accelerated as a group by electromagnetic pinching. Upon reaching a velocity up to 100,000 mph, the gas pulses are exhausted as a single discharge from the nozzle. This applies an impulse to the engine in a direction opposite to the gas flow. One four-pulse discharge occurs during each two-second period, producing 0.01-lb thrust at 10^{-5} mm Hg.

Although the thrust figure is low, the high exhaust velocity gives a correspondingly high specific impulse of 3,000 seconds that will result in a vehicle speed of 75,000 mph. Overall efficiency of electrical input (1 Kw) to output thrust (0.01 lb) is over 50 percent. A two-pound nitrogen fuel bottle is expected to give two years operation.

Auxiliary cooling equipment is not necessary because relatively cool temperatures of 200 to 300 F are produced at engine walls. Thrust level can be controlled by varying pulse rate. Specific impulse can be changed by altering fuel flow rate. Instantaneous starting or stopping of the engine is possible because each pinch is a separate operation and is dependent only on whether or not the capacitor bank is charged. Flight tests are sched-

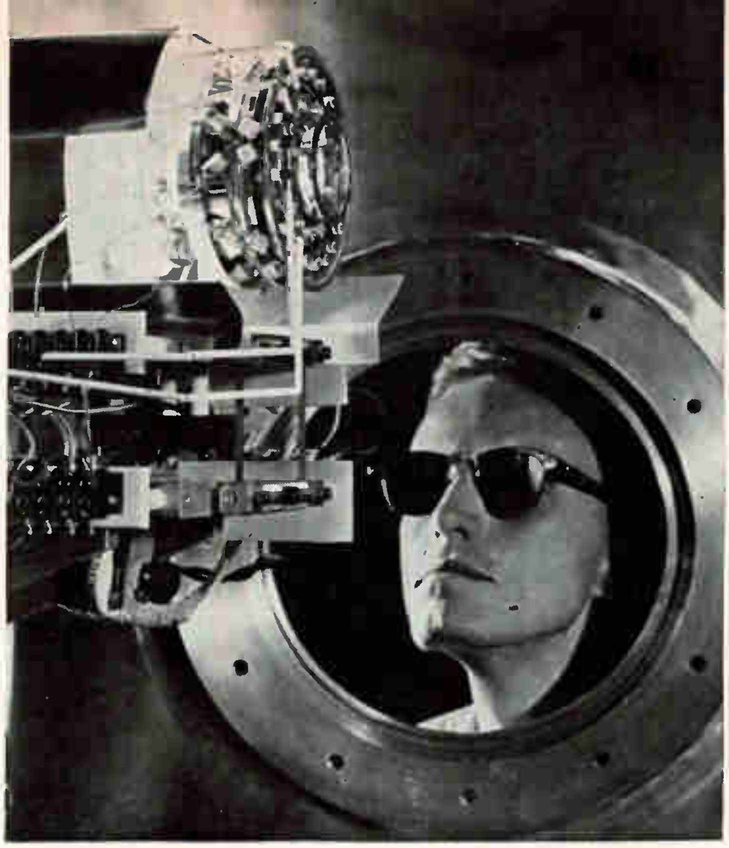
Technician makes final instrumentation adjustment before test run of Republic Aviation's pulse plasma engine. Capacitor bank surrounds exhaust port at right. Photocell units for remote on-off engine control are just above technician's hand. Practically no erosion of primary components was reported

Space Tests

uled for June, 1962 at Wright Field.

Hughes' ion engine, developed for the National Aeronautics and Space Administration, has been designed for operation with a separate power source. A complete ion propulsion system, which will include a nuclear-electric power supply (SNAP-8) under development by NASA and the Atomic Energy Commission, might be flight tested as early as 1965.

Thrust is produced by electrostatically accelerating ionized cesium atoms and discharging them into space. A reservoir of cesium fuel supplies a cesium vapor that diffuses through an annular tungsten element heated to 1,800 F. Contact ionization produces cesium ions that are accelerated in a thin, hollow beam, three inches in diameter, by high-voltage electrodes.

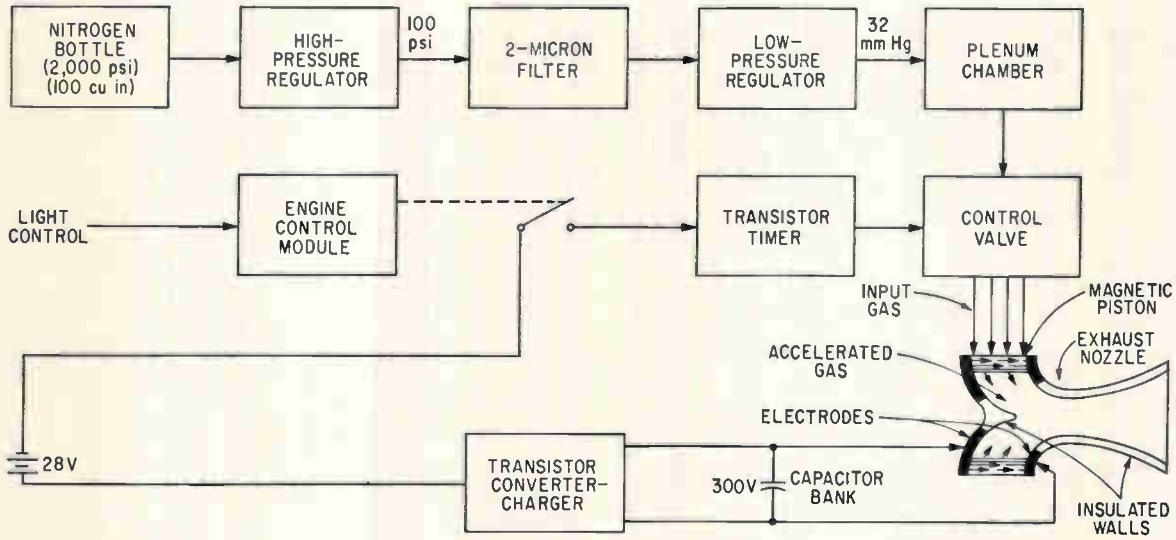


Operator checks performance of Hughes Aircraft's ion engine during test simulating space conditions. Engine has undergone a total of 40 hours testing with 4.6 hours its longest run

Exact determination of ion paths, important in producing optimum electrode configuration, is done with a computer-controlled analog trajectory tracer designed to simulate electrical conditions in the engine. This technique keeps erosion of accelerator electrodes low enough to make long space trips practical.

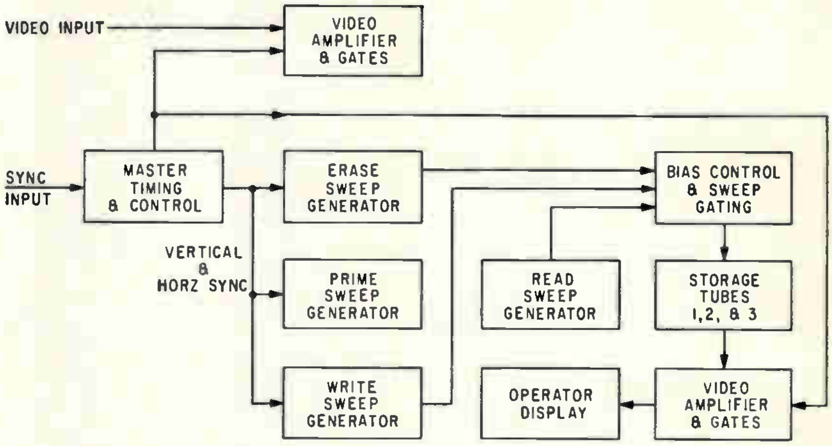
As the high velocity ions exhaust from the engine, electrons are injected into the ion beam to offset the space charge created by the flow of positive cesium ions. Hughes has attempted to solve the problem of space-charge accumulation by placing electron emitter and auxiliary electrodes immediately behind the exit electrode of the acceleration chamber. This forms a self-adjusting reservoir of electrons which intimately mixes the electrons and positive cesium ions to maintain a charge neutrality throughout the cross-section of the ion beam.

At present the prototype gives only about two millipounds thrust. However, Hughes feels this figure can be raised to 10 millipounds by the time the first battery-powered space test is made at Wallops Island in October, 1962. Systems using clusters of engines with several concentric beams are being designed which are expected to deliver 0.2- to 0.4-lb thrust.



Pulse plasma engine demonstrated by Republic Aviation converts 1 Kw of input power to 0.01 pound of thrust. Plenum chamber keeps pressure of nitrogen constant as gas is drawn off in pulses by electronically actuated control valve. Temperature of gas ejected by exhaust nozzle is 200,000 F

STEREO COLOR TV System May Guide



Scan conversion-technique proposed for ground equipment

ROBOT VEHICLE for exploration of the moon's surface was demonstrated by Airborne Instruments Laboratory at the American Rocket Society convention held this week in New York City. Among design problems of such vehicles is selection of a tv system to transmit visual data.

Sensitivities in the image-orthicon range would be required in lunar areas illuminated by starlight, which is dimmer than earthlight. These tubes need protection for general operation on the moon —when they will also be exposed to sunlight and earthlight.

AIL may use a Stereotronics Corporation approach. A set of lenses, laterally separated at normal eye distance, forms two adjacent images on the conventional monocular screen. These dual images are transmitted as a single frame. The monocular scene consists of two identical images. but with the left image on the right of the stereo screen. A polarized screen is placed against each image. The observer wears stereo glasses so that stereo relief is obtained.

A two-color set of filters placed on the stereo adapter at the camera causes monochromatic gray scale pictures to be transmitted. The half-frames would appear on the monitor as two similar images with different gray scales. But color is reintroduced with similar filters at the viewing apparatus.

The filters permit a conventional black and white tv system to transmit more useful information.

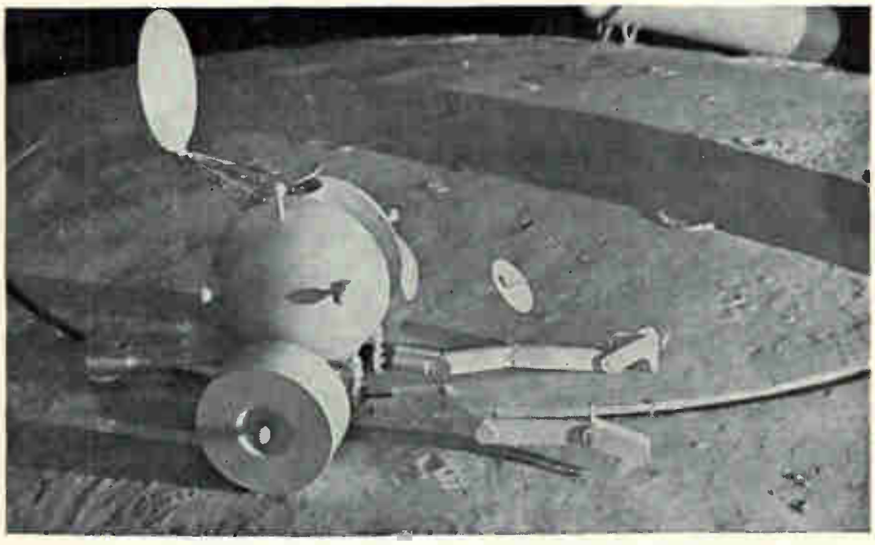
Also under study are scan-conversion techniques for video display. Preliminary studies have shown advantages in slow scan speeds for lunar video transmission, but earth equipment must supply picture enhancement.

A scheme typical of most scan-conversion systems is being evaluated. Storage tubes (single-gun or double-gun) are used as shown in the block diagram to convert the transmission from one frame to 60 frames for viewing. The video is amplified and presented to a storage tube upon command from the master timer. The timing sequence is derived from the horizontal and vertical sync pulses received with the video or telemetry. The timer also controls the mode switching of all storage tubes.

The video is stripped of sync pulses, which are fed to the master timer, then sent to storage tube *1*. Receipt of a signal from the timer places tube *1* in the write mode by setting the bias levels on the electrodes and placing a signal on AND gates associated with the write sweep. This permits the write sweep waveform to be placed on the deflection plates of storage tube *1*.

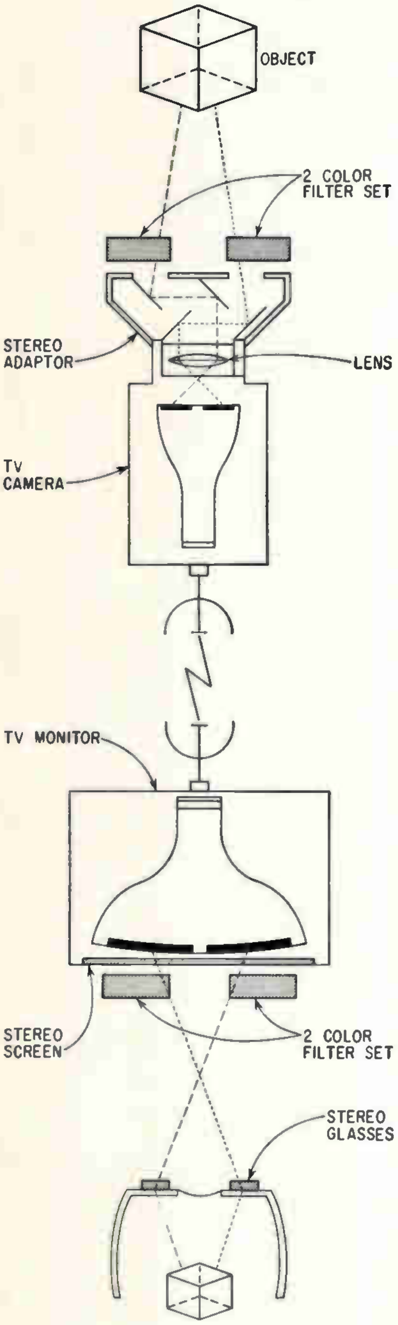
When tube *1* is set in the write mode, tube *2* is set in the read mode. Sweep waveforms and bias conditions are set up, and the output video amplifier is switched to tube *2*. This permits the video from tube *2* to be placed on the display. Tube *3* is set in the erase mode for 49 milliseconds and then switched

Moon Prospector at Coliseum



Sperry Rand's exhibit at the ARS show in New York's Coliseum features scale models of a Prospector moon rover (foreground) and an Apollo-type manned spacecraft, on a simulation of the moon's surface

Moon Robot



Stereoscopic and two-color tv system proposed for moon robot

into prime.

Erasing is performed by writing a d-c level into the tube. The time for this operation depends on the number of storage elements in the tube. A tube with 1,000-line resolution capability has about 8×10^5 storage elements. Since erase time is less than 0.05 microsecond per

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storage element, the total erase time for the tube is less than 40 milliseconds. Priming consists of uniformly charging the surface of the tube.

An individual tube is erased and primed. The write sweep generator is then started for one second and the incoming signal is stored on the tube. The tube is then switched to the read mode and the video directed to the operator's display.

The timing sequence enables the operator to receive a complete picture at all times. New information is presented each second. A problem with this technique is the time delay introduced by scan conversion. This information is stored on the tube for one second before readout begins. Each succeeding line is stored for shorter time until the entire frame is complete. The frame is then presented to the operator. With a wipe display, new information is presented as soon as received, but the display appears to unroll before the operator. In a two-gun storage tube reading and writing can be done simultaneously.

Other items of electronic interest at the convention include GM's projected electrical power unit for space travel, B. F. Goodrich's model ion engine, Republic's new plasma pinch engine for attitude control, Marquardt exhibit of electrical propulsion and Sundstrand's scale model of a solar power system.

Lunar Rover Tester

Variety of possible moon vehicle models are tested at General Motors

Superconducting Magnet

This small coil of niobium-zirconium alloy wire produces a flux density of 43,000 gauss at —450 F, Westinghouse Electric reports

Telephone Satellite Will Take Awhile to Design

PARIS—Space communications symposium held here recently saw delegates of 16 nations outline some hard core problems. The meeting was sponsored by the International Scientific Radio Union.

While all agreed that next year will see a considerable amount of hardware lofted into space, the general feeling is that most of it will be research and data gathering equipment rather than operating communications gear. One British delegate estimated that some $1.5 billion will be needed to pave the way for an operating global system with 8,000-10,000 telephone circuits.

Leonard Jaffe, NASA communications chief, said that satellites for specific scientific missions have performed well, but demonstrate an urgent need for additional research and development aimed at systems with adequate life spans for commercial feasibility. The magnitude of these problems will be determined by six NASA projects planned for 1962.

At the symposium, British scientists presented a general catalog of research needed to bring communications satellites nearer to optimum form. Further information on satellite environment, radiation intensities in the Van Allen belt and the effect of micrometeorites on satellite performance are needed, they said, before decisions can be made on orbits and equipment for long life communications satellites.

Other problem areas discussed included radio wave propagation at 1-10 Gc, electronically - steered ground antennas and less complex, wider bandwidth amplifiers.

Engineers See Instruments In Seven-Company Show

SEVERAL INSTRUMENTS were shown for the first time at the second annual Electronic Instrument Manufacturers' Exhibit, a roadshow for an engineering audience which is touring the East Coast. General Radio, Lambda Electronics, Non-Linear Systems, Panoramic Electronics, Sensitive Research, Tektronix and Trio Labs are participating.

An automatic frequency response plotter for checking bandpass of uhf filters was shown by General Radio. Sine-wave signals swept from 450-1,050 Mc are fed from a uhf oscillator through an amplitude regulator where the signal is constant-amplitude modulated at 1 Kc. The resulting square wave is fed to the filter whose output signal is applied to a strip-chart recorder. Because the recorder's paper-drive mechanism is chain-coupled to the uhf oscillator's frequency-control shaft, the output curve is a direct function of frequency.

Sensitive Research introduced a pocket sized (9 × 4¼ × 13/4 inches) d-c potentiometer that weighs three pounds, has a 0 to 5.099-v range variable in 1-millivolt steps and is accurate to within 0.05 percent. A plug-in unit of the same size and shape extends the range to 500 v. The instrument is battery-operated and contains a transistor galvanometer.

Tektronix demonstrated a dual-trace sampling oscilloscope that presents digital radout and analog displays simultaneously. The instrument will measure rise times as small as 0.4 nanosecond between selected amplitude percentage points on any pulse.

Non-Linear Systems exhibited a transistor analog-to-digital converter that will provide 15,000 readings a second in binary decimal code. An accuracy of 0.01 percent is maintained by using successive approximation circuits.

Data Reduction System Goes up in Blimp

NAVY'S NEED for airborne test of vertical and short take-off aircraft has resulted in a flying wind tunnel. An analog computing system will be carried on an already checked out airship.

The aircraft under test is attached to a twenty foot extension tube below the airship. Tests of powered or unpowered aircraft at speeds of zero to 60 knots yield information on lift, drag and pitching moments by strain gauge.

Data handling is performed in the air by a system employing three solid-state computers of desk-top size. The method avoids landing to process information on ground equipment. The computers, as well as a scanner, analog-to-digital converter, plotting boards and digital printer, are supplied by Electronic Associates, Inc., Long Branch, N. J.

The project is a joint effort of the Subsonic Aerodynamics Lab of Princeton Univ. and the R&D department of the Naval Air Station at Lakehurst, N. J.

Flying wind tunnel allows Navy to test aircraft suspended below airship's cab.

French Tv Manufacturers See Record Sales in '61

PARIS—Reports from the just-concluded radio-tv salon have French receiver manufacturers predicting a record year ahead. At the annual Parisian trade event, manufacturers forecast rises of 12 to 15 percent in sales over 1960. Last year 2,214,000 radios and 655,000 tv sets were turned out in France at a sales figure of some $300 million.

Of the two consumer areas, manufacturers say the tv market has the best prospects because it is far from saturated. France has 40 tv sets for every 1,000 inhabitants compared with 80 for West Germany, 200 for Great Britain and 310 for the U. S.

Another favorable prospect is the intention of the DeGaulle government to set up a second television network. Although no date has been named, the technical characteristics have been spelled out. The new system will be in the uhf band and have 625-line resolution.

Setmakers have responded by producing receivers with both 625 and 819-line sweep circuits plus provision for uhf adaption. All 1962 French tv receivers are being made with uhf positions on the channel selector switch although few contain uhf tuners. Because of the possible time lag of more than 18 months, manufacturers are recommending that purchasers wait for further developments before ordering sets with uhf tuners.

Present prices for tv receivers in France have not risen significantly over last year despite these dual design features. At the low end of the price scale for a 19-in set, list runs to $210. For a 23-in. set, the list is $325.

Push-Pull Loudspeaker Needs No Transformer

SERIES of subminiature push-pull voice coil loudspeakers, for use in miniature radio and audio equipment, has been developed by Pioneer Electric, of Japan. With the voice coil connected in place of a conventional push-pull output transformer, the speakers take less space than the former combination. Ranging in diameter from two to four inches, the speakers have impedances between 10 and 130 ohms.

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NOW'S THE TIME TO GET GROWING IN A GROWING AMERICA!

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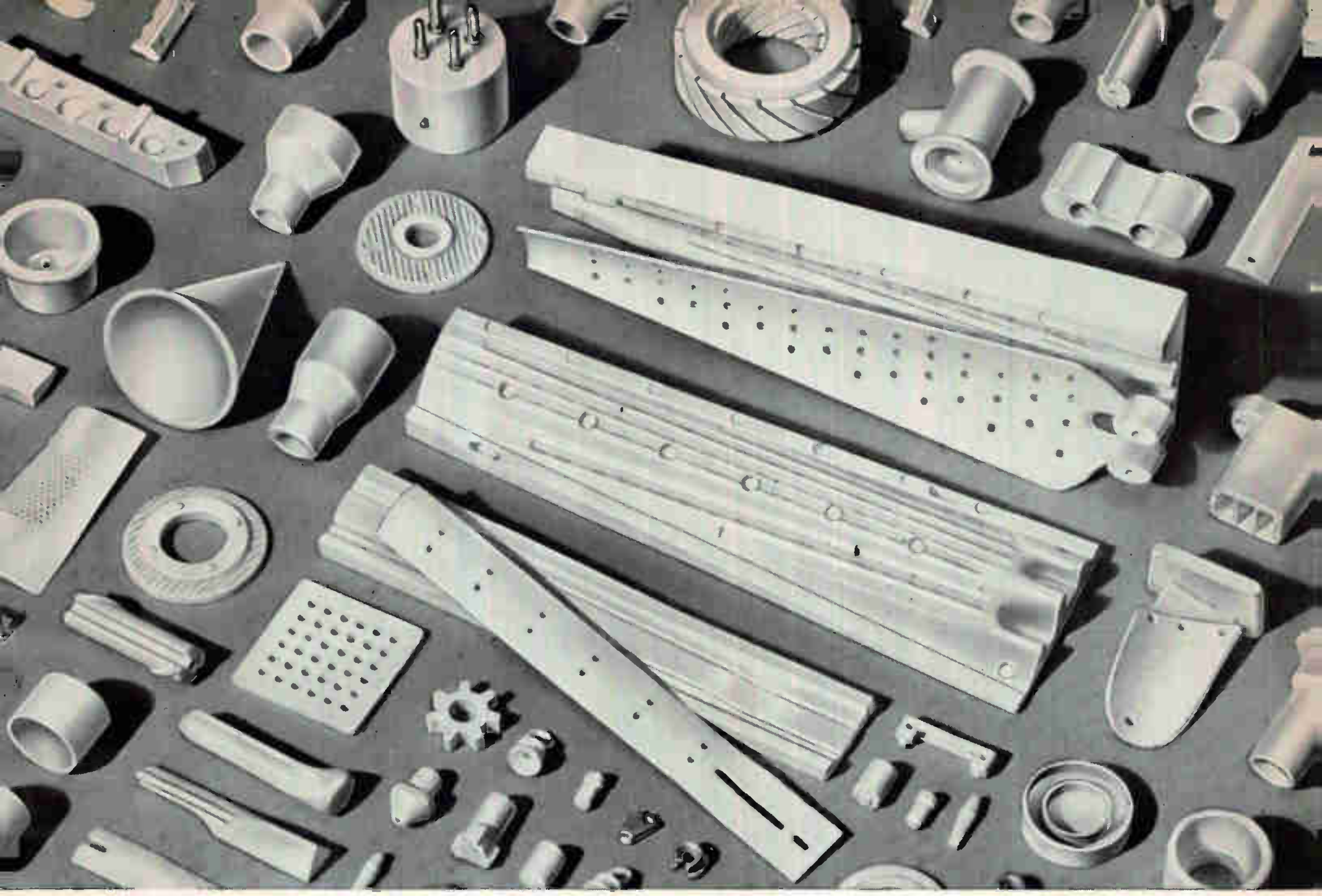

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MEETINGS AHEAD

WRITING & SPEECH, Engineering, PGEWS of IRE; Kellogg Center, Mich. State Univ., East Lansing, Mich., **Oct. 16-17.**

VACUUM SCIENCE and Technology, American Vacuum Society; Sheraton Park Hotel, Washington, D. C., **Oct. 16-19.**

QUALITY CONTROL, American Society for, Chase-Park Plaza Hotel, St. Louis, Mo., **Oct. 19-20.**

RELIABILITY, Electronics, IRE; N. Y. Coll. of Eng., Univ. Heights, N. Y. C., **Oct. 20.**

TELLURIC AND GEOMAGNETIC Field Variations, URSI, Univ. of Texas, ONR; Student Union Bldg. Austin, Texas, **Oct. 20-21.**

AERONAUTICAL & NAVIGATIONAL Elec., East Coast Conference, PGANE of IRE; Lord Baltimore Hotel, Baltimore, Md., **Oct. 23-25.**

URSI-IRE, Fall Meeting, URSI, PGAP of IRE; Univ. of Texas Student Union Bldg., Austin, Texas, **Oct. 23-25.**

QUALITY CONTROL, American Society, ASQC; Sheraton Hotel, Philadelphia, **Oct. 24-25.**

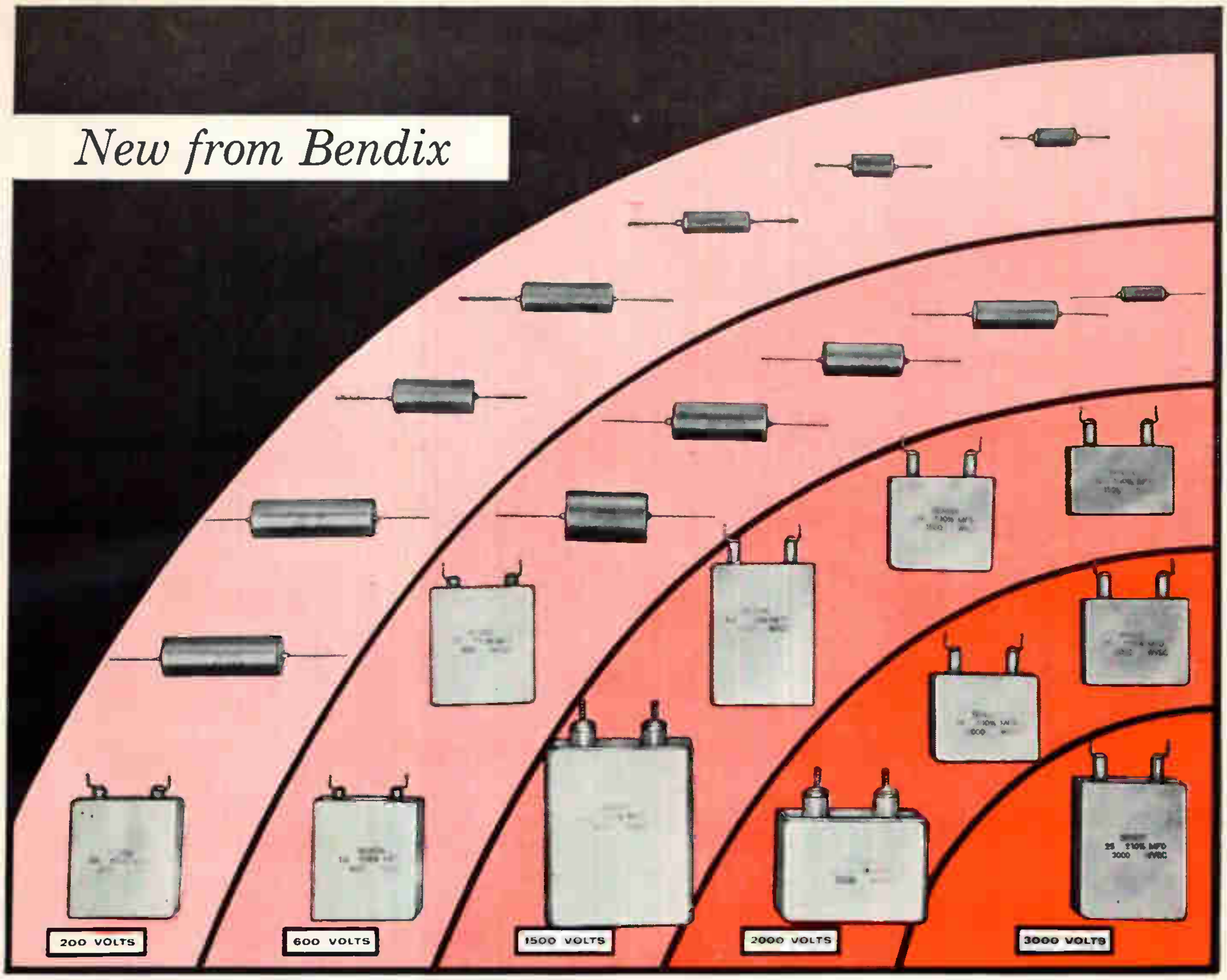
NUCLEAR PROPULSION, Aero-Space, PGNS of IRE; Hotel Riviera, Las Vegas, Nev., **Oct. 24-26.**

INDUSTRIAL ELECTRONICS Exposition, Electronic Representatives, Inc., Detroit Artillery Armory, Detroit, **Oct. 24-26.**

RELIABILITY ASSURANCE Techniques for Semiconductor Specifications, AIA, ASQC, EIA, IRC, JEDEC; Dept. of Interior Auditorium, Wash., D. C., **Oct. 25-26.**

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

IRE INTERNATIONAL CONVENTION, Coliseum & Waldorf Astoria Hotel, New York City, **Mar. 26-29. 1962.**



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DRAWING BOARD NEWS......... No. 3

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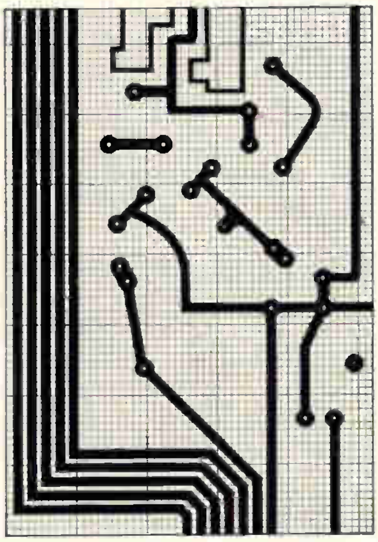

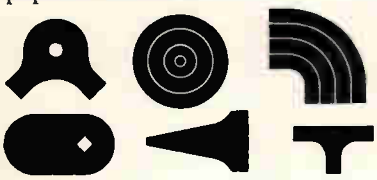

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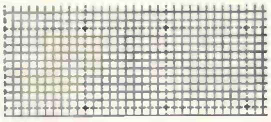

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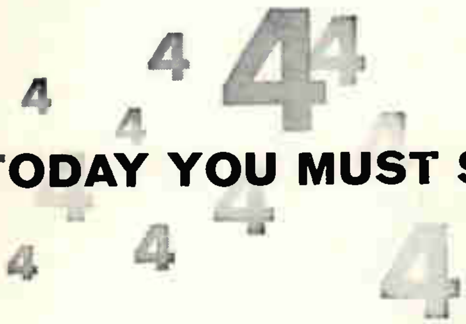

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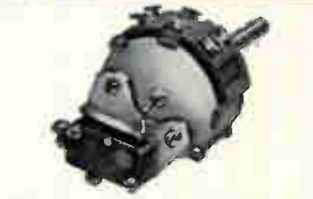
5-gang assembly with precision resistor network between sections.



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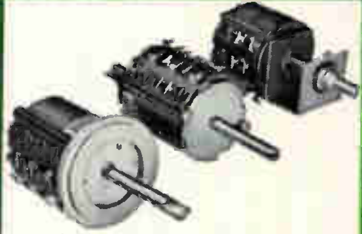

Variations of ganged assemblies with various mounts.

SERIES
42
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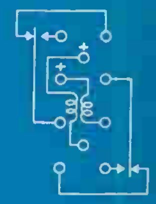
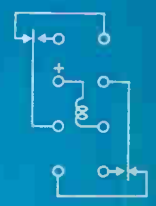
TYPE LF
relay shown (cover removed) is the 2-coil design which controls the entire latching operation within the relay. Shown twice actual size.



2-Coil Circuit Diagram



1-Coil Circuit Diagram

PHYSICAL FEATURES

Life Expectancy
- Wet Circuit:
  - 3.0 amperes, 28VDC resistive—100,000 operations
  - 2.0 amperes, 28VDC resistive—250,000 operations
  - 1.0 ampere, 28VDC resistive—1,000,000 operations
  - 1.0 ampere, 28VDC inductive (100 millihenry)—100,000 operations
  - 1.0 ampere, 115 VAC resistive—100,000 operations
- Dry Circuit:
  - 1,000,000 miss free operations when subject to conventional dry circuit requirements.

Temperature—+125° C to −65° C

Shock—100g's for 1/2 sine wave 11 ± 1 MS pulse

Linear Acceleration—100g's minimum

Vibration—.250″ DA or 30 g's, 5-2000 cps.

Humidity & Salt Spray—MIL-R-5757D

Enclosures: Tinned brass cover with fungus-resistant finish. Hermetically sealed and filled with dry nitrogen at atmospheric pressure.

Contact Arrangement—2PDT latching

Terminals—Plug-in (3/16″ straight), solder hook, 3″ straight

Wiring—Two coils (as shown on drawing above)
One coil (as shown on drawing above)

Weights—.54 oz. for plug-in
.62 oz. for 2 studs, 3″ leads

ELECTRICAL FEATURES

Operate Time—Two coil: When applying—for a minimum of 5 milliseconds—a voltage of at least two times the must operate voltage, the operate time including bounce will not exceed 5 milliseconds. One Coil: operate time will not exceed 8 milliseconds.

Sensitivity—Two coil, approximately 150 milliwatts
One coil, approximately 75 milliwatts

Dielectric Strength
- Sea level: 1000 volts rms—all terminals to case
  - 1000 volts rms—between contact sets
  - 600 volts rms—between open contacts of a set
- 70,000 ft: 350 volts rms—all terminals to case

Insulation Resistance—1000 megohms minimum at +125° C between any two terminals and between all terminals and case.

Maximum Interelectrode Capacitance—
- Closed contacts to case .... 3.7 picofarads
- Open contacts to case .... 2.0 picofarads
- Between contacts of a set .... 2.0 picofarads
- Between adjacent contact sets .... 3.5 picofarads

Maximum Coil Dissipation
- Two Coil: .50 watts at +125° C
  .75 watts at +25° C
- One Coil: 1.25 watts at +125° C
  2.0 watts at +25° C

Standard Adjustment—Relay will operate and hold when the must operate voltage is applied

Contact Resistance:
- Maximum: 50 milliohms at 6 volts, 100 milliamperes.
- Typical: 25 milliohms at 6 volts, 100 milliamperes.

For coil and mounting data on CLARE Type LF relay send for CPC-12. Address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 840 Caledonia Road, Toronto 19, Ontario. Cable Address: CLARELAY.

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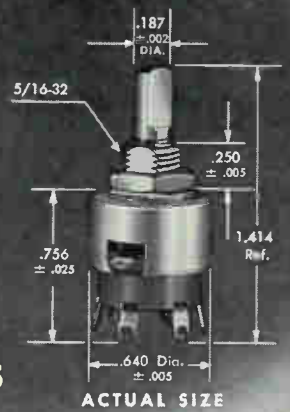

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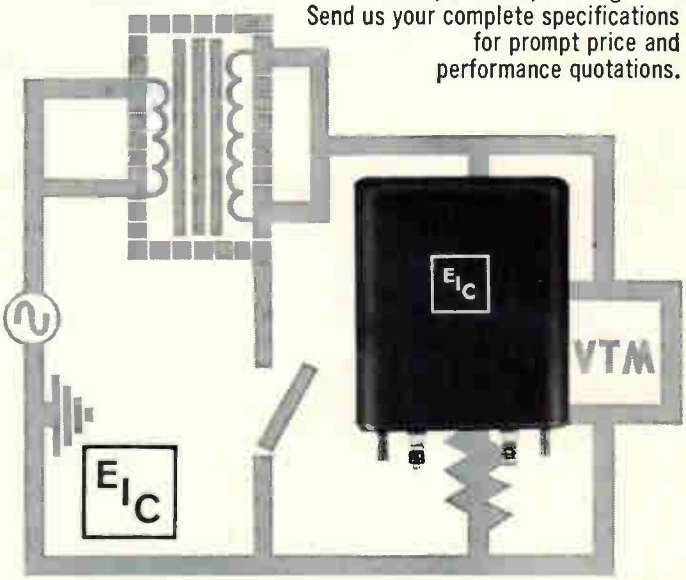

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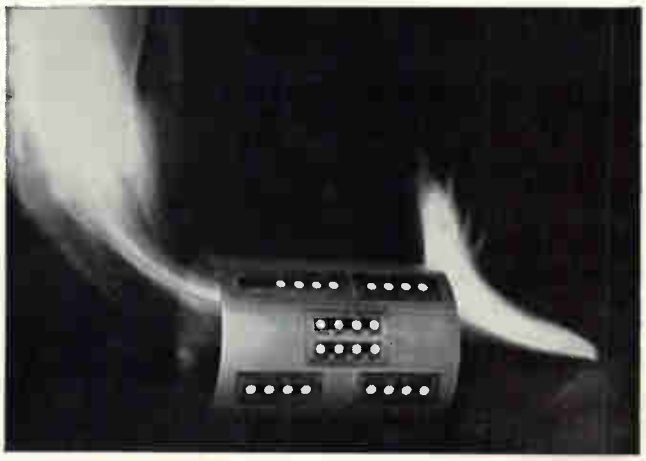

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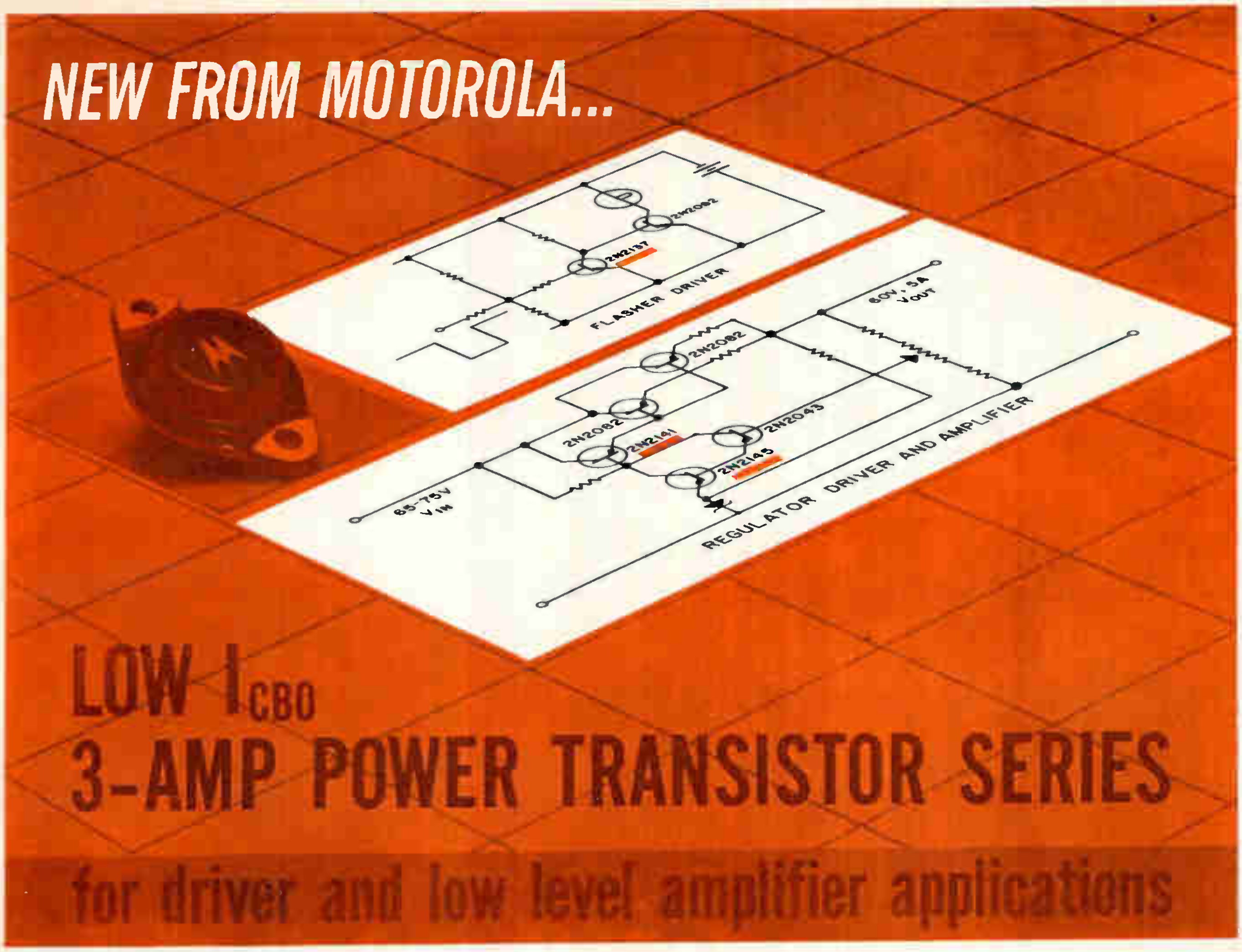

Motorola's new 3-amp power transistor series, the 2N2137-46, offers I_{CBO} (at 2 volts) of only 50 μA instead of the usual 200 μA. Also the thermal resistance of the new small junction devices has been reduced to 1.2°C/W instead of the usual values of 1.5 to 2.5°C/W previously associated with such units. This results in a power dissipation rating of 62.5 watts at 25°C instead of the 35 watts you may be getting out of your present devices.

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	30-60/15 min	50-100/25 min
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BV_{CES} 75V BV_{CBO} 75V BV_{CEO} 60V BV_{EBO} 40V	2N2140	2N2145
BV_{CES} 60V BV_{CBO} 60V BV_{CEO} 45V BV_{EBO} 30V	2N2139	2N2144
BV_{CES} 45V BV_{CBO} 45V BV_{CEO} 30V BV_{EBO} 25V	2N2138	2N2143
BV_{CES} 30V BV_{CBO} 30V BV_{CEO} 20V BV_{EBO} 15V	2N2137	2N2142

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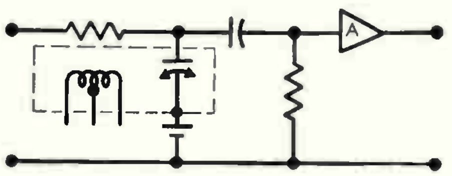

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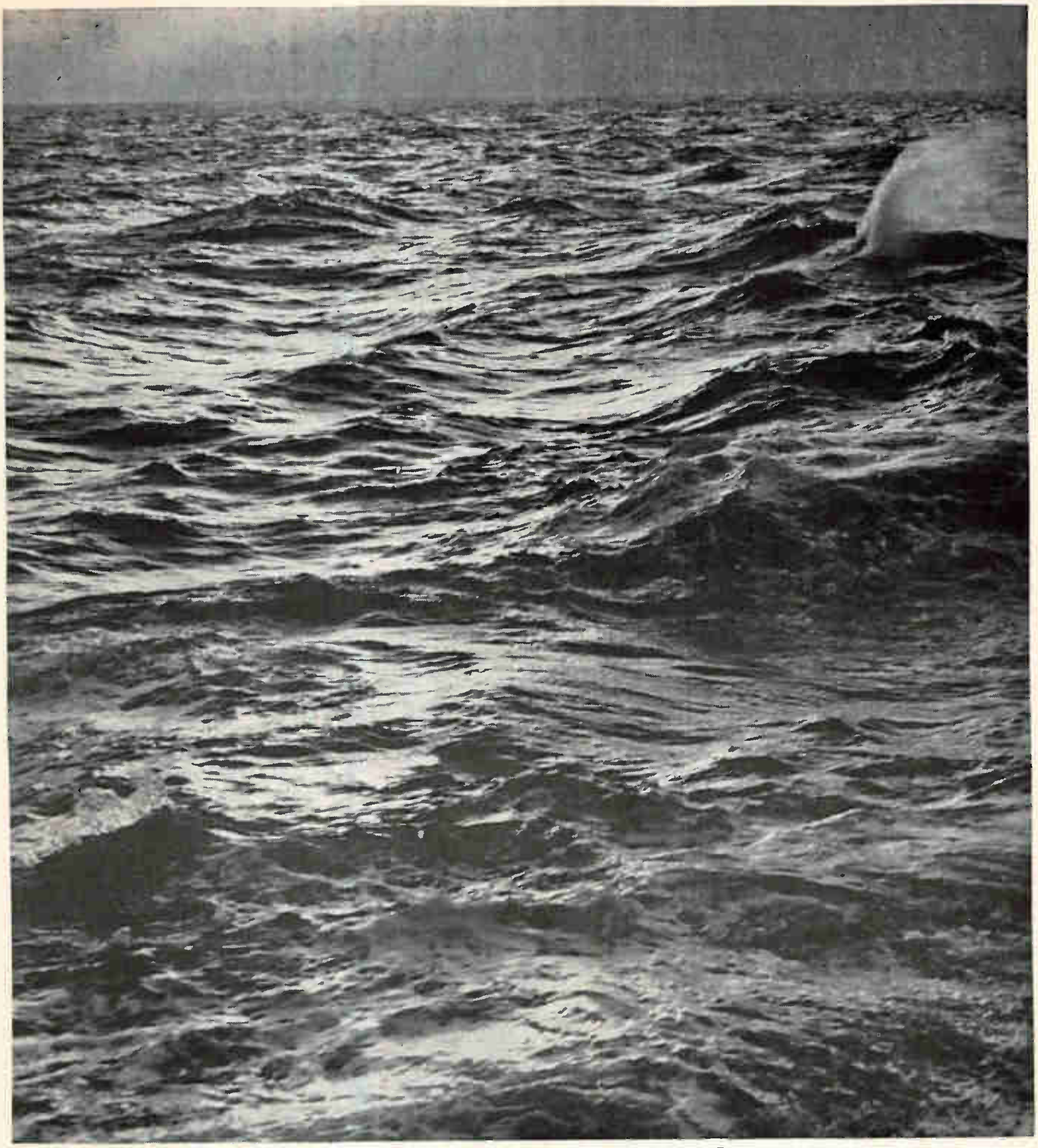

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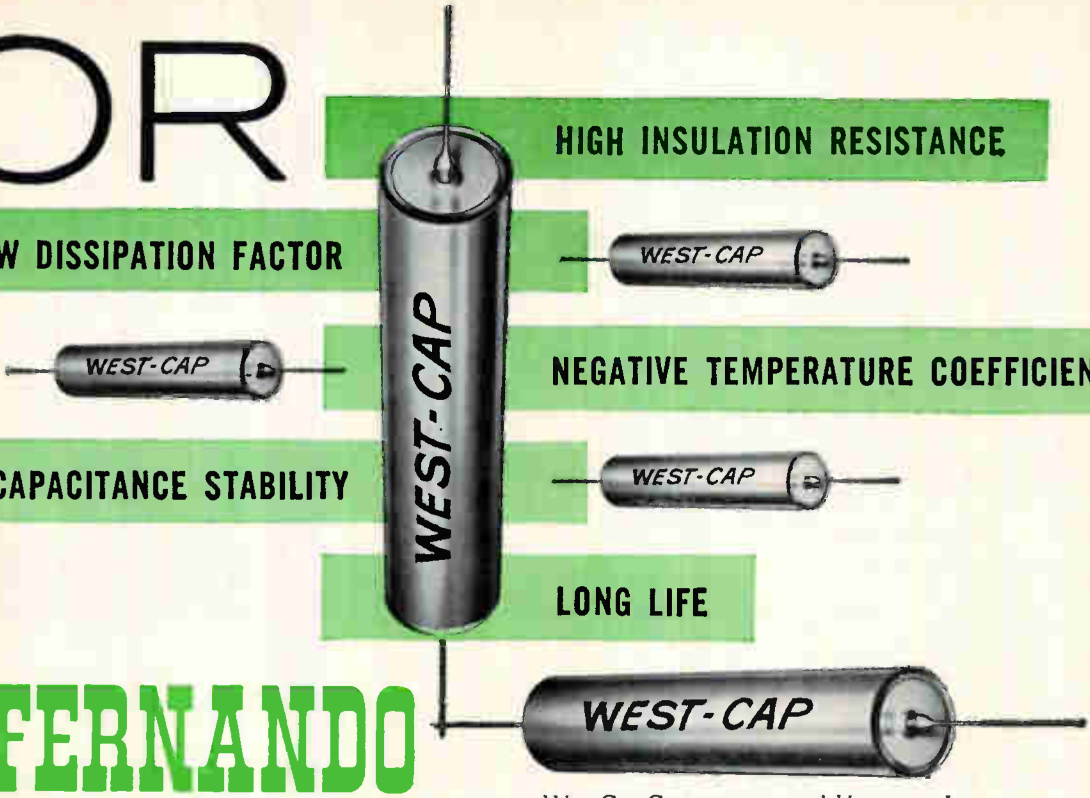

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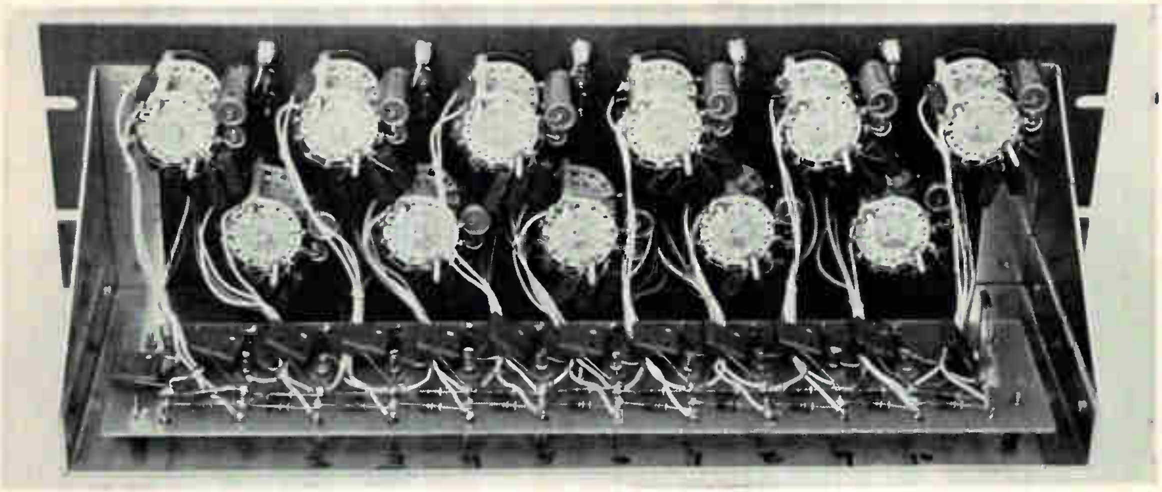
electronics
October 13, 1961



Ten-section neuristor model with adjustable parameters

Simulating Nerve Networks

WITH FOUR-LAYER DIODES

The neuristor, an electronic model of the neuron's axon, is a lumped-element circuit with pnpn diodes in an active transmission line configuration. Possible applications are in data processing.

By A. J. COTE, Jr.,
Applied Physics Lab.,
Johns Hopkins Univ.,
Silver Springs, Md.

IN RECENT YEARS, there has been increasing activity directed toward the development of machines to emulate the performance of nature's biological systems.[1, 2, 3] Success in this endeavor will lead to significant increases in the data processing capabilities of machines and eventually to the long-heralded intelligent machine.

A basic element that processes and transmits data within the nervous system is the neuron,[4] and many models have been proposed to simulate various aspects of its performance.[5, 6] One of the more promising models is the neuristor proposed by H. D. Crane of Stanford[7, 8] and a similar device conceived by J. Nagumo of the University of Tokyo.[9] These devices are active transmission lines which propagate a pulse without attenuation, in much the same way that a neuron's axon performs the same function. Crane has shown that arrays of neuristors can serve as the only elements required in the synthesis of any digital logic function. With appropriate modifications, the neuristor can also probably serve as a more complete neuron model.

The neuristor as proposed by Crane would be a wire-like structure fabricated with appropriately distributed materials and immersed in a distributed power supply. The wire would maintain a standby charge distribution until triggered, at which time it would break down temporarily in the vicinity of the trigger point. The breakdown at this localized point would then spread outward in both directions along the wire, resulting in a propagating breakdown analogous to the burning of a chemical fuse. However, whereas the fuse does not recover, the neuristor does. The recovery of the wire is referred to as the refractory phase of the process and during this time the dis-

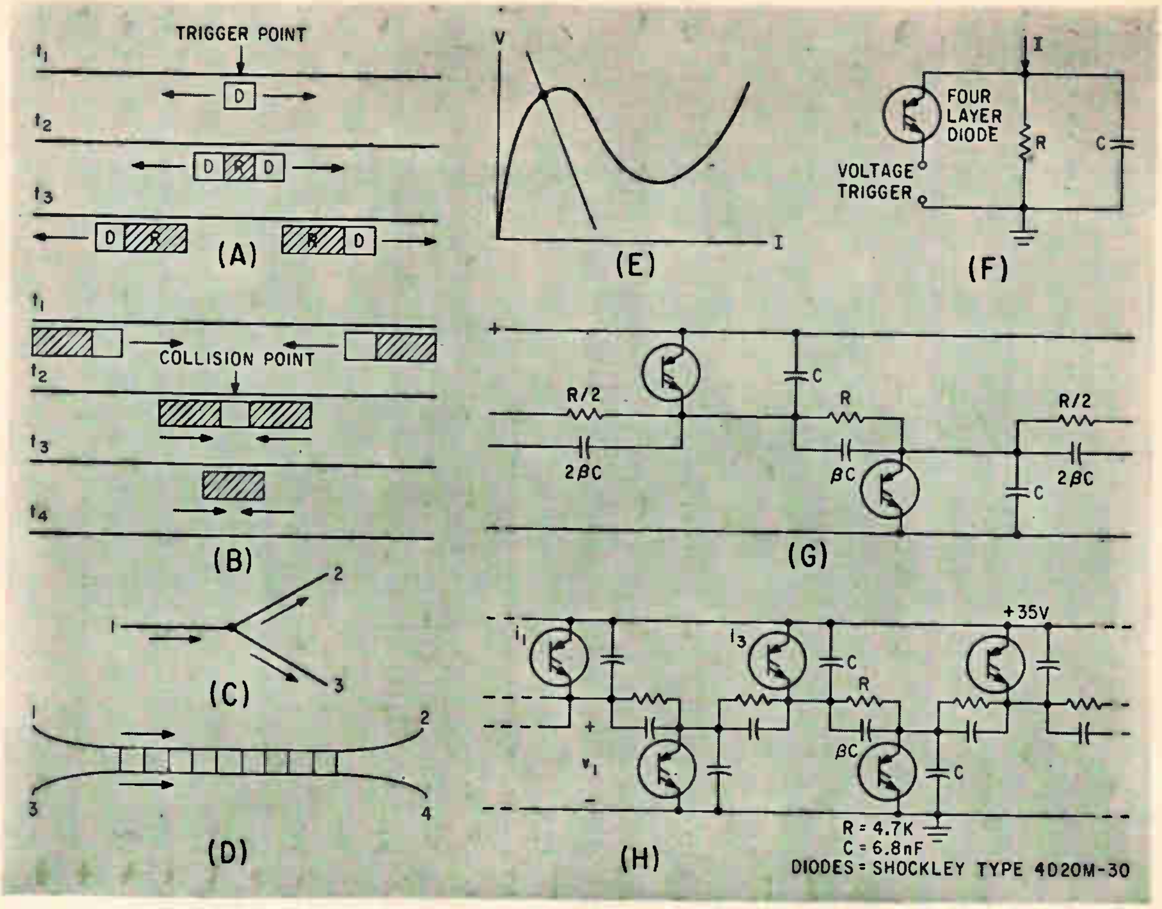


FIG. 1—Illustration of neuristor line propagation shows state of neuristor after triggering (A) as a function of time. Line segment D is in discharge state, segment R is recovering back to the initial state. Arrows indicate the direction of propagation of the discharge and recovery regions. Since the line cannot be triggered readily while in recovery state, two pulses traveling in opposite directions (B) collide and vanish at the point of collision. In a trigger junction (C), a pulse entering at 1 moves to the right and triggers similar pulses at the junction, which propagate toward 2 and 3. Since the pulse is being regenerated continually as it propagates, there is no change in pulse level at the junction. In a refractor junction (D), a pulse entering at 1 propagates to the right and leaves at 2 without energizing the line between 3 and 4. Similarly, a pulse entering at 3 leaves at 4 without triggering a pulse on 1-2. However, when a pulse passes the junction on either line, it temporarily alters the conditions on the other line such that a pulse entering the second line during this refactory period cannot be propagated past the junction and hence dies out. Neuristor configuration of a short-circuit stable active element is shown in static characteristic (E), basic circuit (F), basic section (G), and complete line (H)

charge is not as easily triggered. The operation may be visualized with the aid of Fig. 1A.

The refractory period is responsible for a significant feature of a neuristor's behavior. Two pulses, simultaneously traveling in opposite directions on the same line will destroy each other at the point of collision as shown in Fig. 1B. This is because the triggering process necessary for propagation is inhibited at those points in a line that are undergoing the recovery process.

As a result of these characteristics, pulses can be propagated between neuristors by the two types of junctions, trigger and refractory as shown, in Fig. 1C and 1D.

At the time this article was prepared, the only examples of a distributed neuristors appear to be the axon of a neuron or an iron wire immersed in concentrated nitric acid.[5] When suitably triggered, both the axon and the iron wire exhibit the propagation of a discharge region; however, only the neuron offers any evidence to suggest that the refractory junction might exist.

A lumped-element neuristor can be formed from an appropriately coupled cascaded string of monostable trigger circuits. Each circuit contains three ingredients: an energy source, an energy storage mechanism and a negative immittance. In principle, the negative immittance can be either open- or short-circuit stable and the type selected will then dictate the type of source and storage element required. This discussion is restricted to a neuristor employing a short-circuit stable active element (the *pnpn* diode, capacitive storage, and a current supply).

Returning to the scs (short-circuit stable) neuristor model, the active elements are biased to obtain monostable operation using a biasing network that has a bilaterally symmetrical structure (Fig. 1E to 1H).

The sequence of operations when

a diode is triggered can be explained with the aid of Fig. 2A and 2B. The operating point of all diodes is initially at A. Assume a particular diode in the line is energized. Triggering takes place during phase 1. During phase 2, the bias on the diodes on each side of that diode being triggered, is being altered in the direction required to cause triggering. Line parameters must be selected to insure that sufficient triggering level at the adjacent diodes is achieved during this phase. Phase 3 represents the termination of the original diode's active operation and during the refractory period of phase 4, the diode is more difficult to trigger.

Typical waveforms on the neuristor are given in Fig. 2C to 2E, and Fig. 2F illustrates the method of interconnecting two neuristors to obtain either the T (trigger) or R (refractory) junctions. To evaluate the influence of some of the parameters on neuristor performance, a ten-diode model (photo) was constructed with provisions for varying the values of R and β (of Fig. 1H).

A diode at one end of the line was triggered, and the time required for the pulse to travel down the line was monitored for several values of β. Velocities of propagation between 2 and 20 μsec per section (one diode per section) were obtained for values of β between 4 and 100, respectively. This line did not support propagation for values of β less than or equal to unity; however, a line with a slightly higher value of C (6,800 pf) did operate with $\beta = 1$.

The time required for the line to recover after passage of a pulse places a limitation on the minimum spacing that can be permitted between two successive pulses transmitted down the line. This minimum spacing varied between 1 and 6 msec for β between 4 and 100, respectively. If closer spacings are attempted (by increasing the level at the trigger point) the second pulse will not propagate.

This work was supported by the Naval Bureau of Weapons, under Contract NOrd 7386.

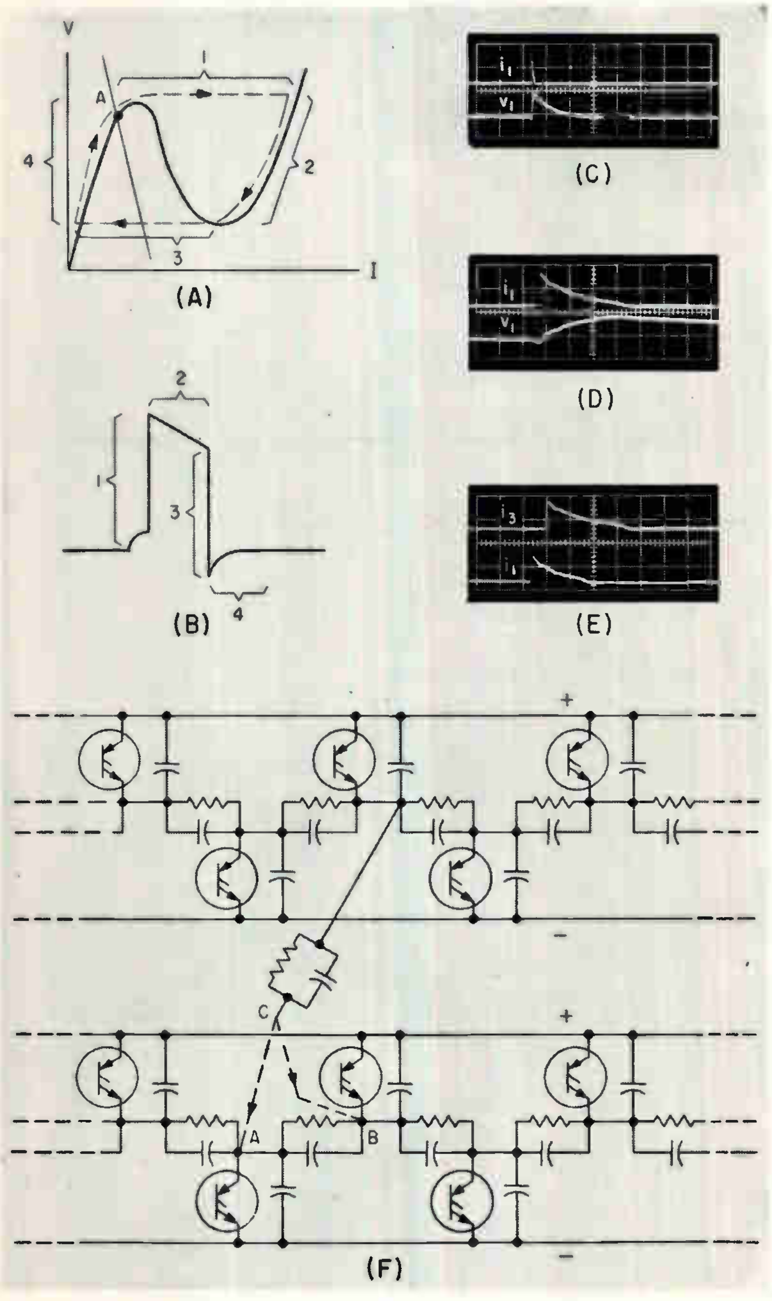


FIG. 2—*Operating sequence demonstrated by static characteristic (A) and by diode current waveform (B). Neuristor waveforms at locations given in Fig. 1H show current and voltage at one point on line (C), same with expanded time scale (D), and time delay between alternate diodes (E). Direction of propagation is from diode 1 toward diode 3. Horizontal scale is 50 µsec/div for first waveform, 2 µsec/div for last two, vertical scale is 200 ma/div or 20 v/div. In the neuristor junction (F), when diodes connected to opposite sides of the power supply are coupled, in the C to A connection, a trigger junction is obtained, and when diodes connected to the same side of the power supply are coupled, in the C to B connection, the refractory junction is obtained*

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(4) T. H. Bullock, Neuron Doctrine and Electrophysiology, *Science*, **129**, 3355, p 997, Apr. 17, 1959.

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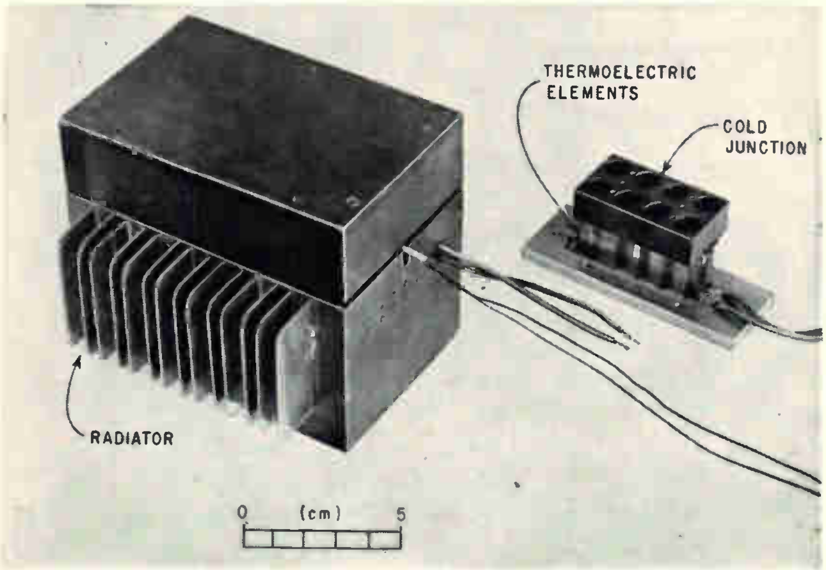
(9) J. Nagumo, An Active Line Using Esaki Diodes, *Report of the Professional Group on Non-Linear Circuit Theory of the Institute of Electrical Communication Engineers of Japan* Feb. 7, 1961.

THERMOELECTRIC ELEMENTS

Constant temperature chamber

sensitive direct-coupled circuits.



Temperature chamber with radiating fins and cold junction for transistors

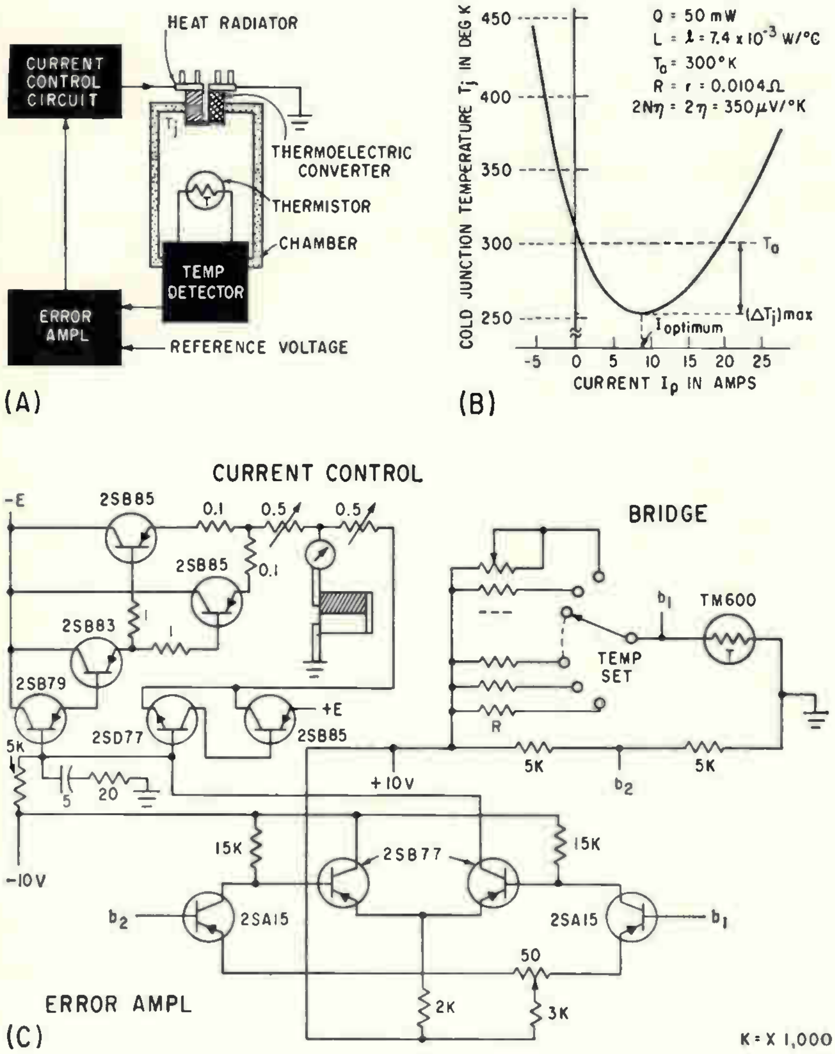


FIG. 1—Control loop of constant-temperature chamber (A). Optimizing cooling current (B). Sensing bridge, error and cooling current amplifiers (C)

PRECISION in circuits using semiconductors, is often limited by changes in device characteristics with temperature. For example, in direct-coupled transistor circuits, variation of β, I_{co}, and V_{be} with temperature changes the operating point of the transistors and make the circuit unstable; the logarithmic increase in I_{co} with increase in temperature is an especially troublesome factor.

A small, lower-than-ambient, constant temperature chamber[1] using a five-element thermoelectric converter was constructed for the purpose of improving zero stability; that is, to minimize drift of sensitive direct-coupled transistor amplifiers. By reducing circuit operating temperature below normal ambients, and by holding it constant, excellent stability was obtained.

The block diagram of the temperature control system is shown in Fig. 1A. Temperature inside the chamber is sensed by a thermistor bridge, bridge output voltage is compared with a reference temperature setting voltage. The difference voltage is amplified and fed to a current control circuit, which controls d-c currents of several amperes. This current operates a thermoelectric converter which cools the chamber and holds it at the desired reference temperature. The advantage of using a thermoelectric converter is that the temperature inside the chamber can be set below as well as above ambient.

The following conditions obtain for the constant-temperature chamber shown in the photograph. The amount of heat leaking into the chamber is given by $L = Nl + l'$, where N is the number of thermoelectric elements, l is heat leak per

for Circuit Cooling

By MINORU NAGATA and ZENEMON ABE
Hitachi Central Research Lab., Hitachi, Ltd., Tokyo, Japan

operates below ambient, provides a favorable stabilizing environment for

Noise and drift of semiconductor circuits are reduced

element, and l' is the heat entering through the chamber walls. The heat Q generated inside the chamber is assumed constant. The heat sink is large enough that the temperature T_a of the high temperature contact is essentially equal to the temperature of the surrounding air. Electrical resistance is $R = Nr + r'$, where r is the resistance of the semiconductor portions of each thermoelectric element and r' is contact and other resistance associated with the thermoelectric element circuit.

Then the temperature of the cold junction in degrees K is

$$T_j = \frac{Q + LT_a + \frac{1}{2} RI^2}{2N\eta I + L} \qquad (1)$$

The term 2η is the thermoelectric power per thermoelectric junction, and I is the current through the thermoelectric converters. Equation 1 is plotted in Fig. 1B. If $Nl >> l'$, $Nr >> r'$, $Q << T_aL$, and if the Peltier coefficient $\pi = \eta T_j$ can be assumed to be constant, then at $I = I_{op} \approx 2\,\pi/r$, where I_{op} is the optimum current through the thermoelectric converter when maximum cooling is required, a maximum temperature difference below ambient of $(\Delta T_j)_{max} \approx 2\pi^2/rl$ can be obtained. Therefore the gain of the thermoelectric converter is

$$A_p = \Delta T_j/\Delta I = (2N\pi - RI)/L = (2\pi - rI)/l$$

To make A_p large, it is necessary to make L and R—or l and r—as small as possible. Converter gain A_p is a linear function of I, and at $I = 0$, A_p becomes $2\pi/l$. For typical values: $2\pi/l$ $(= 2\eta T_j)$ $= 0.1$ v, $r = 0.01$ ohm, and $l = 0.01$ w per deg C; $I_{op} \approx 10$ amp and A_p at $I = 0$ is 10 deg. C per amp.

If C_j is the heat capacity of the cold junction plate attached to the thermoelectric converter, and C_p is the heat capacity of the thermoelectric converter, then the thermal time constant, for $N = 1$, is

$$\tau \approx \frac{C_j + C_p/2}{2\eta I + l} \approx \frac{C_p}{2l} \qquad (3)$$

Typical values are $C_j = 0.08$ joule per degree, $C_p = 0.8$ joule per degree, and $\eta = 170\mu$v per degree. Therefore, at $I = 5$a, the thermal time constant is 41 seconds.

It is desired that A_p be large, and I_{op} and τ be small. The measured values for the experimental apparatus were: $A_p = 1.5$ to 7 C per a (depending on I); $I_{op} = 10$ a; and $\tau = 50$ seconds. The photograph shows the thermoelectric element and the cold-junction plate. The cold junction plate, which is made of copper, can hold up to eight transistors of various types of cases.

Temperature is sensed by a thermistor bridge with a transfer-function gain $G_b \cong 10$ μa per deg C. The first stage of the error amplifier uses differentially-connected 2SA15 transistors. Since the average change of I_{co} of the 2SA15 transistors in the 30 to 40 C temperature range is only 0.1 μ per deg C, and since most of the charge is cancelled by the differential circuit, the error from this cause is small. The current control circuit uses two 5-amp 2SB85 transistors in parallel.

To obtain good control, it is important that $G_b \times A_c \times A_p >> 1$: using the values given above, an error amplifier gain A_c of 83 to 97 db is necessary. The error amplifier and control current circuits are shown in Fig. 1C.

The effects on chamber temperature of changes in the a-c power supply voltage, ambient temperature, and long-time drift are shown in Fig. 2.

The equivalent input drift of a one-stage HJ17D grounded-emitter direct-coupled amplifier with absolutely no temperature compensation when operated in the constant-temperature chamber at 18 C, was much less than 0.1 μa or 100 μv, for a period of several hours. Causes of the drift include changes in I_{co}, V_{be}, β, and changes in the voltage of the batteries, which were located outside the chamber at an ambient of 25C, ± several degrees C.

Other applications of the chamber include measurement of the temperature characteristics of vhf transistors and Zener diodes.

The authors acknowledge the contributions of K. Taniguchi, T. Hirai, T. Fujita, and Y. Baba of Hitachi Central Research Labs.

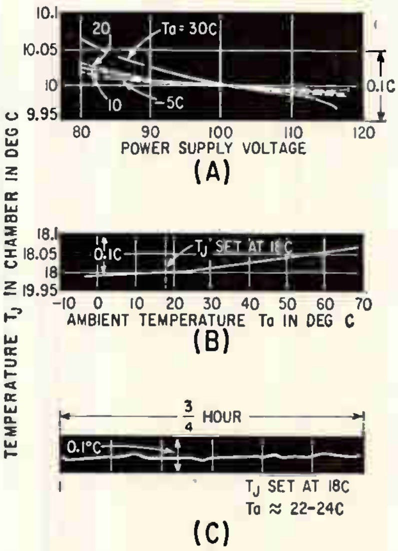


FIG. 2—Chamber temperature as a function of line voltage (A), and of ambient temperature (B). Drift of chamber temperature for a one-hour-period (C)

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Ultrasonics Measures

Instrument comprises two send-receive pairs of transducers, one pair on opposite bank of the river and somewhat downstream from the other. Flow velocity of stream causes prf's of upstream and downstream transmitting transducers to differ. Computing circuits come up with the average river flow velocity over the paths between transducer pairs

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RIVER DISCHARGE is the amount of water flowing through a cross section of the river in a given amount of time. The average flow velocity through the cross section, multiplied by the cross-sectional area, is the amount of river discharge in cubic ft per sec. To achieve accuracy, river-flow velocity must be accurately measured over long periods of time.

Design of the ultrasonic flow-velocity meter described in this article is based on the characteristics of acoustic energy propagated through a river. When propagated through water, acoustic energy travels at a velocity dependent upon water temperature, foreign-matter content, and the water velocity in the direction of propagation. The measurement technique that is used eliminates temperature and foreign-matter content as velocity-measurement factors.

Propagated in the downstream direction of a river, the velocity of acoustic energy is equal to the velocity of acoustic energy in the river with no flow plus the velocity of river flow; propagated upstream, the velocity of acoustic energy is equal to the velocity of acoustic energy with no flow minus the velocity of river flow. If these measurements are made simultaneously over the same water path, and half the difference between them computed, average velocity of river flow will be determined. Thus, any variation in velocity of acoustic energy caused by temperature changes or foreign matter content of the water is cancelled in computation.

The installation (Fig. 1) consists of a transmitting transducer and a receiving transducer mounted upstream near one river bank, and a transmitting transducer and receiving transducer mounted downstream near the other river bank. A pulse is transmitted from the upstream transmitting transducer and is received at the downstream receiving transducer. When the pulse is received downstream it keys the upstream transducer to send a second pulse. Hence, a pulse train is established with a pulse repetition frequency (prf) determined by the time necessary for the acoustic energy to travel down the river. Similarly, a pulse is transmitted from the downstream transmitting transducer and is received at the upstream receiving transducer. The received pulse keys the downstream transmitter to send a second pulse and a pulse train is established with a prf determined by the time necessary for the acoustic energy to travel up the river.

The time for a pulse to travel downstream is given by,

$$t_d = d/(v_s + v_w \cos\theta) \qquad (1)$$

The time for a pulse to travel upstream is given by,

$$t_u = d/(v_s - v_w \cos\theta) \qquad (2)$$

Where t_d = time for pulse to travel downstream, t_u = time for pulse to travel upstream, d = direct path length between transducers, v_s = velocity of sound in water, v_w = velocity of river flow, and θ = angle between line of river flow and direct path of transducers. If Eq. 1 and 2 are solved simultaneously for v_w, the result is

$$v_w \approx (d/\cos\theta)\,[(t_u - t_d)/2t_dt_u]$$

Let $f_d = 1/t_d$ = downstream prf and $f_u = 1/t_u$ = upstream prf; then

$$v_w = (d/\cos\theta)\,[(f_d - f_u)/2]$$

Figure 2 shows how the velocity meter converts the difference between the sampled prf's into an indication of v_w. Since there are two independent transmission loops, there are two transmitters, two receivers, two prf multipliers, two motor-drive amplifiers, and two synchronous motors. Only one of the two channels is shown completely since both are identical except for a few differences in component values required for the 85-Kc and 135-Kc carrier frequencies.

The transmitter (Fig. 3A) is a pulsed oscillator operating at either 85 Kc or 135 Kc, followed by a push-pull driver amplifier and a push-pull power amplifier. The power amplifier is coupled to the output by step down transformer T_1. This transformer matches the output impedance of the transmitter tubes to the 72-ohm impedance of the transducer. The transmitter provides 30 w for the transducer. The driver is a conventional medium gain push-pull amplifier which isolates the power-amplifier stage from the oscillator. Oscillator V_{2B} acts as a Hartley oscillator with its resonant circuit shunted by V_{2A} which acts as a cathode follower. The oscillator is cut off if current is flowing in V_{2A}, but starts oscillating when V_{2A} is cut off. In normal operation, the oscillator is shut off until a 1-msec negative pulse is applied to the grid of V_{2A}. This cuts off V_{2A} and allows the oscillator to operate for a 1-msec period. The required 1-msec pulse is obtained from the

Flow Velocity of Rivers

triggered one-shot multivibrator, V_1. Multivibrator V_1 is triggered by V_6, a free-running multivibrator. The input trigger for the free-running multivibrator is a negative pulse from the receiver output. Range switch S_1 is used so that V_6 can be triggered by receiver pulses, which vary in repetition rates from 24 pps to 3.4 pps. The upstream and downstream transmitters are identical, except for the values of the resonant-circuit components in the oscillator stages.

The receiver (Fig. 3B) is a trf receiver operating at either 135 Kc or 85 Kc. Receiver input impedance is 72 ohms. A signal is fed from the receiving transducer to the grid of the V_1. The output of V_1 is coupled through the 135-Kc filter to V_2. (The downstream receiver uses an 85-Kc filter.) The output of the second amplifier tube is coupled through another 135-Kc filter, to V_3. This tube is coupled through a modified i-f transformer, T_1, to a rectifier bridge. The detected pulse is amplified in direct-coupled amplifier V_4 and differentiated at the output of this tube. The differentiated pulse triggers one-shot multivibrator V_5. The output of V_5 triggers the transmitter and the prf multiplier in the computing circuitry. The one-shot multivibrator increases the sensitivity of the receiver since it responds only to the leading edge of the detected pulse and is not affected by distortion occurring after the leading edge or for the period of the one-shot output. Receiver gain is controlled by applying a negative grid bias to amplifier tubes V_1, V_2 and V_3. These tubes are variable-mu pentodes whose gain decreases with a more negative grid bias. Gain control R_1 directly controls the grid bias and overall gain of the receiver.

The output of the receiver in each channel is sent to a prf multiplier that multiplies the prf by a factor of either 4 or 8 (Fig. 2). The multiplication is necessary since the synchronous motors operate best between 35 and 85 cps. The prf

Examining a recording of river-flow velocity

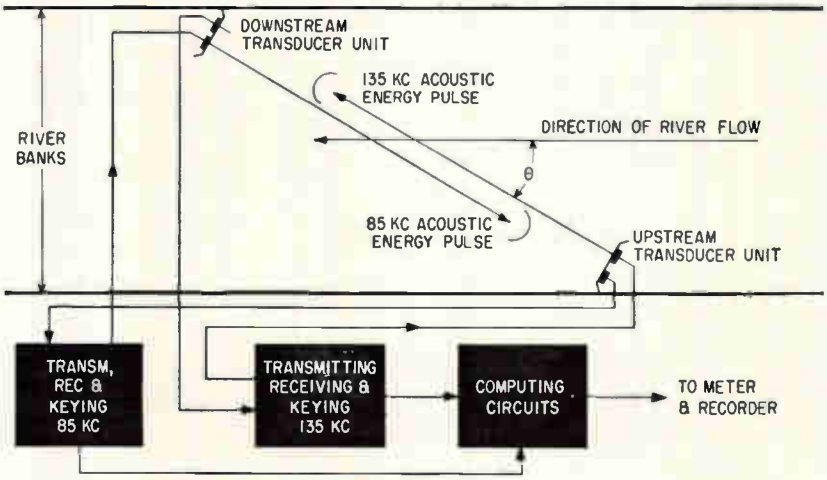

FIG. 1—Each upstream and downstream unit of flow-velocity measuring system has a transmitting and a receiving transducer

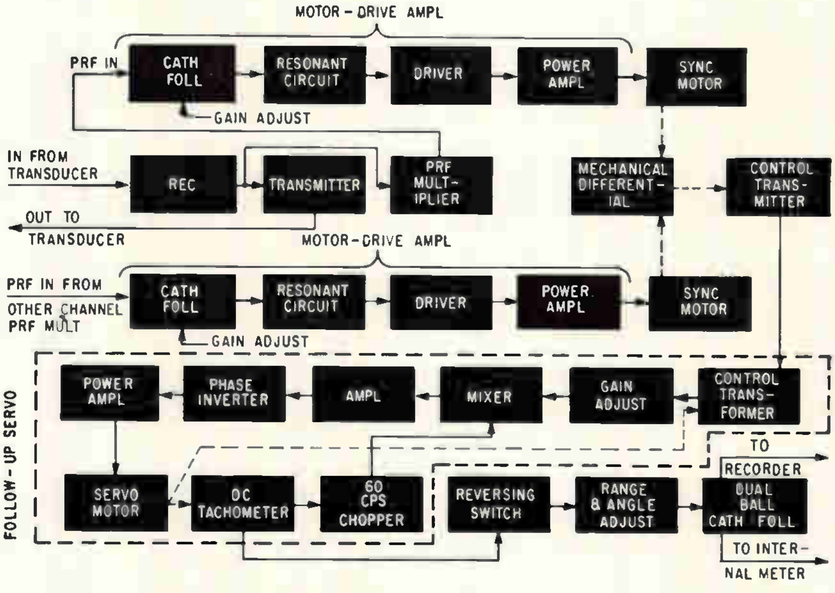

FIG. 2—Detailed diagram of flow-velocity measuring system does not show receiver, transmitter and prf multiplier blocks of other channel

multiplication is based on the functioning of V_1, a controlled multivibrator oscillator (Fig. 3C). The frequency of this free-running multivibrator can be varied from approximately 40 to 180 cps by varying control voltage V_c, which is as a bias voltage to the multivibrator. The multiplier feedback circuit acts to control this voltage so as to make the multivibrator frequency an exact multiple, 8 or 16, of the input pulse rate. The multivibrator has a free-running rate higher than any expected input pulse repetition rate since the feedback control acts only in the direction, that reduces the multivibrator frequency to an exact multiple, 8 or 16, of the input pulse rate. The prf multiplier operates in the following sequence. A negative input pulse from the receiver triggers multivibrator V_1 and resets dividers V_2 to V_5 and V_6. The plate of V_{6B} is now at a low voltage since V_{6B} now conducts. The multivibrator runs at its free rate and the flip-flop dividers count the output pulses. When the count of 16 (with S_1 connected to plate of V_{5B}) is reached, V_{6B} is triggered and its plate rises in voltage. When the next input pulse is received, the dividers are reset and the plate of V_{6B} is returned to its original low voltage. Thus, the waveshape at this plate is a square positive pulse lasting from the time the dividers reach 16 until the next reset pulse triggers the circuit. This pulse width represents the time by which the multivibrator is running faster than 16 times the input frequency. The square pulse is passed into a width detecting circuit (D_1, D_2 and C_1). Capacitor C_1 is charged to a positive voltage proportional to the width of the square pulse. The voltage across C_1 is applied, through V_{7B} and through gain control R_1, to the base of Q_1. Transistor Q_1 is a phase inverting d-c amplifier to supply the control voltage V_c, which is inversely proportional to the square-wave width. Control voltage V_c acts to reduce the frequency of multivibrator V_1 if the square wave pulses are of large width. The frequency is reduced until the square-wave pulse width is just large enough to maintain V_c at an equilibrium value. When this occurs, V_1 runs at 16 times the input pulse frequency. Operation with a multiplication ratio of 4 times is similar to that for 8 times except that S_1 connects V_{6B} to the third divider output instead of the fourth. The output frequency should be between 35 and 85 cps for best operation. The output of the prf multiplier is a symmetrical square wave and is sent to the motor drive amplifier. Since the controlled multivibrator produces 0.1-msec pulses, it is necessary to obtain the symmetrical square wave output from the output of the first divider (V_2) through cathode follower V_{7A}.

The dual-channel motor-drive amplifiers (Fig. 2) receives the output signals from the prf multipliers; the amplified signals drive the two synchronous motors. The input signal in each channel is coupled through a cathode follower to a gain control potentiometer. From the gain control, each square wave signal goes through a band-pass filter and becomes sinusoidal. This signal is coupled through a grounded-grid driver amplifier to the power amplifier. The power amplifier stage in each channel drives a synchronous motor.

The synchronous differential unit is a self contained unit made up of two synchronous motors and a differential gear assembly. The speeds of the two motors are different because their input frequencies differ. The output shaft speed of the unit is equal to one half the difference in speeds of the two motors, and is connected to the shaft of the control transmitter, which drives the control transformer in the follow-up servo.

The follow up servo drives a precision d-c tachometer at a speed proportional to one half the difference between the speeds, and hence the frequencies, of the two synchronous motors. The tachometer output is fed to a potentiometer equipped with a direct reading dial which is used to set up calibration for river angle and transducer separation. Output from the range and angle adjustment is coupled to the meter movement through a long R-C time constant to give a long response time to the meter circuit. This slow response smooths out the jitter and variation introduced at the synchronous differential shaft. Balanced cathode follower circuits are used as outputs to the internal meter, calibrated in feet per second, and to the external meter or strip recorder.

The upstream and downstream transducer units differ only in their use; they are identical and are interchangeable. Each unit consists of two tranducers; the 135-Kc transducer and the 85-Kc transducer. Two different pulse carrier frequencies of 135 Kc and 85 Kc are used to avoid cross-talk between the upstream and downstream pulse trains. Both the 135-Kc and 85-Kc transducers can receive or transmit acoustic energy through water over a relatively broad frequency band (17-Kc) with narrow beam width (12 deg.) characteristics. The transducers have a barium-titanate ceramic disk as the energy receiving or transmitting element. At the prototype installation the transducer units were mounted a few feet from either river bank with a direct path distance between transducers of 625 feet. The angle between line of river flow and direct path of transducers was 45 degrees. Present design limits dictate that the transducer units be placed between 250 to 1,000 feet apart, and that the angle between the line of river flow and direct path of transducers be between 30 and 60 degrees.

The prototype acoustic flow velocity meter was installed in the Sacramento River at Sacramento, Calif. Specifications required an accuracy of 0.1 ft per sec. A correlation between the average velocity in the river at a section measured by the current meter method and the flow velocity measurement obtained with the acoustic flowmeter is being attempted by the U. S. Geological Survey. From the results obtained to date from the Survey it is felt that a direct relationship between the average velocity obtained with a (conventional) current-meter method and that obtained with the acoustic flowmeter exists.

Since water velocity is not the same at each point in the cross sectional area, the acoustic flowmeter cannot be calibrated out of the water. It is necessary to obtain an average flow velocity for a section since the velocity varies both from river bed to surface and from one bank of the river to the other. The procedure used with a current meter to determine an average velocity is to measure the velocity at different depths along several verticals across the river and from these obtain an average. The accuracy of the measurement increases as the number of verticals across the river increases. The acoustic flow velocity meter computes the average velocity for all points in a line of sight between the transducers and is thus an approximation to an infinite number of verticals across a section of the river. Since the line of sight is only in one horizontal plane, an average velocity at only one depth is obtained. It is felt that a direct correlation between the average velocity obtained at one depth and the average velocity for the entire section can be made. If a direct correlation is made, the range and angle adjustment potentiometer (Fig. 2) can be set to make the meter read directly the average velocity of the river.

Present indications are that the average velocity measured at the depth of the transducers is directly related to the average velocity of the section. The results recorded on a 10 inch strip recorder showed that the acoustic flowmeter correctly indicated the expected trends in average river flow velocity for a section. Maximum river velocities were in the order of 2.8 ft per sec.

The prototype acoustic flow meter was built for the U. S. Dept. of the Interior, Geological Survey, under Contract No. 14-08-001-5426. The program's success was largely due to Hal Wires of the U. S. Geological Survey and representatives of Submarine Signal Operations; Raytheon Company, George Miller, Paul Frelich, Norman Serotta, Charles Walker and Thomas Stoupis contributed valuable work.

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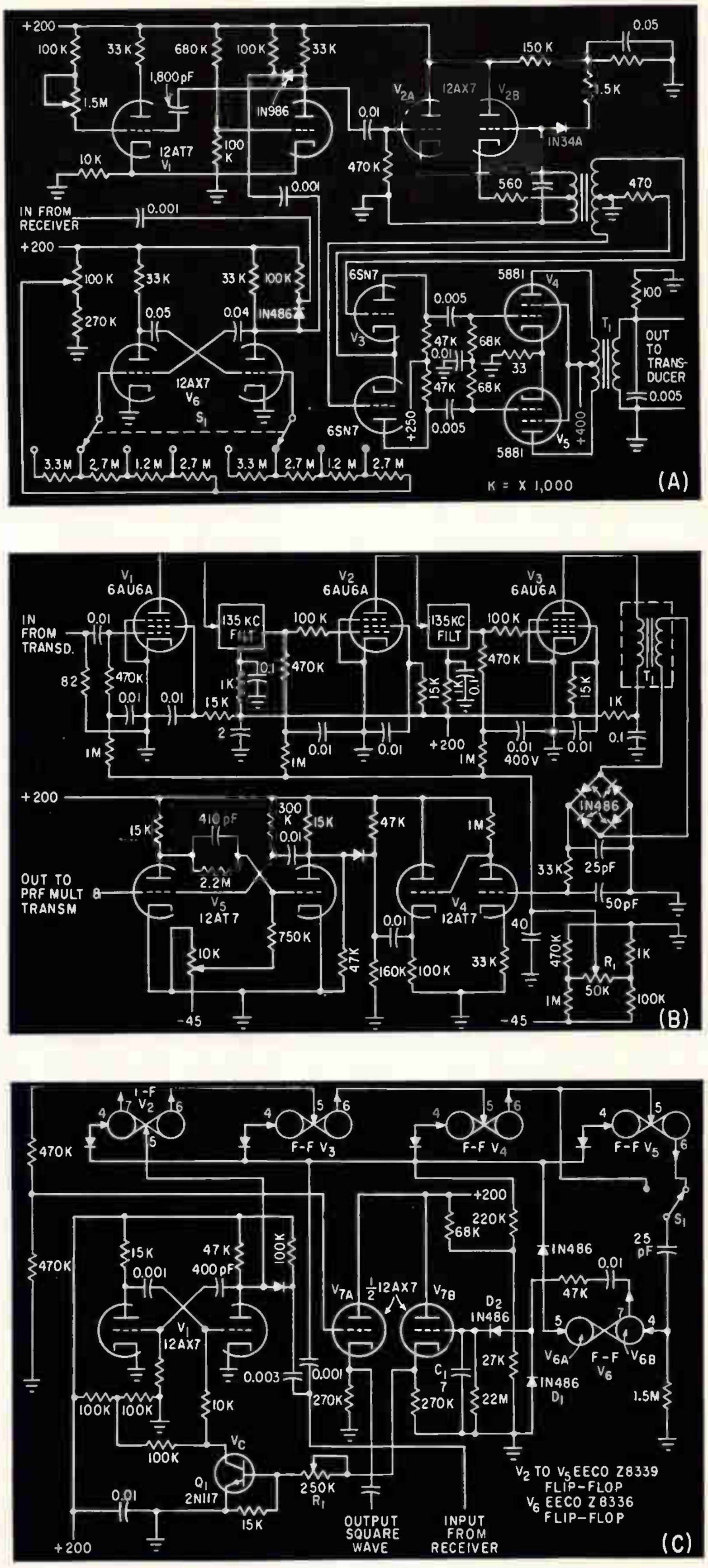
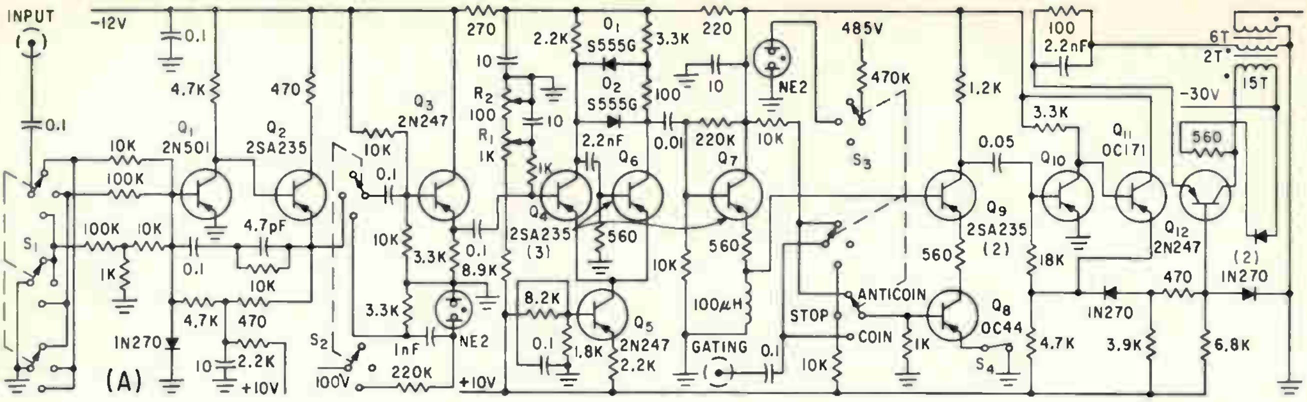


FIG. 3—*Repetition rate of transmitter (A) is controlled by the input from receiver (B) on the opposite bank of the river. Flip-flops of prf multiplier (C) are commercially available packages*

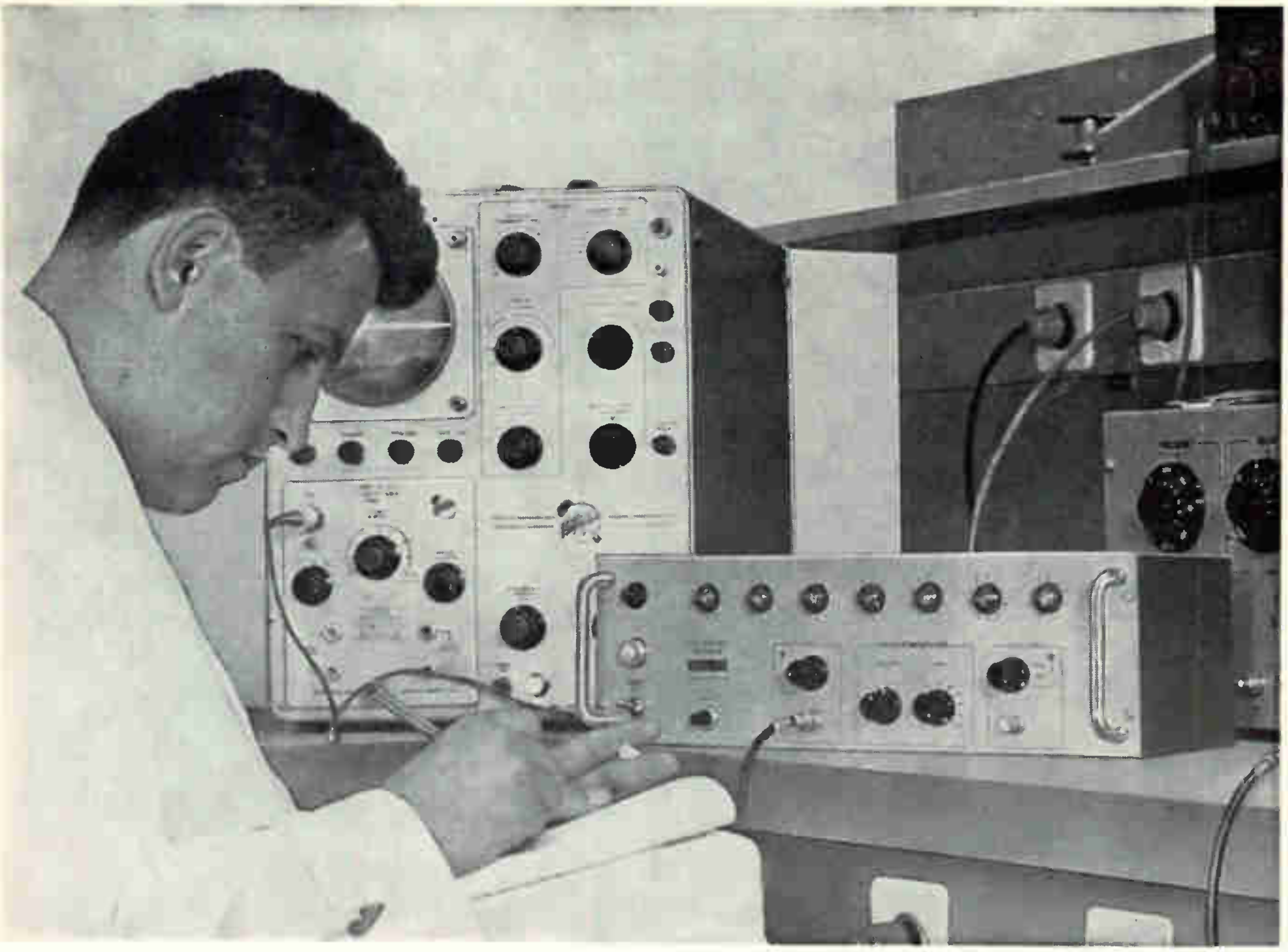


Circuit diagram of cold-cathode scaler shows input channel and the first three of seven

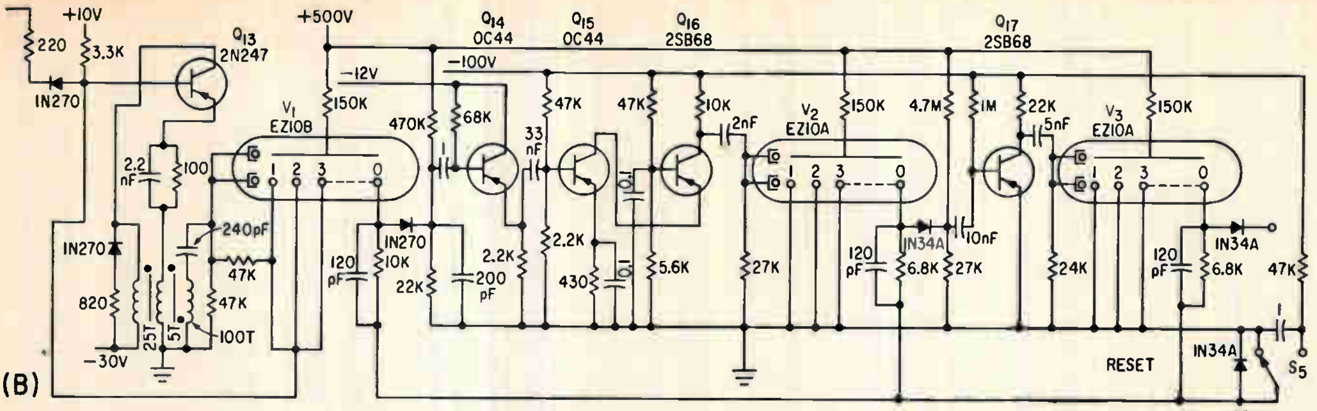
TRANSISTORS DRIVE Half-Megacycle

Pulse of 100 volts amplitude and 1 microsec width triggers cold-cathode counting tubes. Counting rate for scaler is 500,000 pulses a second

By M. BIRK, H. BRAFMAN and J. SOKOLOWSKI, The Weizmann Institute of Science, Rehovoth, Israel



Adjusting and calibrating scaler prior to counting



fast-counting stages. Circuit has been constructed on three plug-in printed boards

Cold-Cathode Scaler

THIS SCALER is intended for counting pulses of nuclear radiation detectors. It uses seven fast gas-filled decade counter tubes[1] driven by transistors. The instrument incorporates an input channel capable of accepting positive or negative pulses ranging from 0.1 to 100 volts, an amplitude discriminator and coincidence-anticoincidence gating.

Transistors Q_1 and Q_2 form an input amplifier that accepts positive as well as negative pulses and has good nonoverloading characteristics. The amplifier has both d-c and a-c current feedback through the loop from the emitter of Q_2 to the base of Q_1, stabilizing the d-c operating point and the a-c gain. Switch S_1 sets the gain at 1, 1/10 or 1/100.

Transistors Q_4, Q_5 and Q_6 form a high-speed, low-hysteresis discriminator. The discriminator is a transistor version similar to the one described by Farley[2]. It is an a-c coupled trigger with diodes D_1 and D_2 between collectors. Normally, Q_6 and D_1 are conducting, while Q_4 and D_2 are cutoff. A negative pulse at the base of Q_4 causes it to conduct. Regeneration takes place when Q_4 has drawn enough current to cutoff D_1. The circuit reaches its second stable point as soon as D_2 conducts. To minimize hysteresis, the dynamic resistance at the collector of Q_6 should be large compared to that at the collector of Q_4.

The discrimination, ranging from 0.1 to 1.1 volts, is set by potentiometers R_1 and R_2.

Transistor Q_7 is both buffer and differentiator while Q_8 is an electronic switch serving as a coincidence, stop or anticoincidence gate. The emitter of Q_8 is grounded through S_4 to provide remote stop operation.

The incoming pulses are amplified and shaped by Q_9, Q_{10} and Q_{11}. In the absence of a pulse, Q_9 is cutoff to prevent the scaler from accidentally counting when S_3 is switched. Output of Q_{11} is applied to Q_{12}. Transistor Q_{12} acts as a blocking oscillator, generating a 10-volt pulse at its output winding. Pulse width is 0.2 microsec.

At a double-pulse resolution of 1 microsec, tube V_1 requires an input pulse in excess of 100 volts and 0.5 microsecond duration. Because the tube represents a capacitive loading of 36 pf, input requirements are a crucial design point. To meet the drive requirements, blocking oscillator Q_{13}, having a maximum repetition rate of 1 Mc, is used. Ideally, a high collector voltage should be used here to reduce loading effect by requiring a minimum transformer step-up ratio. However, lack of inexpensive fast switching transistors having a high V_{cb} breakdown voltage resulted in using a 2N247. Even in the ideal case, regeneration would be poor due to capacitive loading. To reduce this loading effect, the cathodes of V_1 (except one for resetting) are returned to the base of the blocking oscillator transistor rather than to ground. This inserts the tube cathode-to-grid capacitance in a positive feedback path.

The second counting stage is driven by a 2SB68 (equivalent to 2N398), in a grounded-base configuration. The 2SB68, capable of a swing of 105 volts, is driven by grounded-emitter stage Q_{15} that provides both current gain and phase inversion. The following five stages are EZ10A tubes each driven by a single grounded emitter 2SB68.

Reset is accomplished by returning the normally grounded zero cathodes to a negative potential. The diode in the reset circuit is a make-before-break contact. The back-biased diode at the zero cathode clearly defines the pulse transmitted to the following stage.

Double-pulse resolution of the scaler was found to be 1 microsecond. A maximum permissible counting rate of 500,000 pulses per second is imposed by the allowed power dissipation of the blocking oscillator Q_{13}. A 1-microsecond, 50-volt pulse applied to the input of the scaler at the scaler's most sensitive setting blocks the instrument for 2 microsecond only.

The authors thank A. Jacob for the layout design and the construction. This work was supported in part by the B. de Rothchild Foundation for the Advancement of Science in Israel.

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Getting Fast Pulse Response With Video Amplifiers

Design procedure uses 1-Gc transistors to build amplifier with 2-nsec risetime, 12 db gain and reduced d-c power consumption

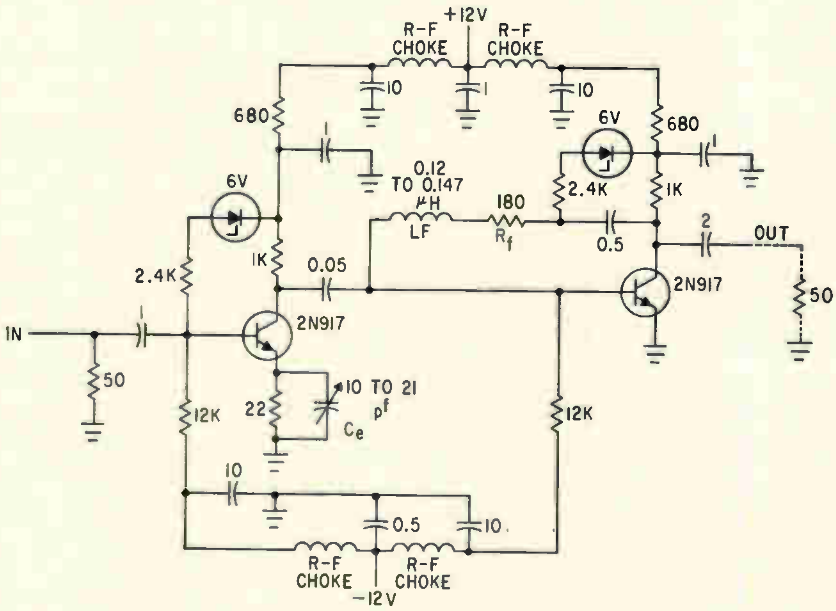

FIG. 1—Video amplifier. Input and output impedance is 50 ohms

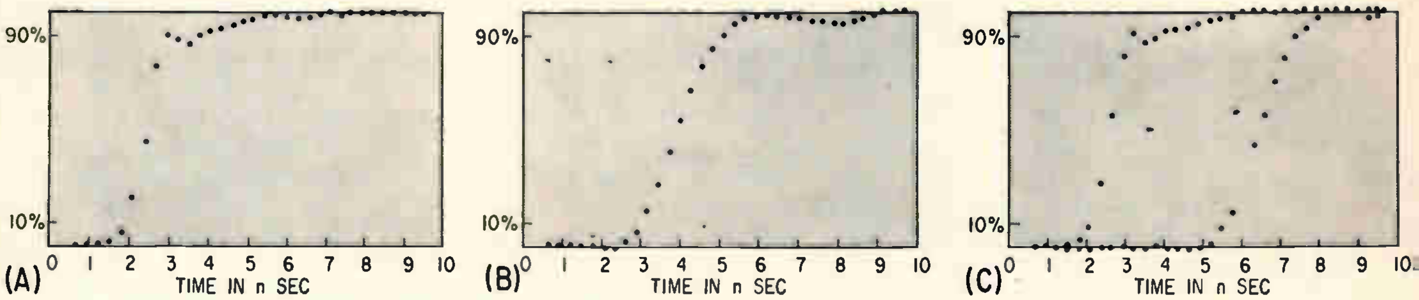

FIG. 2—Pulse response of amplifier in Fig. 1. Input pulse obtained from a Lumatron sampling oscilloscope pulse generator (A); output with compensation adjusted for slight under and overshoot (B); delay characteristic (C)

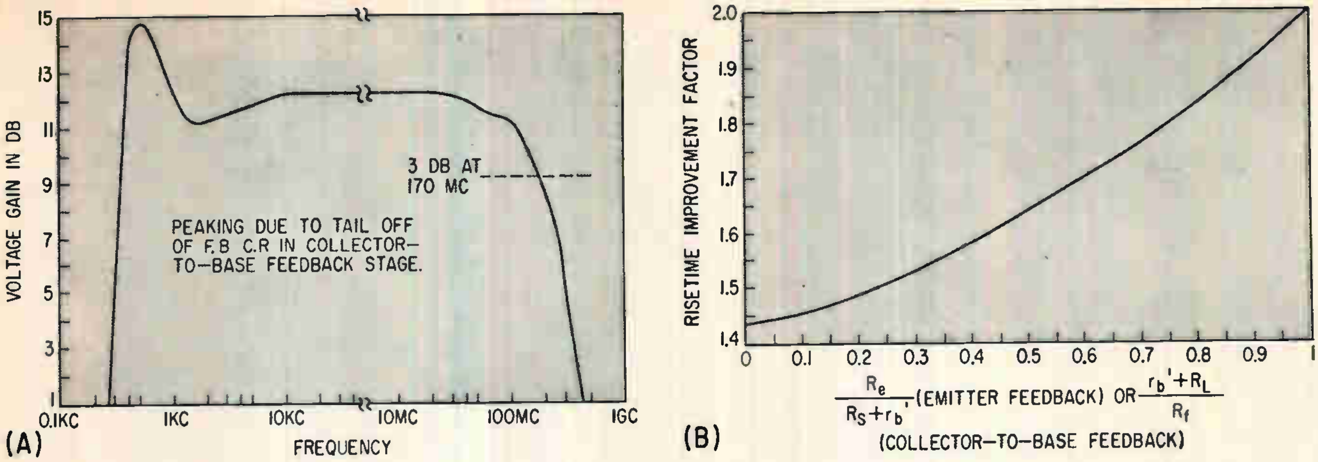

FIG. 3—Frequency response of amplifier from 0.1 Kc to 1 Gc, (A); risetime improvement, (B)

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DISTRIBUTED AMPLIFIER techniques and feedback techniques are two methods commonly used for obtaining the wide bandwidths and extremely fast pulse response required for video amplifiers.

Distributed amplifiers[1] have the advantage of furnishing high power output, since the load current, being additive, comes from several transistors simultaneously. However, they have poor gain-bandwidth products, and where the output power is unimportant, these amplifiers can be considered quite inefficient. Feedback techniques were discussed by Reddi[2]. After appraising two-transistor amplifiers using various feedback techniques, he concluded that for low source and low load impedances, the optimum configuration for a low output-power amplifier consists of an input transistor with emitter compensation, followed by an output transistor with R-L feedback applied between collector and base.

Interesting possibilities for improvement present themselves with the introduction of new fast devices. Several promising transistors have recently been introduced, one example is the 2N917, a 1-Kmc silicon device with properties suitable for use in fast amplifiers. To investigate the gain-bandwidth products available using Reddi's design methods, a 12-db 2-nanosecond amplifier designed for pulse, rather than r-f response, was built and tested. A description of this amplifier and a discussion of its performance follows.

The following specifications were used to design this video amplifier: Risetime for pulse response with no overshoot, 2 nanoseconds. Service impedance $R_S = R_L = 50$ ohms. Transistor parameters pertinent to Reference 2 for the 2N917:

$V_{CB} = 6$ volts, $C_c = 0.5$ pf, $f_t =$ 880 Mc, $C_{bc} = 1.2$ pf, $\beta_o = 40$, $I_E =$ 3 ma, $r'_b = 100$ ohms, $r'_e = 26.6/$3 ma $= 8.9$ ohms, $r''_e = 4.5$ ohms.

Reddi's design procedure was then followed; over-all risetime being 2 nanoseconds, each stage had to be 0.707×2 or 1.41 nanoseconds.

A risetime improvement factor η of 1.8 was arrived at through the trial and error methods described in reference 2 and use of the graph in Fig. 3B. Then the uncompensated risetime $t_r = 1.41 \times 1.8 =$ 2.54 nsec.

The amplifier schematic is shown in Figure 1. It consists of a first stage with emitter peaking followed by a second stage with R-L collector-base feedback. Biasing is of the breakdown-diode variety[3]. This biasing has the important advantage of removing the usual difficulty of obtaining good emitter bypassing without any deterioration in d-c operating point stability. The choice of R-C product in the collector and coupling circuits determines the low-frequency response. With the comparatively small capacitors used the lower 3-db response point of the amplifier is about 350 cps. The decoupling of the ±12-volt power supplies is conventional and is required to insure stability.

The pulse response of the amplifier is presented in Figures 2A and 2B. Figure 2A shows the input pulse obtained from a sampling oscilloscope pulse generator and Fig. 2B shows the output of the amplifier with the compensation adjusted for slight amounts of undershoot and overshoot. The risetime is about 2 nanoseconds. The delay characteristic in Fig. 2C shows a delay time of about 4 nanoseconds. The frequency response of the amplifier is shown in Figure 3A, and is within ±3 db from 340 cps to 170 Mc. Considerably better r-f response could be obtained; but at the cost of pulse overshoot. For example, if an amplifier were to be designed for a wide-band r-f preamplifier, presumably different values of compensation would be used.

A two-transistor, 2-nanosecond pulse amplifier with 12 db gain has been presented. This relatively low-power amplifier is suitable, economical and reliable where output swings of more than a few tenths of a volt are not required.

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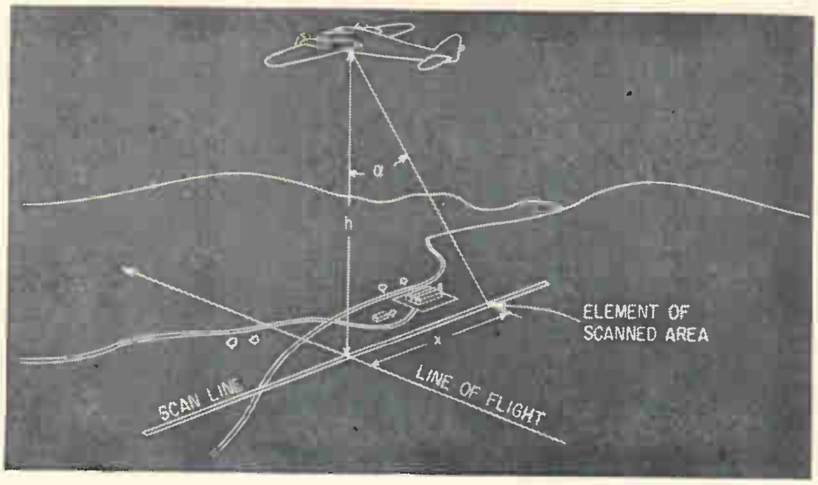


Geometry of slant-range correction, referred to in the theory discussion

Generating Tangential

Eight-transistor circuit generates an approximation of the

By JOHN L. WOIKA, Senior Engineer, HRB-Singer, Inc., State College, Pa.

GENERATION of cathode-ray-tube sweep voltages whose waveforms differ from a linear ramp function generally requires many filters or nonlinear circuit elements to modify the ramp function. Such modification circuits are usually inflexible and unwieldly to such an extent that adjustments to a given waveform are difficult. This circuit affords simple and direct adjustment of positive-slope waveshapes formed by straight-line segments.

This system was used in generating a straight-line approximation of the tangent function for the sweep waveform in a cathode ray tube display of the video signal from an airborne rotating scanner. Between minus 45 deg and plus 45 deg, the tangent function may be approximated with less than 2 percent error by three straight-line segments; one line through the origin extending to plus and minus 28 deg, the others extending outward from that point. The tangential sweep waveform approximation will then consist of a three-segment ramp function in which the two end segments will have identical slopes greater than that of center section (see waveform).

A block diagram is shown in Figure 1. As in conventional sawtooth generators, a positive step is applied to a resistant-capacitance network to charge the capacitor through a high-impedance path, the voltage across the capacitor providing the sweep waveform. The rate of change of the capacitor voltage, and therefore the slope of the sweep waveform, is proportional to the capacitor charging current. Two parallel constant-current sources supply effectively all this

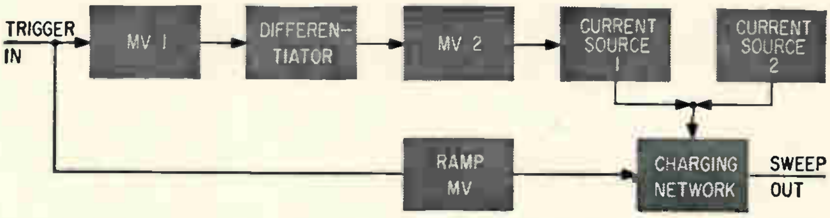


FIG. 1—Block diagram of tangential waveform generator

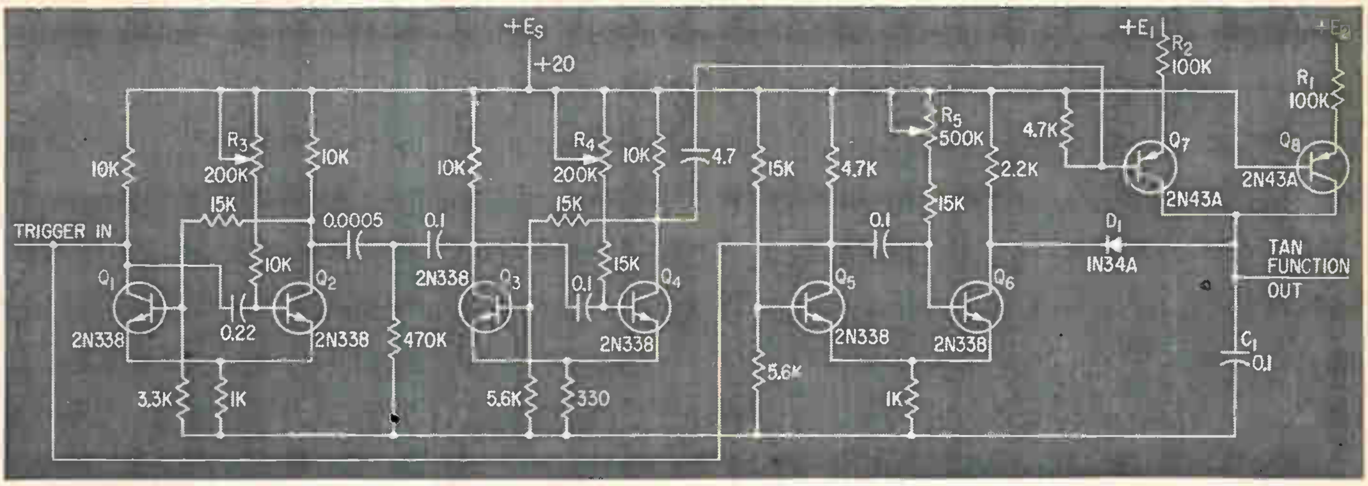


FIG. 2—Circuit of tangential waveform generator

Sweeps for Infrared Mapping

tangent function for the slant-range correction of video signal from an airborne scanner

charge current, so that by controlling the output of the current sources, the sweep waveform slope is adjusted. One of these current sources may be gated off, so that, while this source is supplying no charge current, the rate of change of capacitor voltage is decreased, and hence the sweep-signal slope is reduced. By adjusting the position and width of the current source turn-off pulse with respect to the step function input, the reduced-slope center section of the tangent approximation may be positioned.

The ramp multivibrator and timing multivibrator *MV* 1 are triggered simultaneously. A positive pulse from *MV* 1 is differentiated to obtain a negative spike at its trailing edge. This negative spike triggers the timing multivibrator *MV* 2, whose positive output pulse is the gate pulse for the gated current source. The width of the output of multivibrator *MV* 1, therefore, positions the start of the center segment of the tangent function and the width of the *MV* 2 output determines its duration.

The tangential sweep generator circuit is shown in Fig. 2. Transistors Q_7 and Q_8 form the parallel current sources to charge C_1. Transistor Q_8, in the grounded-base configuration, provides a nearly ideal constant current source, its collector current virtually unaffected by variations in collector voltage. Since its base voltage is fixed, the collector current of Q_8 is determined only by the emitter supply voltage E_2 as

$$I_C \doteq I_E \doteq \frac{E_2 - E_B}{R_E}$$

$$\doteq \frac{E_2 - E_S}{R_1}$$

$\doteq$ a constant (assuming collector voltage $< E_S$ and $E_2 > E_S$)

Voltage across C_1 (the sweep waveform) is then

$$e_c = \frac{1}{C} \int i_c \, dt$$

and the slope of the sweep waveform is

$$de/dt = \frac{1}{C} I_C$$

and will remain constant as long as Q_8 provides all the charge current i_c.

Transistor Q_7 does not provide the nearly ideal constant-current characteristics of the grounded-base configuration of Q_8, but still exhibits excellent current source characteristics. Emitter degeneration introduced by R_2 in the emitter lead makes this circuit an even better current source than the common-emitter configuration whose V-I curves normally display fairly good constant characteristics. In the absence of a gate pulse, collector current of Q_7 is determined by its emitter supply voltage E_1, and like Q_8, is fairly independent of collector voltage changes. In this situation, both transistors are supplying a constant charge current to capacitor C_1 and a linear ramp function is developed across C_1.

A positive pulse applied to the base of Q_7, however, abruptly back-biases the base-emitter diode to turn the transistor off and interrupt charging current from that transistor. Now charging current

THEORY OF THE TANGENTIAL SWEEP WAVEFORM

The scanning system consists of a single detector element and scanning mirror, so that an element of the scanned area may be considered as the projected area of the detector surface, moving along a given line of scan perpendicular to the line of aircraft flight. For an aircraft at altitude h, *and assuming a flat earth, the distance along the earth from a point directly under the aircraft to the area element will be*

$$x = h \tan \alpha$$

where α *is the angle between vertical and a line drawn directly to the area element from the aircraft. The velocity of the area element along a scan line will then be*

$$dx/dt = \omega h \sec^2$$

where ω *is angular velocity of the scanner (a constant).*

If the spot on a cathode-ray tube is intensity modulated according to the infrared radiation from an area element, then to obtain an accurate map of this radiation on a flat photographic film, the velocity of the spot across the tube face should correspond to the velocity of the area element along the line of scan. Position of the electron beam (or spot) in the cathode-ray tube it determined by the unbalance of current through the horizontal deflection coils in the yoke, hence the velocity of the spot is determined by the rate of change of current unbalance. For a linear sweep

$$I = at$$

where I *represents the difference of currents through the deflection coils, the rate of change of current is, of course, a constant* a. *Since the velocity of the scanned area element is not a constant, however, a linear scan device cannot present an accurate display of the scanned area. The most noticeable effect is in long targets positioned diagonally with respect to the line of flight. Straight edges will appear curved, becoming more distorted toward the edges of the constant however, a linear scan device cannot present an ac-display. A straight road, for instance, diagonally across the flight path will appear S-shaped.*

If the sweep waveform is

$$I = b \tan \theta$$

then the rate of change of current is

$$dI/dt = cb \sec^2 \theta$$

and the velocity of the spot is of the same form as that of the area element. This sweep waveform tends to eliminate the edge distortion.

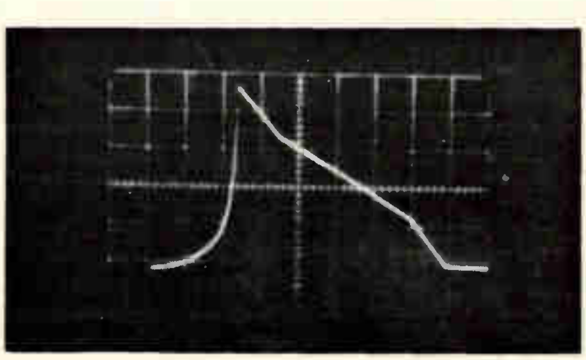
is due almost entirely to Q_8 and the ramp slope accordingly becomes less. When Q_7 is reactivated, its current is abruptly restored to its original level and the ramp slope reverts to the slope it had before charging current from Q_7 was interrupted.

Some charging current is drawn from the ramp multivibrator through D_1, but since it is drawn through the high back-impedance of the diode, its current is negligible with respect to that from the current sources. Slopes of the tangent function are therefore determined entirely by the two emitter supplies E_1 and E_2. Since Q_8 supplies current for the entire duration of the sweep, adjustment of E_2 will change the slope of all three segments. Transistor Q_7, however, supplies charge current for only the end segments, so an adjustment of E_1 will change only the slope of those segments.

The three final waveform adjustments are R_3, which determines the width of output from *MV* 1 and thus positions the start of the center segment of the tangent approximation, R_4 to control the width of output from *MV* 2 and control the duration of the center segment, and R_5 to adjust the duration of the entire sweep waveform.

In this application, where the sweep was approximately six milliseconds long, there was no noticeable deviation from linearity in any section of the waveform. The waveform photo shows the tangential waveform obtained with this circuit, with the difference in slopes exaggerated.

This gated current source principle could easily be applied to more complex waveforms by more current sources with gates. Then combinations of the current sources could be set up by timing the multivibrators to approximate any positive slope waveform. Waveforms with negative slopes or a combination of positive and negative slopes may be obtained by using a similar technique with complementary transistors and negative supplies to generate a negative ramp function and adding it or, with further gating, portions of it to the positive-slope ramp.



Function generator waveform, with vertical scale of 1 v/cm, horizontal scale of 0.8 msec/cm

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Irradiation Susceptibility Nomograph

By FRED KUGLER
ALBERT R. KALL,
Ark Electronics Corp.,
Willow Grove, Pa.

THIS NOMOGRAPH determines interference-susceptibility in complex electronic systems. Its use is demonstrated in a problem in which a high-power pulsed radar and a receiving system are located near each other. The receiver is in a shielded building. The problem is: will the net radar field incident upon the receiving source exceed the threshold levels at which the latter will malfunction?

If the radar ground-level field intensity near the building is known, start at B_1 on the nomograph for field intensity measured in electric-field intensity (v per m peak), or at B_2 (smaller nomograph) for field intensity measured in power density (w per sq cm average). This level should represent the max-max level: (a) with the radar antenna moving in its normal design function (rotating for a search radar, nodding for a height finder radar) and with angles of declination or azimuth representing maximum effect in the direction of the building, and (b) with the radar antenna fixed at the maximum effective position, measure the level all over the area, covering at least the area near two walls of the building. The maximum intensity under all conditions is used for entry in line 9 or 15.

If the ground level has not been measured and is not known, start at point *A*, line 1. Enter at the known radar peak power point. Enter antenna gain, line 2. This is a design parameter for the radar. The gain figure is in db relative to an isotropic radiator. If the db gain figure for the antenna is in db referred to a dipole antenna, add 1.64 db and enter the sum figure into the nomograph. Draw a line through the points on lines 1 and 2, intersecting 3.

Enter line 4, slant-line distance in feet, between (a) the radar antenna and (b) the building housing the receiver source. For (a) use the approximate focal point of the antenna paraboloid. For (b) use either the side or roof of the building (if the distance is large compared with dimensions of the building) or the center of the receiving source (if the distance is of the same order as the building dimensions). Slant-line distance is the hypotenuse of the right angle triangle whose sides are the elevation of the radar antenna and the horizontal distance. Draw a line from the point on line 3 through the point on line 4 to line 5, intercepting on line 5 a power density level in w per sq m (peak).

The procedure thus far applies the following formula, which gives the power density along the main radar beam for the far field (Fraunhofer region) $P_d = P_t G/4\pi D^2$ w/m² (peak) where P_t is radar transmitter power, G is gain (a number or ratio), and D is distance in meters.

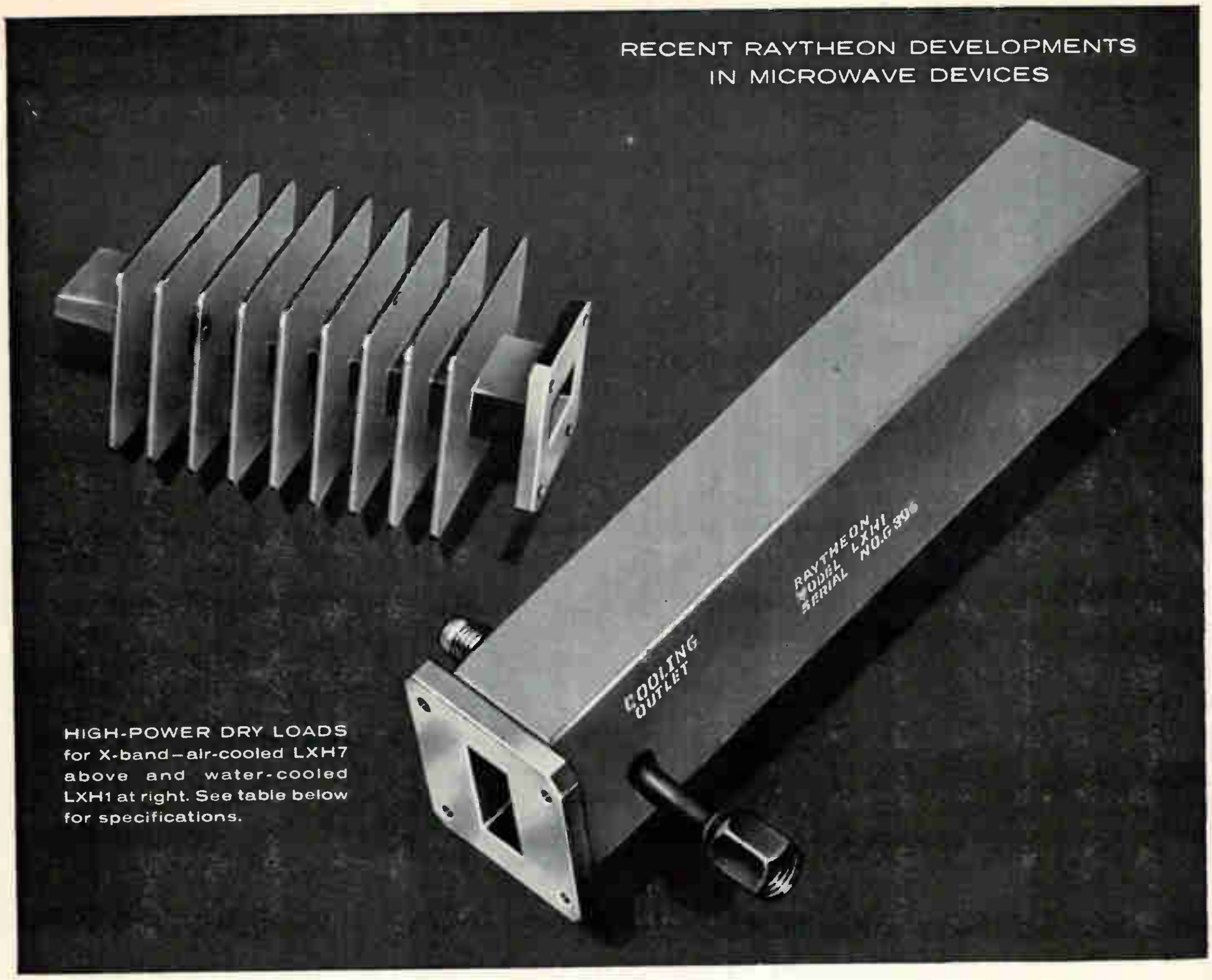
A convenient formula, used in the nomograph, is $P_d = 0.855\, P_t G/D^2$ w/m² with D in feet.

Obtain the Fresnel field correction factor. The Fresnel region radiation intensity represents the non-uniphase combination of all the individual radiating elements of the antenna aperture and the influence of the intervening terrain. If terrain is disregarded and free-space radiation is assumed, only the physical size of the antenna must be considered and a correction factor established for application to the level obtained from far field considerations. With the ground and terrain neglected this factor is always

TABLE I—Typical Fresnel Region Correction Factors (db)

	Distance	Antenna Aperture Dimensions (in wavelengths) Horizontal/Vertical									
		10		20		30		40		50	
Freq = 100 Mc, λ = 0.75 M	100 ft = 40λ	1	1.5	6	9	9.5	15	12	16	14	18
	200 ft = 80λ	0	0.5	3	6.5	6.5	9.5	9	12	11	16
	500 ft = 200λ	0	0	0.5	1	2.5	5	5	8	7	11
Freq = 6,000 Mc, λ = 0.05 M	100 ft = 600λ	0	0	0	0	0.5	0.5	1	2	2	4.5
	200 ft = 1200λ	0	0	0	0	0	0	0.5	1	0.5	2
	500 ft = 3000λ	0	0	0	0	0	0	0	0	0	0.5

The Fresnel region correction factor is the sum of two factors for horizontal and vertical aperture dimensions. Values are based on cosine illumination of aperture in the horizontal plane, and uniform illumination of aperture in the vertical plane and for antennas with uniform phase distribution.



HIGH-POWER DRY LOADS for X-band—air-cooled LXH7 above and water-cooled LXH1 at right. See table below for specifications.

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TYPICAL SPECIFICATIONS — HIGH POWER LOADS

Band	UHF	S	S	X	X	X	X
Model No.	LUH1	LSH1	L_CSH1	LXH1	LXH7	LXH11	LXH12
Freq. (kMc)	.325-.475	2.6-3.1	2.9-3.1	7.0-10.0	7.0-10.0	9.0-12.4	7.0-10.0
Av. Power	60 kW	25 kW	500 W	5 kW	600 W	5 kW	5 kW
Max. VSWR	1.10/1	1.10/1	1.10/1	1.10/1	1.10/1	1.10/1	1.10/1
Waveguide	WR 1800	RG75/U	RG96/U	RG51/U	RG51/U	RG52/U	RG51/U
Flange	Alum CPR-1800	UG584/U	UG45/U	UG51/U	UG51/U	UG39/U	UG51/U
Cooling	Liquid	Liquid	Liquid	Liquid	Air	Liquid	Liquid
Length	90	36	8 9/16	9	6 1/8	9 3/4	7 15/16
Width	14	5 15/16	1"	1 7/8	3 1/8	1 5/8	1 7/8
Height	24 1/2	5 5/16	2 1/8	1 15/16	2 1/2	1 11/16	1 3/16
Approx. Wt. (lbs.)	200	35	1.5	4.05	1	5	4

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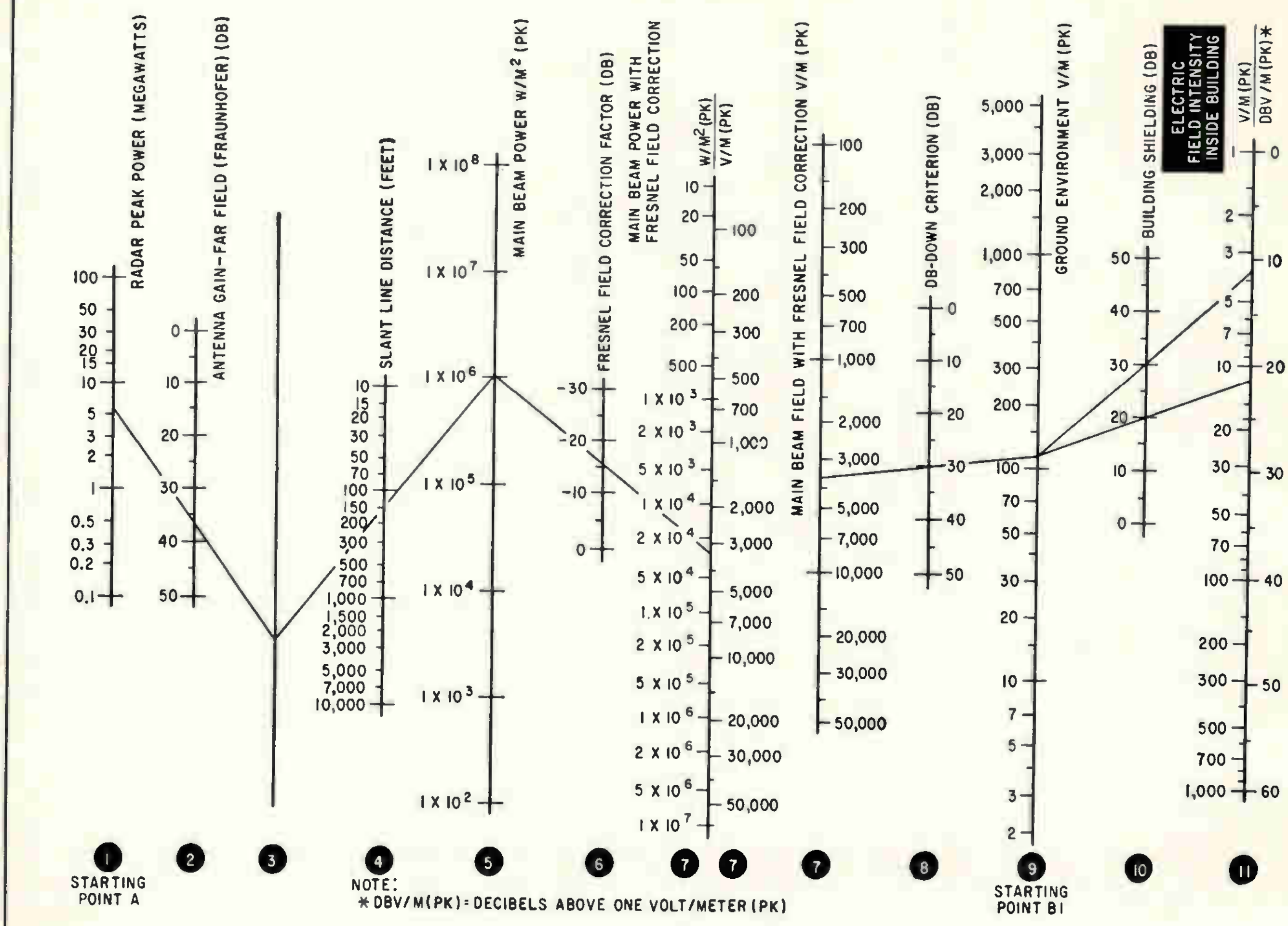

less than unity, and usually lies between 0.01 and 1 (corresponding to the range −20 to 0 db). The far field region prevails for distances greater than $2L^2/\lambda$ where L is the maximum antenna aperture and λ is the wavelength, both in the same units. The Fresnel region prevails for distances less than $2L^2/\lambda$.

Table I shows correction factors for the antenna aperture horizontal and vertical dimensions, at two frequencies and at three distances. Other values can be interpolated.

With the Fresnel region correction determined, enter it on line 6 and draw a line from the point on line 5 through the factor on line 6 to intersect line 7. The point on this line is now the main beam power density in w per sq m (peak). The right hand legend on this line is peak electric field intensity E in v/m (peak) calculated from $P_d = E^2/Z_o$ where Z_o is the impedance of free space, 120π or 377 ohms. Use of this expression is predicated on linear polarization of the wave near the field intensity receiving antenna.

From line 7 the nomograph branches into two legs: one, from lines 7 to 11 carries on in units of electric field intensity (peak), while the other, lines 7′ to 17 (separate chart), continues in units of power density (peak and average). Use the one that corresponds to the measured data and the problem requirements. The analysis continues with the electric field case, then with the power density case.

Field intensities along the radar main beam have been considered. To obtain the field intensity near ground level, at the building wall or at a point corresponding to the center of the receiving source, information must be obtained on the db-down criterion for the radar antenna and the colocated situation on that base.

For an excellently colocated site, the side lobe in the direction of the building typically may be some 25-35 db down from the main beam; for a poorly colocated site, 5-15 db down. Enter the proper db-down number on line 8. Draw a line through the points on line 7 and line 8, intersecting line 9. This gives the ground field intensity level, before accounting for the effect of the shielding in the building walls. Note that this level represents the starting point B_1 if the level had previously been measured.

In line 10 enter the shielding effectiveness of the building. Typical values for on-site single-

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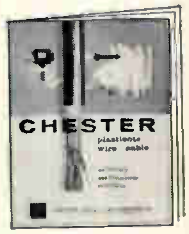

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shield construction incorporated within the building walls are summarized in Table II.

Draw a line through the points entered on lines 9 and 10, intersecting line 11. This is the electric field intensity, in v/m (peak), impinging on the receiving source.

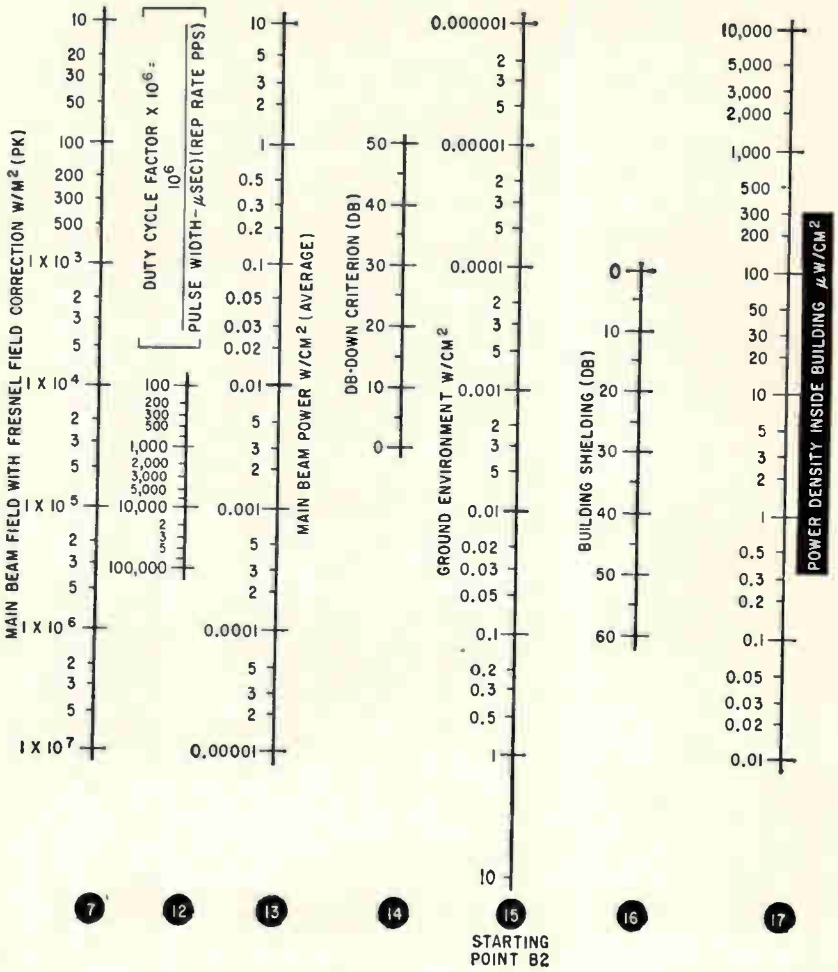
This final level should be compared with the threshold susceptibility status of the receiving units to determine if there could be any malfunctioning due to the radar field on the receiving source.

For the power density case, return to line 7′ on the separate chart. This is the main beam power in w/m² (pk) with Fresnel field correction. In line 12, enter the duty cycle factor of the radar defined by: nomograph duty cycle factor × 10^6 = 10^6/[pulse width μs) × pulse repetition rate (pps)], the factor 10^6 being applied to produce easily handled numbers.

Draw a line through the points on lines 7′ and 12, intersecting line 13. This is the main beam power level of radiated power density in units of w per sq cm (average), as would be measured by a bolometer.

Enter the db-down criterion in line 14 and draw a line through the points on lines 13 and 14, intersecting line 15. This represents point B_2.

Enter the figure for building shielding effectiveness in line 16, and draw a line through the points on lines 15 and 16, ending finally on line 17 at a point representing the power density, in μw per sq cm (average), impinging on the receiving source.



This final level should be compared with the present threshold susceptibility status of the receiving unit. If the level derived from the nomograph exceeds the threshold susceptibility level there is a probability that the receiver will malfunction in the given environmental conditions.

A typical example is shown by light lines: peak radar power = 6.5 megawatts (radar frequency, 400 Mc); antenna gain = 37 db; slant line distance = 150 feet; Fresnel region correction = −15 db; db-down criterion, 30 db; ground environment level outside the building = 115 v/m (pk), obtained from nomograph; building shielding = 30 db; and electric field intensity inside building = 3.6 v/m (pk), from nomograph.

If the receiving source threshold susceptibility level is 10 v/m (peak) at 400 Mc, there should be no receiver malfunctioning.

This work was conducted by Ark Electronics Corp., (formerly Ark Engineering Co.) under subcontract to the Burroughs Corp., Paoli, Pa., Prime U. S. Air Force contractor.

TABLE II—Typical Shielding Effectiveness in Db (Five-Sided Shield)

Freq (Mc)	Seam-Soldered Copper Screen	Spot-Soldered Copper Screen	Galvanized Exp. Metal Lath	Six-Sided Shield*
400	20–35	15–30	10–25	Add 20
1,000	25–35	20–30	20–30	Add 15
3,000	30–40	25–35	10–20	Add 10

* If shield is a six-sided structure, add to the value selected from the five-sided ranges the increment listed in the right-hand column

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S-5018—replaces 5AU4, 5AW4, 5AZ4, 5T4, 5U4, 5V4
5W4, 5Y3, 5Z4, 5931, 6087, 6106
S-5207
replaces 6X4
S-5130—replaces 866, 866A, 3B28
S-5343—replaces 816, 836, or 3B28
and 866 at reduced voltage
S-5033—replaces 6AU4, 6AX4, 6BL4,
6W4, 12AX4, 17AX4, 25W4, 6U4
S-5019—replaces 5R4
S-5011A—replaces 80, 82, 83, 83V, 5Z3
S-5017—replaces 0Z4, 5X4, 5Y4, 6AX5, 6X5
S-5251—replaces 5U4, 5AU4,
5AW4, 5AZ4, 5T4, 5V4,
5W4, 5Y3, 5Z4
S-5367—replaces 8020
Illustrations
approximately ½ size
S-5347
replaces
12BW4, 6BW4
S-5344
replaces 872A
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Resonator Is Developed for Millimeter Waves

MILLIMETER wave resonator can be used with associated equipment for highly accurate measurements of millimeter wavelengths. This type cavity is also suitable for materials study and for use in masers. The resonator was developed by the National Bureau of Standards' Boulder Laboratories.

Millimeter waves are useful for studying molecules and atoms, electron density of heavily ionized gases and properties of superconducting materials. A better understanding of these frequencies could also lead to new devices. However, the short wavelengths are difficult to handle and there had been no efficient way to generate or resonate millimeter waves.

A conventional cavity resonator, which is about a half wavelength long, would be difficult to build for millimeter waves. Surface irregularities must be only a small fraction of a wavelength, which would be a few millionths of an inch for millimeter waves. At the same time, a resonant cavity to study electrons, atoms and molecules must be big enough to allow sufficient interaction between them and the electric field inside the cavity.

The new resonator, which treats millimeter waves like light, has two perforated end plates and no sides. The ends are made of polished brass or silver sheets usually six to twelve inches square. In one case, perforated sheets of polished brass $\frac{1}{32}$ inch thick and twelve inches square were used having a reflectivity of about 99.9 percent. Plates made of perforated films of silver deposited on glass have been used, and silver-on-quartz optical flats will be tried.

Sheet size, and size and spacing of holes are calculated for the frequency involved. The holes act as transformers to couple millimeter waves into and out of the cavity while maintaining a high Q inside the cavity. Effectiveness of the holes depends on their diameter and spacing, which vary with frequency. In an interferometer for 6-mm wavelengths using perforated silver films, holes are 0.0236 inch in diameter and 0.057 inch between centers.

The plates, one fixed and one movable, are placed parallel to each other and millimeter waves are beamed at the fixed plate. A small amount of the energy passes through the small holes so that it strikes and is reflected by the second plate with little energy passing through the holes in the second plate. The waves captured inside the cavity are reflected back and forth by the highly polished surfaces. By adjusting the movable plate for proper spacing, the cavity resonates and transmission through it is maximum. An entire series of standing waves is created inside the cavity, one between each pair of holes at opposite ends.

The plates control millimeter waves like semiopaque mirrors control light waves. The polished plates tend to reflect the waves back and forth with almost no loss of energy through the open sides. The absence of sides permits size adjustments for a wide range of frequencies. Since the cavity is large compared to a wavelength, it is precise and easy to use.

Maximum output occurs each time plate spacing is increased exactly one-half wavelength. Plate spacing is usually about six inches but can be two to three feet, depending on plate size and frequency. The sharp maxima at each half wavelength permit spacing to be measured very precisely.

The device was tested as the resonant cavity of a millimeter-wave Fabry-Perot interferometer, which provides a transmitting horn with plastic lenses to feed millimeter waves into the cavity, a receiving horn to pick up waves leaving it and instrumentation to record output variations. With it, millimeter wavelengths have been measured to accuracies exceeding 0.04 percent. This approach provides the sharpest response ever obtained with such an instrument in radio or optics and is more accurate than other wave-meters.

Almost no energy is lost in the cavity, giving it a quite high Q, which has been difficult to obtain at millimeter wavelengths. For waves about 6 mm long, Q was about 100,000 (10 to 50 times theoretical Q of conventional cavities). Since these cavities build up a millimeter signal from electron streams, they can be used in relatively high-powered generators. They also become more efficient at shorter wavelengths.

Such cavities are relatively easy to make and are not limited in shape. A gold-plated silver spherical (biconical) cavity with two perforated sides has been operated by focusing energy to the center. It was designed primarily to test the spherical concept. The first sphere is four inches in diameter and operated successfully at 8 mm. This type of perforated cavity should be valuable for electronic power generation at millimeter and submillimeter wavelengths and might enable design of a resonator for two-level and three-level solid-state masers.

Bandwidth permits operation over a wide frequency range, making the cavities applicable to materials study and for masers. In the 6-mm interferometer being used to study materials like plastics, a sheet of the material is placed in the center parallel to the plates. Since radio waves must be reflected through the material, cavity length must be changed for resonance by an amount that is a measure of dielectric constant of the material.

Another Fabry-Perot interferometer (3.4 mm wavelength) is being used in a maser. (See ELECTRONICS, p 45, March 17.) This device is initially being used to study hydrogen-cyanide molecules. The Bureau is also constructing a Michelson-type interferometer that will use millimeter waves to determine the velocity of light.

Electron Filter Lens Has Longer Focal Length

ELECTRON filter lens design is suitable for use as a monochromator, an electron beam analyzer or a beam-blanking element in a high-speed cathode ray tube. It has a longer focal length and increased aperture, and at 5 Kev primary en-

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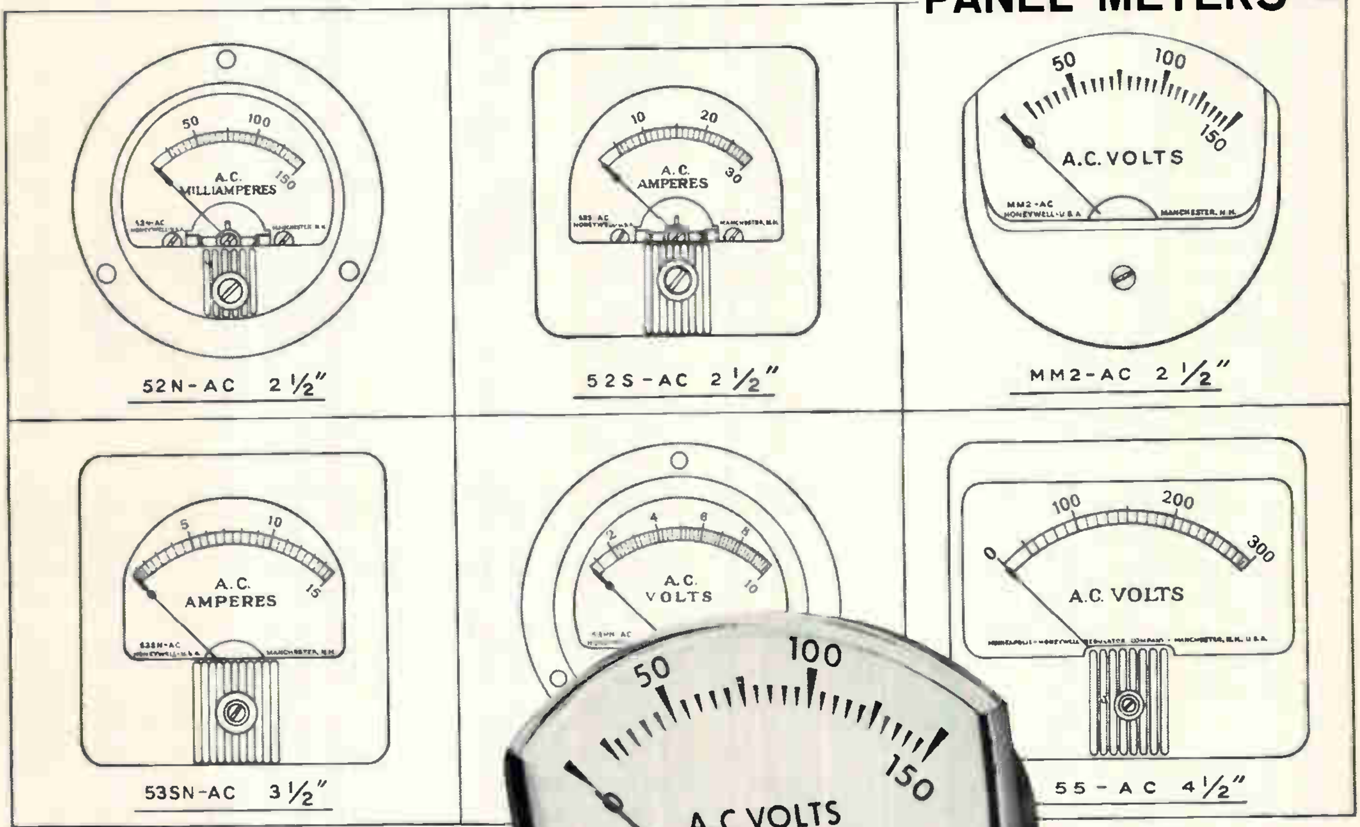
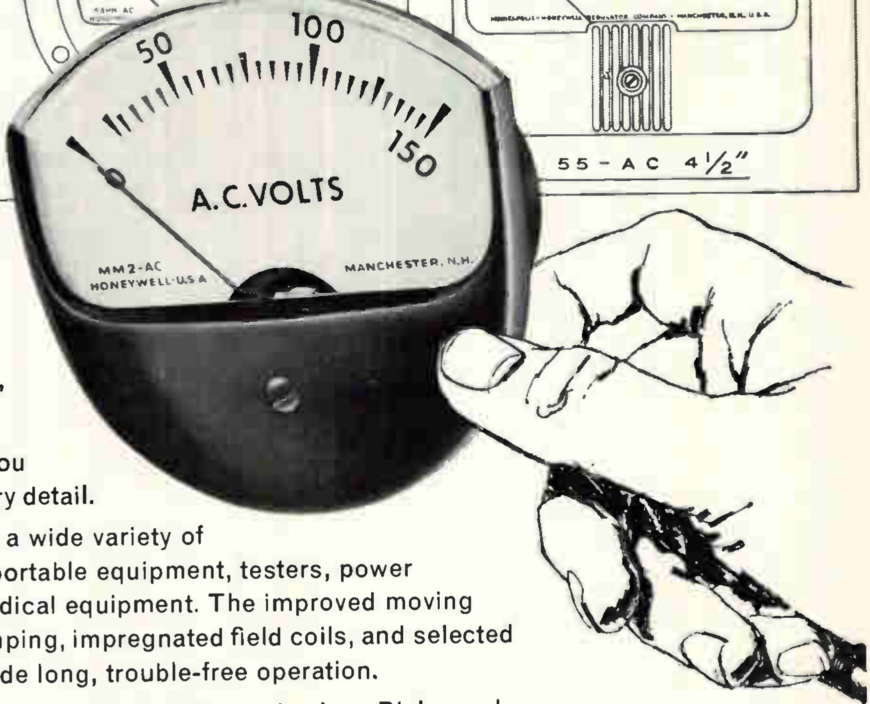




Here are the AC counterparts of Honeywell's popular DC panel meters. Iron Vane AC Meters are perfectly matched to the DC range and are available in both the Medalist and "standard" case styles. This means a minimum of trouble and expense in mounting. And you are assured of harmonious styling in every detail.

Iron Vane AC Meters are designed for a wide variety of commercial applications — including portable equipment, testers, power supplies, generator equipment and medical equipment. The improved moving iron mechanism features magnetic damping, impregnated field coils, and selected fixed and moving iron material to provide long, trouble-free operation.

These meters are available in a wide selection of case styles and colors. Dials can be custom designed with your company name, trade-mark or other data. For full information, contact our representative in your area — he's listed in your classified telephone directory. Or us: Precision Meter Division, Minneapolis-Honeywell Regulator Co., Manchester, N.H., U.S.A. In Canada, Honeywell Controls Limited, Toronto 17, Ontario and around the world: HONEYWELL INTERNATIONAL — Sales and service offices in all principal cities of the world.

Honeywell

H HONEYWELL *Precision Meters*

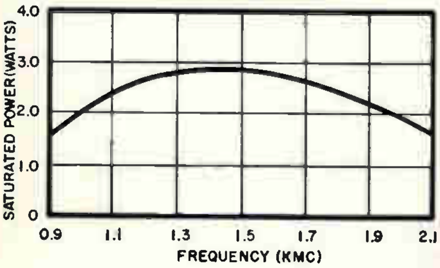
SPERRY ELECTRONIC TUBE DIVISION **microwave memo**

Sperry extends 30-day delivery to cover ECM and augmenter TWT's operating in L, S, and X bands

In a dramatic extension of its capability for delivering high-performance microwave tubes on short notice, Sperry Electronic Tube Division has added three system-proved traveling wave tubes to the list of those available in 30 days. Included in the move are tubes operating in L, S, and X bands. They cover a frequency range 1.1 to 11.0 kMc.

APPLICATION FLEXIBILITY

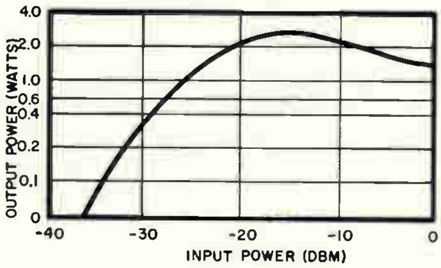
The tubes in this series are particularly suited to application in augmenters and ECM equipment. The inherent broadband characteristic and unusual ruggedness of these PPM focused tubes makes them unusually versatile in airborne applications. A full course of MIL and environment tests, as well as considerable in-system experience have verified these characteristics.



A typical saturated power versus frequency curve for an L band Sperry TWT.

INCREASED POWER POSSIBLE

Although these tubes nominally operate in the 1-2 watt power output range, optimum tuning can increase power to as much as 5 watts. A high-mu control grid adds to the versatility of these tubes by allowing remote switching, modulation control and gain adjustment.



Drive characteristics at mid-band for a typical Sperry ECM/augmenter TWT.

SYSTEM DESIGN SIMPLIFIED

Use of these Sperry tubes greatly simplifies system design problems. Low voltage and high gain reduce power supply requirements. Application is further simplified, since ambient cooling is sufficient in most applications and the tubes may be mounted in any position.

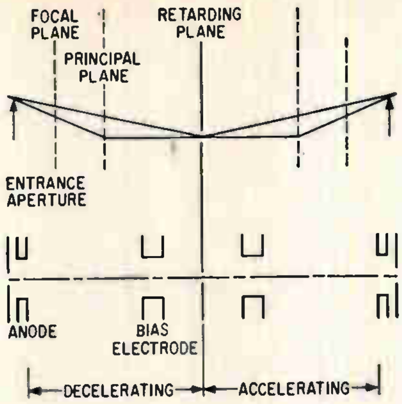
For FREE technical information on these Sperry Traveling Wave Tubes, write to Section 302, Sperry Electronic Tube Division, Gainesville, Florida.

The L-Band tube is priced at $1,900., the S-Band tube at $2,195., and the X-Band at $2,540.

For application assistance and quotation, consult your nearest Cain & Co. representative. His address and phone number appear on the opposite page.

SPERRY ELECTRONIC TUBE DIVISION

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



One short-focus lens retards electrons to saddle point while second symmetrically placed lens accelerates them to their original energy

ergy, it maintains an energy resolution less than the thermionic spread of the initial beam.

The lens was designed and assembled at the National Bureau of Standards to be used as an electron monochromator. An electron filter lens is an electrostatic lens designed so that electrons having energies above some critical value are transmitted. Electrons with energies below the critical value are rejected. The critical value is associated with the potential of an electric potential barrier.

Filter lenses have been used to increase contrast of diffraction diagrams and electron micrographs by rejecting the inelastically scattered background. Recently these lenses have been used for ion energy analysis.

For the electron monochromator, the initial beam and the final filtered beam had to be essentially collimated. A very long focal length, preferably infinite, was therefore desirable.

In the plane containing the saddle point (where negative potential is greatest in transmitted beam path), the reduction of energy of the electrons leads to sharply curved paths, high angular divergences, and thus short focal lengths. Using a classic lens for this purpose would require a short focus lens to recollimate the beam. However, the electric or magnetic fields of the short focus lens, which usually extend far beyond the focal plane of the lens, would interfere with the filter lens field. Although a long focus recollimating lens does not cause this difficulty, it would lead to an undesirably large beam diameter.

An intermediate lens in the saddle plane solved the problem of recollimating the beam. The large divergence in this plane therefore has no effect on the final design.

Intermediate imaging is obtained with a filter lens consisting of two short-focus lenses positioned symmetrically about the saddle lens. One lens forms a small image of the entrance aperture to this plane and retards the electrons to the saddle point, as shown in the figure. The second lens forms an image of the saddle plane at the exit aperture and accelerates the electrons to their original energy. The filter lens thus operates as two electron immersion lenses placed back to back.

The two stages of the filter lens can be designed using data for lenses used in emission microscopy, which provided a starting point for designing a series of lenses. By giving the greatest attention to the most promising design, a lens resulted that can be used at energies up to 40 Kev. In conjunction with a multiplier phototube, it becomes a high resolution electron analyzer.

Earlier lenses were designed for specific applications so that different importance was attached to particular characteristics. Therefore, data about these characteristics is incomplete. Comparison of the filter lens with the most complete set of data available on an earlier lens indicates that the new lens will tolerate much wider beams, or conversely more misalignment, for equal sharpness of cutoff. Range cannot be compared directly because even the largest aperture of the new lens is satisfactory for as great an image range as that for which comparative data is available.

When set at 1 volt from cutoff, measured spatial resolution of the lens is 50 microns, which is sufficient for most purposes.

Output of the lens is a well collimated beam about 1 mm in diameter, which cuts off without significant change in size. This electrode configuration can therefore be useful as a beam-blanking element in a high-speed crt. In this application, the very low drive requirements and distance from the cathode are advantageous.

How Dangerous are Beryllia Ceramics?

By C. E. WINDECKER,
Vice President, and Chairman,
Safety Committee, National
Beryllia Corp.,
Haskell, N. J.

ALTHOUGH BERYLLIUM OXIDE is widely used in electronics, circuit engineers who would like to take advantage of the material's unique properties, are hampered by fear of material's toxicity on the part of plant management, safety departments, and others. Beryllium oxide ceramics have the remarkable property of conducting heat like a metal while exhibiting the high resistivity and low dielectric loss characteristic of a pure oxide. Strength is high, density is low, melting point is extremely high, neutron capture cross-section is low, and in general beryllium oxide is being found an excellent material for such applications as heat sinks, micromodule wafers, microwave windows, coil forms, tube envelopes and thermocouple insulation. (ELECTRONICS, p. 109, May 20, 1960; p 76, July 14, 1961.)

Concern arises from the fact that in certain circumstances, beryllium and beryllium oxide can cause serious illness and have been responsible for some fatalities. This leads one large firm which uses beryllia shapes in units it manufactures to write a separate beryllia purchase order for each unit, often writing several in one day, to avoid keeping beryllia in stock. Other firms refuse to allow beryllia in their plants despite applications that admittedly need it. Actually, such extreme measures are unjustified.

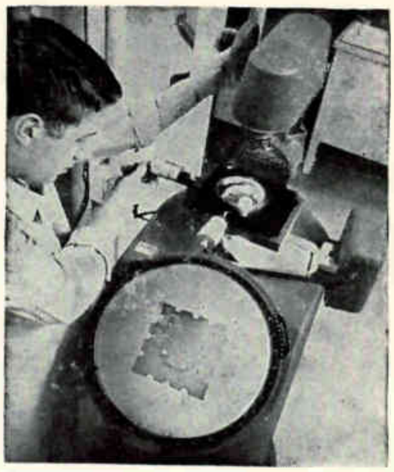
The question is not how dangerous is beryllia, but how likely is it that someone will be exposed to its danger? The answer, for most applications, is highly unlikely. Beryllia might be compared with iodine. If mishandled, either can be fatal. But this is unlikely.

To be dangerous, beryllia must enter the respiratory system. Skin reactions associated with compounds encountered in refining and other chemical processing are not a problem in ordinary use of the ceramics. Considerable hazard must be contended with by those who process beryllium ores and alloys. Less, but substantial, hazard is faced by those who produce beryllia ceramics. Still less, but nonetheless definite, hazard must be considered when beryllium or beryllia is machined or metallized. But in the handling of hard-fired beryllium oxide ceramic objects in and out of stock and in assembly, there is no hazard and no special precautions are required.

To enter the respiratory system beryllium compounds must be in the form of airborne particles. This can happen if beryllia is heated above about 1,850 F in the presence of water vapor, or if small-enough particles are mechanically produced from the solid. In ordinary uses of beryllia, these heating conditions can hardly occur accidentally and are rarely produced deliberately. If such heating is necessary, as in metallizing or in experiments with high-temperature thermocouple insulation, it is naturally done by trained personnel. Conventional brazing, in a dry atmosphere at safe temperatures, does not represent a hazard.

Thus the only hazard the electronics user of beryllia ceramics must be concerned with is mechanical production of fine dust particles. Such particles are difficult to produce. Beryllia, as hard-fired by National Beryllia Corporation, ranks just below the diamond in hardness at 9 on the Mohs scale. The ceramic is ultrasonically cleaned at the factory so the products are free of dust when shipped. The abrasion encountered in transit, in handling in and out of containers and bins, and in assembly operations will not produce dust.

Breakage is infrequent; if it does occur particles produced are too large to become airborne. Normal plant housekeeping should take care of pieces which traffic might grind into potentially-dangerous amounts of dust. It is usually recommended that such pieces be returned to the ceramic supplier by volume users of beryllia, so that they will not accumulate in the user's disposal system.



Technician at National Beryllia Corp. checks dimensions of beryllia ceramic micromodule wafer on optical comparator. No hoods, protective coating, masks or other protection is necessary in ordinary handling and assembly of such beryllia ceramic objects

Machining, metallizing, or both, of beryllia remain the only sources of real hazard. Hazard is easily avoided by doing neither. Most users of beryllia heat sinks and other shapes buy them off-the-shelf or have them machined and metallized to specification by the ceramic supplier who has the equipment and experience to do this work efficiently and safely. If machining is necessary, dust created must not be allowed to escape into the plant atmosphere even in small amounts. Criteria of the Atomic Energy Commission are: average inplant concentration over an 8-hour day should not exceed 2 micrograms per cubic meter of air, and momentary exposure should not exceed 25 micrograms/cu meter. Experience over the past 12 years, where these limits have been observed, has been most satisfactory. There has been no new incidence of the beryllium disease.

In machining of beryllium metal, an industrial vacuum cleaner of suitable capacity is considered adequate if its intake is positioned

Addendum for the 1961-62 electronics BUYERS' GUIDE and Reference Issue

PRODUCT LISTINGS

ANADEX INSTRUMENTS, INC.
14734 Arminta St., Van Nuys, Cal. ADV. PG. 435

CONVERTERS—*Frequency to D C*

Manson Laboratories, Inc.
375 Fairfield Ave., Stamford, Conn.

AMPLIFIERS—*Microwave*
BLOWERS & FANS
COMMUNICATION SYSTEMS
CONVERTERS—*Signal*
COUNTERS—*Electronic*
DIVIDERS—*Frequency*
GENERATORS—*Power*
GENERATORS—*Signal*
LOADS—*Dummy*
MARKERS—*Frequency, Microwave*
MODULATORS
OSCILLATORS—*Microwave*
OSCILLATORS—*R-F*
OVENS—*Crystal*
POWER SUPPLIES
RECEIVERS—*Radio Communication*
STANDARDS
TESTERS—*Insulation*
TESTERS—*Tube*
TRANSFORMERS—*Iron Core & Ferrite Core, Special*
TRANSMITTERS—*Radio Communication*

Transformers, Inc.
200 Stage Rd., Vestal, N. Y.

AMPLIFIERS—*Magnetic*
BRIDGES
CALIBRATORS—*Meter*
COILS
COMPARATORS
CONVERTERS—*Power*
DEMONSTRATORS—*Electronic Circuit*
FILTERS
NETWORKS
POTENTIOMETERS—*Precision*
RESISTORS—*Wire-Wound Fixed*
STANDARDS
TRANSFORMERS—*Iron Core, A-F*
TRANSFORMERS—*Iron Core, Power*
TRANSFORMERS—*Iron Core & Ferrite Core, Special*

Change of Address

SOLA ELECTRIC CO.
1717 Busse Rd., Elk Grove Village, Ill. Adv. Pgs. 189-192

POWER SUPPLIES
REGULATORS—*Voltage*
TRANSFORMERS—*Iron Core, Power*

MANUFACTURERS INDEX

MANSON LABORATORIES, INC.
375 Fairfield Ave.,
Stamford, Conn........DA 5-1391

SOLA ELECTRIC CO.
1717 Busse Rd.
Elk Grove Village, Ill........HE 9-2800

TRANSFORMERS, INC.
200 Stage Rd.
Vestal, N. Y........PI 8-3311

Correction for Manufacturer's Representative

George Stevens Mfg. Co.
6022 N. Rogers Ave.
Chicago 46, Ill.

New York Territory: Allied Winding Equip. Co., 2 Avenue J, Brooklyn 30, N. Y........CL 2-8150

STREAMLINED in 1961 . . . the current electronics **BUYERS' GUIDE** contains more product listings, more buying information than ever before . . . **STREAMLINED** for the greater benefit of the user.

properly to provide air velocities of 500 ft/min at the work. High-speed operations such as sawing and grinding requires more care, and this is the only type of machining that can be done on materials as hard as beryllia. Such processes can throw particles beyond the range of a simple vacuum intake so the only safe procedure is to totally enclose most or all of each machine tool. Such enclosures must be maintained under negative pressure by individual exhaust blowers or an exhaust system, and air filtered before leaving the system.

The elaborateness of the air cleaning system depends on the amount of machining a shop does. Beryllia processors, who have large shops with consequent high dust loading, require air-cleaning efficiency above 99.5 per cent. Shops not processing large quantities of beryllia will find 98 or 99 per cent efficiency less expensive and entirely adequate from the safety standpoint.

Since metallizing of beryllia ceramic surfaces involves temperatures above the potential danger point and is a wet process, particles can be produced. The rate is very low but accumulation within the furnace must be considered. Furnaces should be equipped with filtered exhaust systems capable of maintaining substantial positive inrush of air through access openings.

When contamination is entirely confined within enclosures and exhaust systems, the general environment in the plant is safe, and special precautions are not required. National Beryllia Corp. operates a large beryllia processing, machining, and metallizing facility without such production impediments, and has never had a slightest hint of beryllia-caused illness. They are plainly not required, therefore, of a beryllia user who merely does a little machining or metallizing.

Care should be taken when filters are changed or when machine enclosures or furnaces are opened for maintenance or alteration. It need not be elaborate. Workmen should wear laboratory smocks or similar garments over their regular clothes, and wear respirators, when working on contaminated equipment and filters. With reasonable care they will not bring dust out into the room; if they should, a vacuum cleaner in dry areas or a good mopping in wet, should be sufficient for safety.

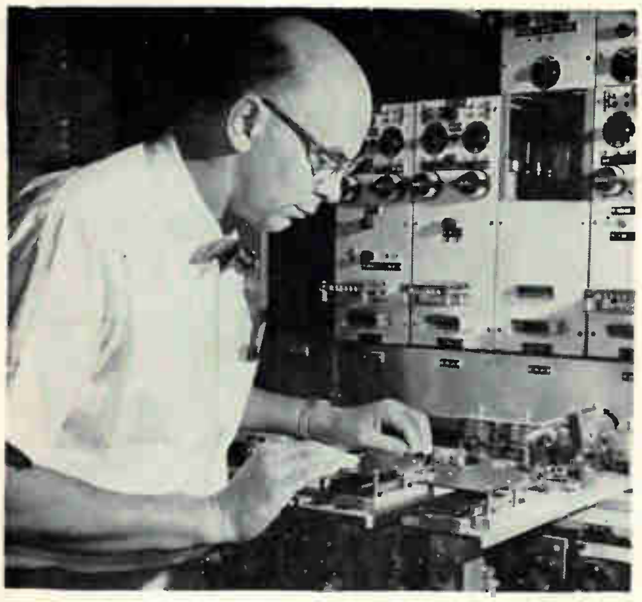
Disposal of contaminated filters, hand towels, mops, and similar waste should not utilize conventional trash removal nor incineration. The type of service which handles radioactive waste, now widely available, should be utilized and the wastes should be sealed in containers for storage and transfer. Fiber or metal drums, taped shut, would be adequate.

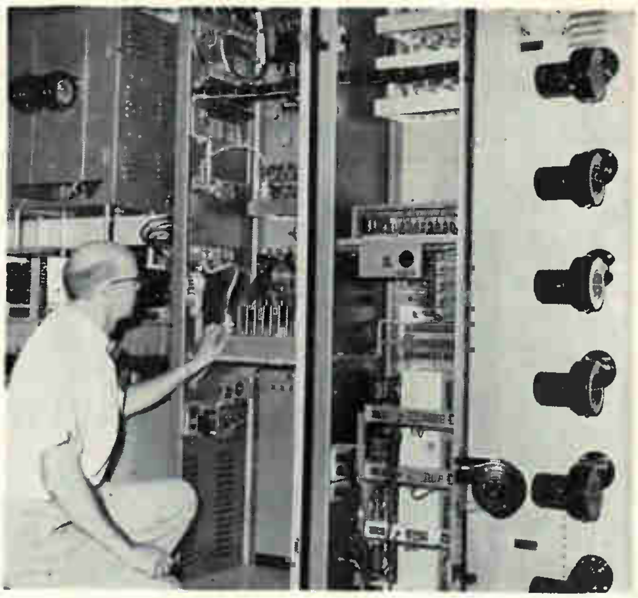
The above discussion refers entirely to hard-fired beryllium oxide objects, and all ceramics supplied by National Beryllia are of this type unless otherwise specified. A certain type of thermocouple, however, is insulated with beryllia beads deliberately made friable. After being sealed in the protective sheath the entire assembly is swaged or drawn, thus crushing the beads, to reduce diameter and improve resistance to vibration and shock. These friable beads must be handled by the thermocouple manufacturer as well as the beryllia fabricator under hoods with filtered exhaust systems creating positive air inrush through access openings.

The finished thermocouple is safe because the sheath is sealed. Even if the sheath were somehow breached by accident, the beryllia inside is not in the form of a loose powder, but is highly compacted. So dust would not be released in the atmosphere. If pieces were somehow broken out, dust could be produced from them by abrasion or crushing, so particles should be disposed of.

A plant deciding to do machine or metallize beryllia should monitor its air as a check on its enclosures and exhaust provisions. Equipment for this purpose is widely available, as is laboratory service for analysis of air sampler filters.

Thus there is no real impediment to machining and metallizing beryllia. Nevertheless, most users of beryllia components prefer to avoid the installation of enclosures and exhaust systems, and disposal problems, and do so by having any needed machining and metallizing done to specification by their beryllia source.





Tube clamp and tube tapper module, left. Back view of part of the automatic tester, right. Tubes are tested at 1,800 per hour, assuring uniform tests and giving quick feedback to production

Automatic Tube Tester

ELECTRON TUBES are tested automatically on a machine designed by company engineers at Raytheon Company, Newton, Mass.

One operator loads the seven-ton machine with tubes and another worker packs tested tubes. The machine performs twenty static and dynamic electrical tests, at a rate of 1,800 tubes per hour. After loading, the tubes index single file to the preheat section where operating conditions are simulated. Then the tests shown in the table are performed automatically.

Field rejects have greatly decreased since the machine was placed in operation and a higher quality assurance factor and repeatability of performance have been obtained. The ability of the machine to subject all tubes to exactly the same test conditions has upped acceptance. The human fatigue factor, with its consequent lowering of quality assurance, is not a problem.

After preheat cycles, the tubes are indexed for each of the twenty parameters tests. If a tube is within preset limits, it proceeds to the next test position; if it is outside limits, it is ejected into bins, as shown in the picture on the cover. Counters indicate the number of rejects for each position, and also count total input and total output. Testing speed is such that process engineering can be alerted if tubes coming through production are not up to standard. Quick corrective action is possible and scrap is less.

The automatic test set is calibrated daily, as well as prior to changeover to a different tube type. A sample of 25 tubes considered acceptable is checked five times each day. Quality control x and r graphs are plotted hourly for up to 20 reject items and for acceptable tubes, to ensure product quality. A quality assurance sample is selected at the completion of each lot and submitted to tightened inspection per MIL Std 105B. A feature soon to be added is an adapter for testing flying lead and other type tubes.

Tests that follow can be conducted in any sequence:

1. Shorts (tap test)
2. Filament current
3. Continuity (tap test)
4. Plate current cutoff
5. Plate current, high
6. Plate current, low
7. Plate current difference (activity test)
8. Transconductance or voltage gain, high
9. Transconductance or voltage gain, low
10. Grid No. 2 current
11. Heater-cathode leakage (positive filament)
12. Heater-cathode leakage (negative filament)
13. Cathode emission
14. Grid No. 1 current
15. Audio and r-f noise (tap test)
16. Insulation
17. Insulation
18. Pulse emission
19. Spare
20. Spare
21. Good tube ejection station

Self-Programmed Circuit Checkout

BROOKS RESEARCH INC., East Rochester, N. Y., has developed a Self-Programming Automatic Circuit Evaluator (SPACE IV System) for production testing computer and missile electronics. The first of the units—which will provide reliable automatic continuity testing at large man-hour savings—has been delivered to General Electric's

Now! Get premium features in a DVM priced at only $940

Cubic Corporation announces the V-45 – the first low-cost digital voltmeter with premium features. Now industrial users can buy a top-quality, precision four-digit instrument at a price they can justify – only $940. Here are the premium features you get in a V-45:

Floating Input: Both sides of the input may be floated above or below ground. The floating input circuit provides more than 80 db rejection to 60-cps common-mode signals. A grounded input is also supplied.

Extended Range: A 10% extension is incorporated in each of the V-45's three ranges. Voltages up to 10.999 may be read on the 10-volt range; voltages up to 109.99 may be read on the 100-volt range; and voltages up to 1099.9 may be read on the 1000-volt range. Therefore, the operator need not constantly shift back and forth between ranges when reading close to the normal upper limit of a range.

Transistorized Logic and Drive Circuit: The V-45 DVM uses construction techniques representing the latest state-of-the-art, with all-transistorized circuitry driving reliable stepping switches.

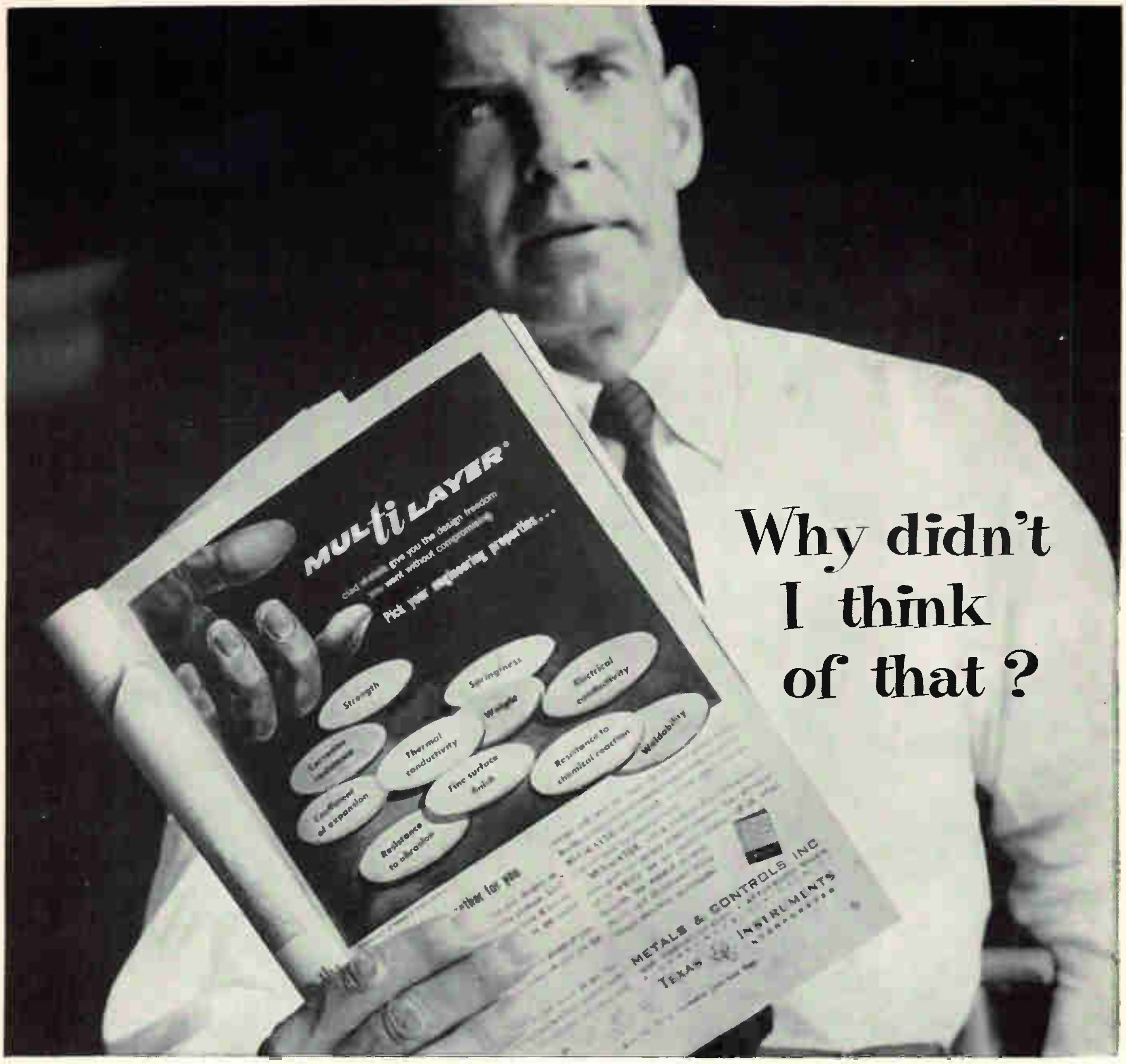
Cubic manufactures a complete line of quality digital instruments, including a-c and d-c voltmeters, ohmmeters, ratiometers, scanners and printer controls. Write for literature to Dept. E-110, Industrial Division, Cubic Corporation, San Diego 11, California.

SPECIFICATIONS

MODEL V-45 DIGITAL VOLTMETER

Input Impedance: 10 megohms at balance.
Ranges: Manually selected, 10% extended range
Low ±0.000 to ±10.999 vdc
Mid ±00.00 to ±109.99 vdc
High ±000.0 to ±1099.9 vdc
Sensitivity: 1 millivolt
Sensitivity Control: Continuously variable from 1 digit to standby lockout.
Power Input: 105-125 vac, 50-60 cps, 25 watts standby, 30 watts operating.
Dimensions: 19″ wide, 5¼″ high, 14″ deep, rack or bench mounting with dust-proof switch and bridge section.
Average Balancing Time: Less than 2 sec.

cubic CORPORATION



MULtiLAYER* Clad Metals Combine The Exact Operating Properties I Must Have.

This design engineer has just realized a fact we wish more people would discover. MULtiLAYER CLAD METALS PROVIDE MORE COMBINATIONS OF OPERATING CHARACTERISTICS THAN ANY SINGLE MATERIAL OR ALLOY.

If you need a spring with high conductivity, superior elastic properties. high temperature strength and easy weldability, no single spring alloy can satisfy all the requirements. MULtiLAYER clad spring metals can!

If a tube for chemical processing must have a clean, corrosion resistant, stainless steel surface, high thermo conductivity, plus high forming ductility for flaring and bending; no single material can satisfy all these requirements. MULtiLAYER clad tubing can!

Therefore, why compromise? Why be limited to only partial reliability in your components when, with MULtiLAYER clad metals, you can get maximum satisfaction?

You specify the engineering properties you need . . . we'll put the metals together for you — and even make the components in many cases. Find out about this modern design material. Call us or write for our illustrated brochure GP-1.

For materials and components come to Metals & Controls

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METALS & CONTROLS INC.
1310 FOREST ST. • ATTLEBORO, MASS.
A CORPORATE DIVISION OF
TEXAS INSTRUMENTS
INCORPORATED

Ordnance Department at Pittsfield, Mass., where it will be used to test wire wrap assemblies of the Polaris weapons system. The test system can handle up to 10,000 terminations, and will complete a test in less than 90 minutes. If done manually, the operation would require 500,000,000 separate tests, and would take approximately six man-months.

The system is punch-tape programmed in ordinary use but is also self-programming when an unknown wiring assembly is to be tested. The system can also test high potential leakage of wiring harnesses for aircraft and missiles and cables between silos on hardened missile sites.

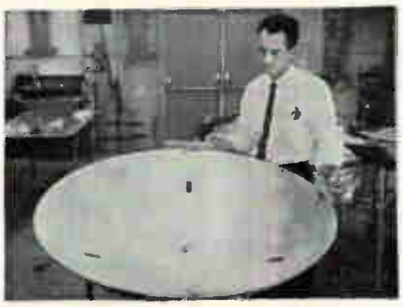
Automatic continuity tester checks wire-wrap assemblies for Polaris

Aluminum Foil for Reflector

Aluminum foil bubble, formed at 400 F by compressed air, is placed on mold, in an early step in making the antenna reflector

Preformed honeycomb is placed on the plastic covered foil, providing the structure with strength and rigidity

Foil reflector surface, 0.002 inch thick, is made ready



Completed structure is a highly accurate parabolic reflector

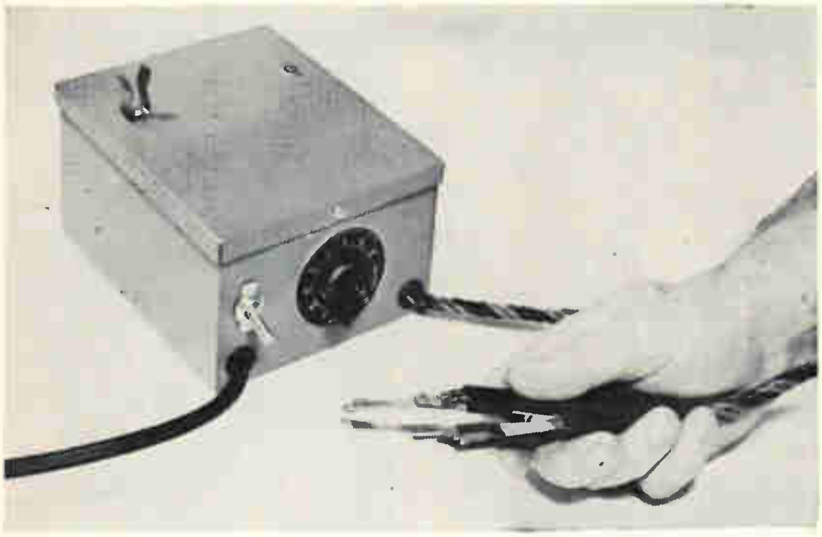
ALUMINUM foil is being used in the manufacture of reflectors for antennas.

The antenna for the Bell Automatic Landing System operates at such high frequencies that the reflecting surface could not be made of glamour cloth, a material often used for antenna reflectors. The spray metal technique, used when a metal surface is required, was not entirely satisfactory with respect to conductivity and adhesion. In this technique metal is sprayed onto a mold, then built up with plastic backing.

An alternative method using aluminum foil has been developed by Dalmo Victor Co., Belmont, California. The method produces an accurate parabolic reflector that can be used at high frequencies.

The foil for the reflector surface, 0.002 inch thick, is clamped between rings and heated to 400 F. Compressed air is used to force the foil into a bubble, and the bubble is then stretch-formed over a mold. Plastic is applied over the back of the bubble and cured. Then a preformed aluminum honeycomb structure is added as shown above.

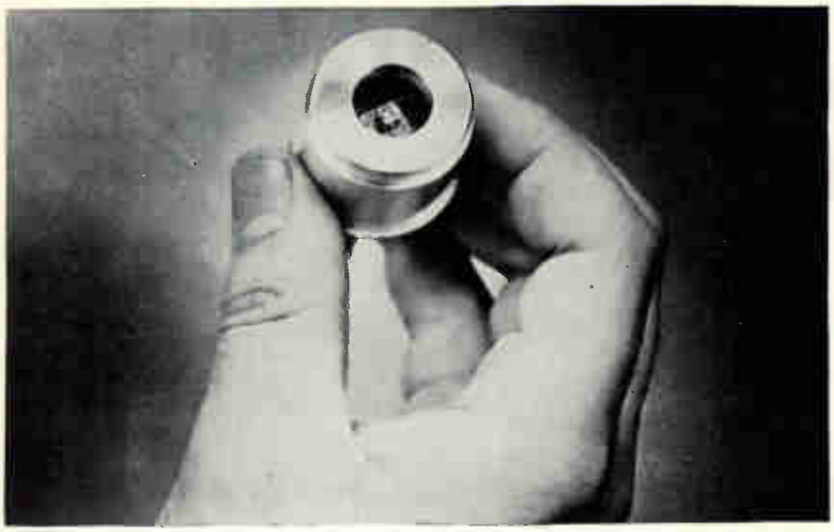
New On The Market



Miniature Thermal Wire Stripper
VARIABLE HEAT CONTROL

WESTERN ELECTRONIC PRODUCTS Co., 2420 N. Lake Ave., Altadena, Calif. Model G-1 Tiny-Therm is designed for stripping insulation from small-gage wire in restricted space. It strips Teflon and other high-temperature insulation as well as lower-melting materials such as vinyl, polyethylene, and the like. It is recommended for use on wire gages from No. 16 to No. 40 or smaller without any adjustment. Pincers-type heated filaments permit grasping the wire to sever insulation and then pulling to remove insulation.

CIRCLE 301 ON READER SERVICE CARD



Infrared Detector
THERMOELECTRICALLY COOLED

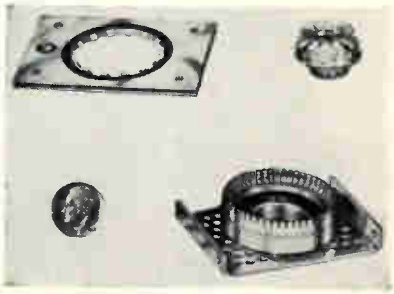
RADIATION ELECTRONICS CO., 5600 Jarvis Ave., Chicago 48, Ill. An efficient, low current thermoelectric (Peltier) cooler has been coupled to a photoconductive indium antimonide (InSb) element to provide high detectivity in the 1 to 6 micron spectral region without complex gas or liquid cooling systems. Operating temperature is approximately −78 C. Unit offers performance compatible with military and industrial environments and applications.

CIRCLE 302 ON READER SERVICE CARD

Laser Material
NEW OUTPUT WAVELENGTH

SEMI-ELEMENTS INC., Saxonburg Blvd., Saxonburg, Pa. Barium fluoride doped with uranium has an output wavelength of 26,000 angstroms which makes it an excellent infrared laser material. The crystals are priced at $150 per inch of length in [illegible] in. diameters and are available up to 1½ in. to 1¾ in. in length. Fabricated, finished and ready to use laser crystals are priced at $595.

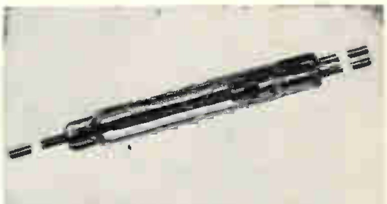
CIRCLE 303 ON READER SERVICE CARD



UHF Capacitors
BY-PASS & COUPLING

ERIE RESISTOR CORP., 644 W. 12th St., Erie, Pa., has developed uhf by-pass and coupling capacitors with short lead lengths and low inductance to be used with ceramic and glass seal concentric ring termination vacuum tubes. The custom-designed units have working voltages varying from 350 vdcw to 500 vdcw. Nominal capacitance range is 100 pf to 5,000 pf.

CIRCLE 304 ON READER SERVICE CARD



Magnetic Switches
LONG LIFE UNITS

HAMLIN, INC., Lake Mills, Wisc. The DRG-DT and DRG-DTH series provide a thoroughly reli-

Big volume of engineering prints? Put Ozalid's new Printmaster 900 to work. This new, heavy-duty whiteprinter is a workhorse for capacity, a thoroughbred for quality, a favorite for economy.

Fast! Top speeds up to 75 feet per minute. Versatile ... processes any dry diazo material up to 42" wide without sticking. Develops both sides in one pass! Unique ... new, sleeveless, scratch-proof developing and simplified control make it top performer in its price class.

Here, in truth, is a new concept in whiteprinting. New ideas, new designs from the leader in the industry that spell new efficiency, reliability, economy in engineering reproduction.

The coupon will bring you the facts on Ozalid's new "900". Facts that may save you thousands yearly. Mail it today.

OZALID®

Division of General Aniline & Film Corporation, Johnson City, New York

REMEMBER, FOR PEAK EFFICIENCY, ALL OZALID WHITEPRINTERS WORK BEST WITH OZALID SENSITIZED MATERIALS

Mr. James A. Travis, Mgr., Marketing
Ozalid, Dept. 187 Johnson City, New York

Please send information on New Printmaster 900.

Name________________

Firm________________

Address________________

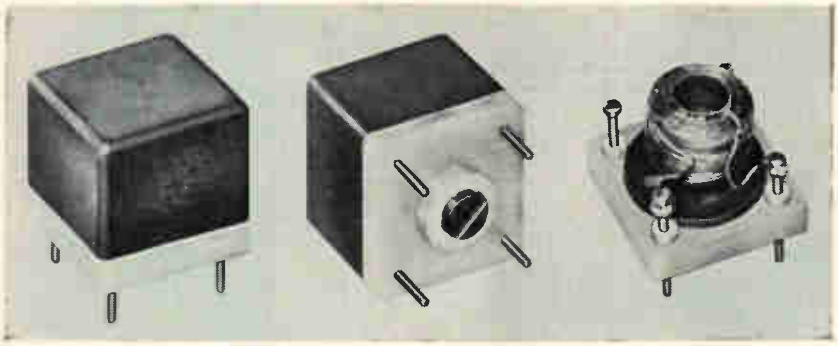
City________________

able source of a normally closed reed switch without requiring biasing the switch with magnets and remove the potential source of troublesome problems, such as shielding, loss of strength, etc. Eliminating biasing magnets also reduces the space requirements for compact component assemblies. Contact arrangement: spdt-form C. Contact resistance: 25 to 40 milliohms.

CIRCLE 305 ON READER SERVICE CARD

non-locking and locking types. Mounts on 5/8 in. centers in panels up to 3/16 in. thick.

CIRCLE 309 ON READER SERVICE CARD

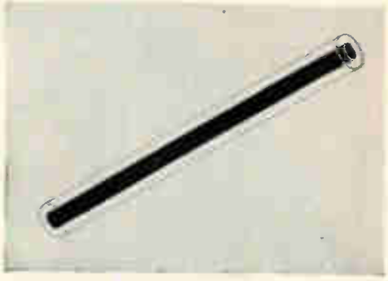


Variable Coil Forms

COMPLETELY SHIELDED

MICROMETALS, 72 E. Montecito Ave., Sierra Madre, Calif., has developed L52 coil forms. Their efficient use of space and the ease with which they can be assembled make them ideal for many p-c applications. They are available from stock in four grades of iron powder for use from 50 Kc to 150 Mc. Assemblies are 17/32 in. sq by 1/2 in. high and are available with a 9/16 in. sq can. Winding space is 0.437 in. diameter by 0.200 in. long.

CIRCLE 306 ON READER SERVICE CARD

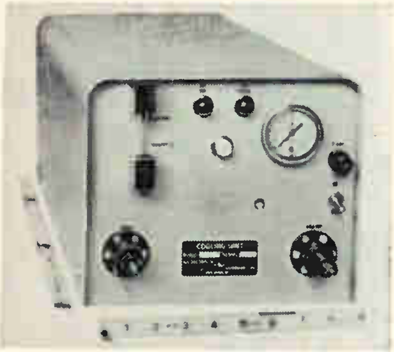


Ruby Rod

SAPPHIRE OVERLAY

VALPEY CRYSTAL CORP., 1244 Highland St., Holliston, Mass., announces a ruby rod with sapphire overlay, exhibiting improved characteristics which are expected to put the ruby optical maser another step closer to continuous wave operation. The rod offers increased capture cross section for greater efficiency. It also has increased conduction cooling area, providing more cooling of the rod to allow operation at lower threshold levels.

CIRCLE 310 ON READER SERVICE CARD



Transistor Heat Sink

LIQUID-COOLED

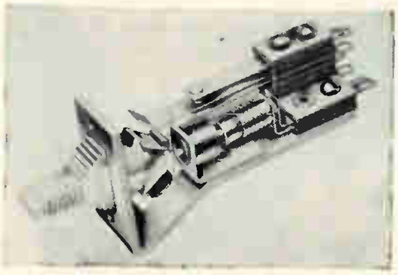
ELECTRO IMPULSE LABORATORY, INC., 208 River St., Red Bank, N. J., announces a liquid-cooled transistor heat sink. Cooling unit dissipates 500 w of power in 1 sq ft of sink area. Temperature gradient is 0.04 C/w. At 500 w the heat sink temperature does not exceed 110 F with the ambient temperature at 75 F.

CIRCLE 307 ON READER SERVICE CARD

Header

EPOXY PRODUCTS DIVISION, Joseph Waldman & Sons, 137 Coit St., Irvington 11, N. J. Header design has a 6 deg tapered edge to provide a tight fit and prevent liquid encapsulant from leaking out of the case.

CIRCLE 308 ON READER SERVICE CARD



Lever Switch

ILLUMINATED

SWITCHCRAFT, INC., 5555 N. Elston Ave., Chicago 30, Ill. An illuminated lever switch, the Lever-Lite, is designed to color code switching positions and functions. One switch replaces an ordinary switch and up to three indicator lamps. Control panel costs and space requirements can be cut by at least 40 percent. It is available in 2 and 3 position,

Ceramic Tube

VOLTAGE-REGULATOR

GENERAL ELECTRIC CO., Schenectady 5, N. Y., has a ceramic voltage-regulator tube with vibration-proof mounting that maintains stable voltage throughout its entire ambient temperature range of −65 to 400 C. Voltage is held constant to within ±2 v. Type ZR-7501 operates at a design point of 103 v over a current range of 5 to 100 ma. Its d-c starting voltage is 150 v max.

CIRCLE 311 ON READER SERVICE CARD

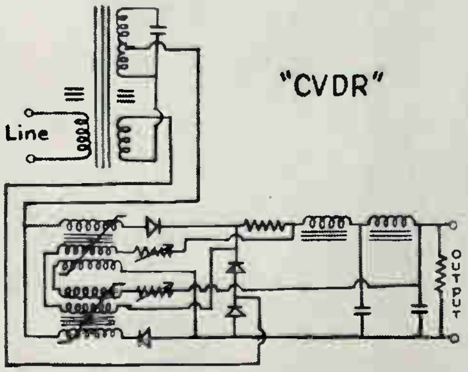
Amplifier Klystron

EITEL-MCCULLOUGH, INC., San Carlos, Calif. The X-841, designed to

calculated advantage

New SOLA "CVDR" d-c supply simplifies missile-age circuit design, reduces costs.

It's a natural for computers, communications equipment, and similarly sophisticated electronic gear. Made for today's stringent operating parameters. Ends costly dependence on over-engineered d-c power sources.



CVDR provides both line and load regulation without tubes or transistors. Line regulation ±1%, for ±15% line voltage changes; 1% load regulation from zero to full load; 1% peak to peak ripple. Fits 19" relay racks, and measures only 3½" high. Custom configurations and power ratings available on special order.

Line voltage stabilization is by means of the Sola "CV" self-regulating transformer. Load voltage stabilization is accomplished by the series "IX" voltage drop in the saturable reactor (see schematic). This voltage drop is controlled by the load current itself.

CVDR is ready right now, off-the-shelf, in units rated 6-volts, 10-amps . . . and 12, 18 or 24 volts, 5-amps. For outstanding reliability in a-c and d-c power supplies tailored to every application, see your SOLA representative . . . or write to address below.

SOLA ELECTRIC CO., 1717 Busse Road, Elk Grove Village, Ill., HEmpstead 9-2800

IN CANADA, Sola-Basic Products Ltd., 377 Evans Ave., Toronto 18, Ontario

SOLA

B P C

Division of Basic Products Corporation

provide pulse-power of 1.25 megawatt in long-range radar systems, has operated successfully at 2.5 megawatt peak power at 6 percent duty.

CIRCLE 312 ON READER SERVICE CARD

Power Supplies
HEAVY DUTY

ATLAS TRANSFORMER CO., 1839 Moore St., San Diego 1, Calif. The P-132 series of heavy duty 28 v d-c regulated power supplies are designed for relay control circuitry. They are available in various current ratings: 25 amp, 50 amp or 100 amp.

CIRCLE 313 ON READER SERVICE CARD

Detector-Preamplifier
INFRARED

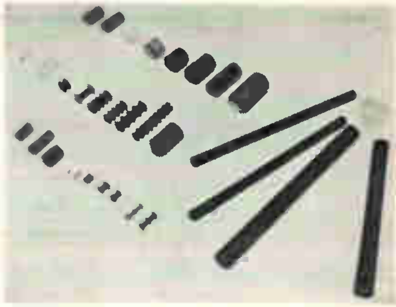
MINNEAPOLIS-HONEYWELL REGULATOR CO., 1915 Armacost Ave., Los Angeles 25, Calif., announces a photo-electro-magnetic InSb IR detector combined with integrally-mounted very low noise preamplifier. It features in one rugged uncooled unit: high responsivity, long wavelength detectivity (7μ), frequency response of 300 cps to 20 Kc, 30 mw power consumption, and compactness (5.7 oz).

CIRCLE 314 ON READER SERVICE CARD

Breadboarding Kit

PRECISION METAL PRODUCTS CO., 41 Elm St., Stoneham, Mass. Construction set enables designer to complete prototypes without using any power tools except a soldering iron.

CIRCLE 315 ON READER SERVICE CARD



Cast Epoxy Rod

FOR WINDING FORMS

BOONTON MOLDING CORP., Boonton, N. J., can supply cast epoxy rod formulated to meet the most rigid specifications when used for precision wirewound resistors under MIL-R-93B. The BMC 2000 series is available in standard colors and diameters. Material is distinguished by its high volume resistivity at high temperatures—0.19 $\times 10^{16}$ at 180 C, and also by its high heat distortion—133 C at 264 psi.

CIRCLE 316 ON READER SERVICE CARD

Transducer

ALLEGANY INSTRUMENT CO., 1091 Wills Mountain, Cumberland, Md. Model 342 precise universal force transducer meets the requirements of rocket and missile testing.

CIRCLE 317 ON READER SERVICE CARD

Bar Solder

CUTS REJECTS

ALPHA METALS, INC., 56 Water St., Jersey City 4, N. J., announces a bar solder that has been effective in cutting p-c joint rejects from 8 in 400 to 1 in 5,000. The oxide-free Alpha Vaculoy bar solder (shown at right) cuts dross, increases bath life, reduces inherent inclusions, improves wetting and produces brighter joints. It comes in standard 1 lb bars, or 9 lb ingots for automatic soldering machines.

CIRCLE 318 ON READER SERVICE CARD

THERMISTOR MOUNTS broadband. General Microwave Corp., 47 Gazza Blvd., Farmingdale, N. Y. (319)

MAGNETIC COMPUTER TAPE heavy duty. Computron, Inc., 122 Calvary St., Waltham, Mass. (320)

ULTRASONIC CLEANER pint-sized, low cost. Ultrasonic Industries, Inc., Ames Court, Engineer's Hill, Plainview, N. Y. (321)

SILICON COMPUTER DIODES high speed switching. Microwave Associates, Inc., South Ave., Burlington, Mass. (322)

TV MONITOR transistorized, dual display. RMS Associates, Inc., 805 Mamaroneck Ave., Mamaroneck, N. Y. (323)

TORQUE RECORDER automatic. Baldwin-Lima-Hamilton Corp., 42—4th Ave., Waltham 54, Mass. (324)

D-C AMMETER, clip-on type. Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif. (325)

CIRCUIT TEMPLATE with semiconductor symbols. Quintec Instrument Co., Box 85, Altadena, Cal. (326)

BINARY COUNTER MODULES semi-miniature. Walkirt Co., 141 W. Hazel St., Inglewood, Calif. (327)

PARAMETRIC AMPLIFIER small lightweight. Lel Inc., Akron St., Copiague, L. I., N. Y. (328)

TIME DELAY RELAY solid state. Guardian Electric Mfg. Co. of California, Inc., 5575 Camille Ave., Culver City, Calif. (329)

DIGITAL VOLTMETER with four digits plus sign. Telecomputing Corp., 9229 Sunset Blvd., Los Angeles 46, Calif. (330)

STATIC FREQUENCY CHANGER 10 Kva, 3 phase. American Electronics, Inc., 1598 E. Ross Ave., Fullerton, Calif. (331)

PRESSURE TRANSDUCER high frequency response. Taber Instrument Corp., 107 Goundry St., North Tonawanda, N. Y. (332)

ANTENNA MOUNT low weight. Temec, Inc., 7833 Haskell Ave., Van Nuys, Calif. (333)

Literature of the Week

CHASSIS SLIDES Leichner Mfg. Co., 1510 N. Neil St., Champaign, Ill. Bulletin describes Chassi-Slides for use with any standard rack or cabinet. (334)

C-C TV Fairbanks, Morse & Co., 100 Electra Lane, Yonkers, N. Y., has published a brochure entitled "Closed Circuit TV—New Eyes For Science and Industry." (335)

PNPN DEVICE Tung-Sol Electric Inc., 1 Summer Ave., Newark, 4, N. J., has released a brochure on the Dynaquad—a four layer semiconductor. (336)

SEMICONDUCTOR PACKAGE Corning Glass Works, Corning, N. Y. Bulletin describes a microminiature semiconductor package made of glass. (337)

PULSE COMPRESSION NETWORKS Ortho Industries Inc., 7 Paterson St., Paterson 1, N. J. Catalog page describes pulse compression networks (Chirp radar). (338)

POLYMERS Marbon Chemical Division of Borg-Warner Corp., Washington, W. Va. Catalog covers nine major grades of Cycolac brand polymers. (339)

CORONA TESTING Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill. Bulletin contains data on corona test sets, detectors and pickup networks. (340)

POWER SUPPLIES Valor Instruments, Inc., 13214 Crenshaw Blvd., Gardena, Calif. A catalog describes a line of high efficiency d-c power supplies. (341)

COMPUTING SYSTEM Bendix Computer Division, 5630 Arbor Vitae St., Los Angeles 45, Calif., has available a six-page brochure on the G-20 high-speed computing system. (342)

SEMICONDUCTOR MANUFACTURE Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y. A booklet describes the manufacture of semiconductor devices. (343)

INSULATION MATERIAL Johns-Manville, 22 E. 40th St., New York 16, N. Y. Bulletin EL-65A describes a high dielectric sealing compound. (344)

POLYCARBONATE RESIN General Electric Co., Pittsfield, Mass. Brochure discusses the advantages of Lexan polycarbonate resin for components. (345)

STRESS - STRAIN GAGE Baldwin-Lima-Hamilton Corp., Waltham, Mass. Product data sheet describes a bonded-resistance foil-type stress-strain gage. (346)

MICROMINIATURE CONNECTORS Continental Connectors Corp., Woodside 77, N.Y. Six-page brochure covers the series MM22 precision microminiature connectors. (347)

IMPULSE TRANSMITTERS Landis & Gyr, Inc., 45 W. 45th St., New York 36, N.Y. Folder describes five different basic Sodeco impulse transmitters. (348)

RETENTION/COOLING DEVICES The Birtcher Corp./Industrial Division, 745 S. Monterey Pass Rd., Monterey Park, Calif. Catalog lists a line of retention/cooling devices for tubes, transistors and components. (349)

INSTRUMENTATION C. L. Berger & Sons, Inc., 37 Williams St., Boston, Mass. Booklet discusses the availability of facilities for the production of critical elements of instrumentation. (350)

PHOTO-OPTICS Consolidated Systems Corp., 1725 South Peck Road, Monrovia, Calif. Brochure describes the facilities and products of the company's Photo-Optical division. (351)

TRANSISTORS Texas Instruments Inc., P. O. Box 5012, Dallas 22, Texas, offers 10 transistor product data sheets to bring TI technical literature files up to date. (352)

REINFORCED PLASTIC Taylor Fibre Co., Norristown, Pa. Properties for an asbestos-base reinforced plastic are given in bulletin 8.5. (353)

MICROWAVE CHAMBERS Emerson & Cuming, Inc., Canton, Mass., offers a standard microwave chambers catalog and price list. (354)

PULSE INSTRUMENTATION Servo Corp. of America, 111 New South Road, Hicksville, L. I., N. Y., offers a short form catalog on E-P line of pulse instrumentation. (355)

INLAND

Standard DC Torquers available in the widest range of sizes and capacities

Silent, gearless, Inland DC pancake torque motors have high torque-to-inertia ratios and excellent linearity throughout the torque range. They provide an exceptional degree of accuracy for direct-drive servo positioning, while eliminating problems of backlash, windup, and compliance.

Inland's complete line of DC torquers serves in such varied applications as: missile and aircraft stable platforms, radar tracking antenna, space vehicle reaction wheel drive, rate table drives, rotary solenoids for missile arming systems, and special machine tool applications—just to name a few.

For systems duty with Inland torque motors, a line of rotary and solid state amplifiers is also available. All Inland products are backed by extensive experience . . . thorough quality control, reliability, and field testing . . . successful performance in practically every major missile and space vehicle program. For details, complete specifications, and illustrated brochure, write Department— 1210

Standard Model Specification Range
from smallest to largest torque motors*

FRAME SIZE	1.3 INCHES	36.0 INCHES
Peak torque, lb.-ft.	0.1	3000
Volts at peak torque, stalled at 25°C	48	246
Amps at peak torque	1.21	30
Sensitivity, lb.-ft./amp	.09	100
Temperature rise per watt, ultimate, °C	13.4	0.04
Total friction, lb.-ft.	0.003	18
Ripple torque, pound-feet		
At low torque levels	0	0
At peak torque	0.1	trace
Weight, lbs.	0.313	1200

*Numerous sizes available in between. Non-Standard sizes designed to meet specific requirements in these ranges and larger.

INLAND MOTOR

CORPORATION OF VIRGINIA
A SUBSIDIARY OF
KOLLMORGEN CORP.
NORTHAMPTON, MASS.

Craig: growth potential counts

WHEN an electronics consultant with 35 years experience chooses a full-time corporate home, he selects (if he's like Palmer Hunt Craig) a medium-sized firm with strong growth potential.

Craig recently joined Airpax Electronics Inc. (1960 sales, $4.1 million) on a full time basis, after serving as consultant to several firms including Airpax. Holder of more than 40 patents on his electrical and electronic inventions, he is director of research at the Airpax headquarters in Fort Lauderdale, and a right-hand aide to Herbert A. Cook, the firm's president.

Craig believes that full electronic potential is just beginning to unfold. His current process of insecticide detoxification illustrates the point. Basically a chemical engineering process for reducing toxicity without dilution, its key rests with electronics.

An electronic meter, invented by Craig, precisely monitors the percentage of oxidation taking place within the process, permitting continual and controlled manufacture of powerful insecticides safe to human beings. Other Craig inventions include an ultraviolet lamp, a photoelectric tube called Photodyne, a means for cooling glass-walled bodies, and a television system.

Palmer Craig may be best known for supervising development of the proximity fuse of World War II.

He has also devoted a large part of his career to teaching. For five years before the war, he taught hundreds of engineers attending the University of Florida. They benefited from Craig's triple preparedness (Ph.D., University of Cincinnati, 1926) in physics, electrical engineering and mathematics. Following the war, at the University of Miami, he served as professor of engineering and director of the university's electronics research.

More recently, Craig completed an educational-political mission under the auspices of the U. S. Department of State. As a member of the Technical Cooperation Mission, and the leader of the American Delegation to the Indian Science Congress, he lectured at Indian universities over a two-year period. He was received during this experience by Prime Minister Nehru, and by the president and the vice president of India.

Despite his long experience in business, including consulting work for the Peninsular Telephone Co., Tampa; the Clark Controller Co., Cleveland; and the Roller-Smith Co., Bethlehem, Pa., Palmer Craig retains an absorbing interest in the welfare and development of students. Asked in a recent interview what he considered science's primary responsibility today, he immediately answered, "Youth." He added, "You know, young people in science today have a far greater task at hand than any of us who started in the twenties ever had."

GPE Elects Taylor As Board Member

ELECTION of Philip B. Taylor, formerly Assistant Secretary of the Air Force for Materiel, to the board of directors of General Precision Equipment Corp. is announced.

Prior to taking his government post in 1959, Taylor was a management consultant specializing in the engineering and construction fields.

GPE is a manufacturer of electronic equipment whose products are used on space vehicles, satellites, missiles and aircraft.

Sylvania Appoints Carl Faflick

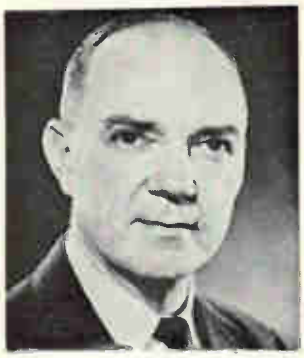
APPOINTMENT of Carl E. Faflick as senior staff specialist-systems for Sylvania Electronic Systems, a division of Sylvania Electric Products

Inc., Waltham, Mass., has been announced. He was previously manager of the microwave and antenna laboratory at Sylvania's Waltham Laboratories.

George Dacey Joins Sandia Corporation

GEORGE C. DACEY recently became vice president, research at Sandia Corp., Albuquerque, N. M. He was formerly director of solid state electronics research at Bell Telephone Laboratories in Murray Hill, N. J.

Sandia Corp. is a wholly-owned subsidiary of Western Electric Co.



Wilcox Electric Names Bullock

COL. E. T. BULLOCK, U. S. Army (Ret.), has joined the Wilcox Electric Co., Inc., Kansas City, Mo., as director of military program planning.

Bullock's professional service encompasses 35 years of military and industrial experience. He has been affiliated with Southern Bell Telephone & Telegraph Co., and prior to coming to Wilcox, with the Cook Electric Co., Chicago, Ill.

CEC Announces Three Promotions

THREE major promotions within the Data Recording division of Consolidated Electrodynamics Corp. have been announced by Henry S. Black, division general manager.

John J. Smith and Edgar E. Hotchkin were appointed assistant directors of engineering and Lewis B. Browder was named manager of advanced development. All three men will report to Herbert I. Chambers, director of engineering for the division.

Metex Electronics Appoints Cohen

METEX ELECTRONICS CORP., Clark, N. J., manufacturer of r-f engineered shielding, announces the appointment of Albert H. Cohen as vice president and chief operating officer.

Before coming to Metex, Cohen spent a year in charge of analysis and research of electronic and electrical materials at General Cable Corp. Later with Metal Textile Corp., a General Cable division, he was appointed product manager in charge of sales, development and engineering on various mesh products and r-f shielding materials.

Honeywell Division Hires Maislinger

JOHN MAISLINGER has been appointed chief development engineer for Minneapolis-Honeywell's Precision Meter division.

He had previously been chief engineer for International Instruments, Inc., West Haven, Conn.

In his new position, Maislinger will be responsible for the development of new or improved meters and indicating instruments for aircraft, industrial and other applications.

Schuller Advances At CBS Laboratories

MAX J. SCHULLER has been promoted to manager of the semiconductor device development section, solid state physics branch, CBS Laboratories, Stamford, Conn.

Schuller joined CBS Laboratories a year ago. Prior to that he was associated with the U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N. J., where he specialized in semiconductor device design and circuit theory.

Air Reduction Sales Promotes Rendos

J. J. RENDOS has been appointed assistant manager of Air Reduction Sales Company's Cryogenic Engineering department in Plainfield, N. J. He will assist W. B. Moen, department manager, in operations covering the design and construction of major air separation and other related cryogenic facilities.

Prior to this appointment, Rendos was supervisor of process and equipment design.

Fred Carlson Takes New Post

FRED CARLSON recently moved up from test engineer to senior reliability engineer for the reliability engineering department at International Resistance Co.'s St. Petersburg, Fla., division.

St. Petersburg produces a wide line of precision potentiometers, including subminiature, metal-clad, multiturn, single-turn, hermetically sealed and other types.

PEOPLE IN BRIEF

Robert T. Adams, formerly with ITT Federal Laboratories, has joined the scientific staff of Sichak Associates. **K. O. William Sandberg** leaves Norton Laboratories, Inc., to become assistant to the v-p and manager of the Aero-space-Rockets Div. of Bell Aerosystems Co. **James W. Hart,** ex-Motorola, named manager of the microwave division of Mark Products. **Mille Stand,** previously with the Venture Corp., appointed director of research at Sealectro Corp. **J. V. Naish,** formerly with General Dynamics, elected a director of McDonnell Aircraft. **Sidney Stark** promoted to director, advanced systems, at Martin-Orlando. **R. M. Knoop** transfers from P. R. Mallory & Co. Inc. to works manager of Mallory Capacitor Co. **Luis E. Benitez** advances to asst. g-m at the ordnance operation of Avco Corp.'s Electronics and Ordnance div. **Rod E. Packer,** until recently with General Dynamics, is now a member of the technical staff of Ramo-Wooldridge. **William S. Dennis, Jr.,** of Consolidated Electrodynamics Corp., takes new post as manager of quality control engineering for the data recorders division. **Don M. Marshall,** former vice president of the Jerome Murray Corp., is chosen as president and chief executive officer of Bogue Electric Mfg. Co.

LEGAL NOTICE

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, JULY 2, 1946 AND JUNE 11, 1960 (74 Stat. 208) SHOWING THE OWNERSHIP, MANAGEMENT AND CIRCULATION

Of ELECTRONICS, published weekly at Albany, New York for October 1, 1961

1. The names and addresses of the publisher, editor, managing editor, and business manager are: Published by McGraw-Hill Publishing Company, Inc., 330 West 42nd St., New York 36, N. Y.; Editor, W. W. MacDonald, 330 West 42nd St., New York 36, N. Y.; Managing editor, J. M. Carroll, 330 West 42nd St., New York 36, N. Y.; Business manager R. S. Quint, 330 West 42nd St., New York 36, N. Y.

2. The owner is McGraw-Hill Publishing Company, Inc., 330 West 42nd St., New York 36, N. Y. Stockholders holding 1% or more of stock are: Donald C. McGraw, Elizabeth McGraw Webster, Donald C. McGraw, Jr. & Harold W. McGraw, Jr., Trustees under Indenture of Trust m/b James H. McGraw, dated 1/14/21 as modified; Donald C. McGraw & Harold W. McGraw, Trustees under an Indenture of Trust m/b James H. McGraw, dated 7/1/37 as amended; Donald C. McGraw, individually; Estate of Mildred W. McGraw, Donald C. McGraw and Catharine McGraw Rock, Executors; (all of 330 West 42nd Street, New York 36, N. Y.); Grace W. Mehren, 536 Arenas St., LaJolla, California; Douglass & Co., 140 Broadway, New York, N. Y., Touchstone & Co., c/o Wellington Fund, Inc., Claymont, Delaware.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: 53,464.

McGRAW-HILL PUBLISHING COMPANY, INC.

By JOHN J. COOKE, Vice President & Secretary.

Sworn to and subscribed before me this 18th day of September, 1961.

[SEAL] JANET A. HARTWICK.

(My commission expires March 30, 1963)

EMPLOYMENT OPPORTUNITIES

electronics

WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

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

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

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WHAT TO DO

1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
4. Circle the corresponding key number below the Qualification Form.
5. Fill out the form completely. *Please print clearly*.
6. Mail to: 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 Electronics Div. of General Motors Corp. Milwaukee, Wisconsin	99	1
ERIE ELECTRONICS DIV. Erie Resistor Corp. Erie, Pennsylvania	134*	2
ESQUIRE PERSONNEL Chicago, Illinois	106	3
IBM DEVELOPMENT LABORATORY Poughkeepsie, New York	105	4
LAWRENCE RADIATION LAB. University of California Livermore, California	105	5
LOCKHEED CALIFORNIA CO. A Div. of Lockheed Aircraft Corp. Burbank, California	49*	6
MITRE CORPORATION Bedford, Massachusetts	129*	7
MOTOROLA INC. Military Electronics Div. Western Center Scottsdale, Arizona	105	8
SIKORSKY AIRCRAFT Div. of United Aircraft Corp. Stratford, Connecticut	133*	9

* These advertisements appeared in the 10/6/61 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) 1061

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

CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

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

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

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250 KW X-Band. 60 & 120 mile ranges to 60,000 feet. Complete.

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rec. GE Model 4ER21A1
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Bids for the above will be received in the Purchasing Division, 12 Broad Street, Red Bank, New Jersey on October 30, 1961 at ten o'clock (10:00 A.M.) Daylight Saving Time and will be opened immediately thereafter.

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(Continued from preceding page)

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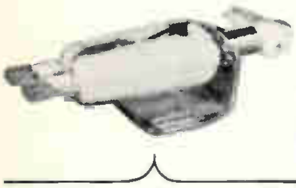

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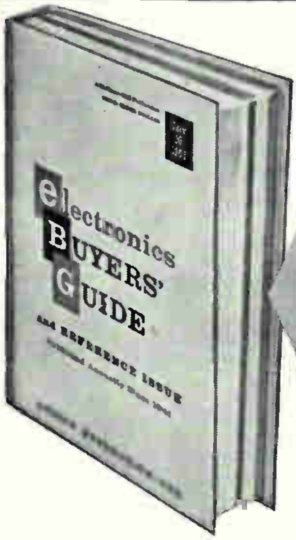

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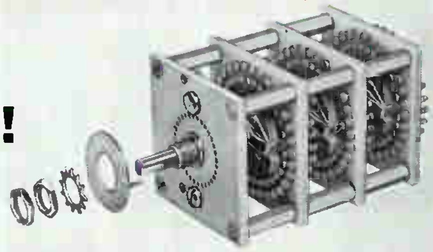

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RMS Supply Volts	840	1400	2100	2800	3500	4200	4900	5600	6300	7000
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Peak Recurrent Amperes	← 5 →									
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